INCAS - National Institute for Aerospace Research "Elie Carafoli"
(under the aegis of The Romanian Academy)

AEROSPATIAL 2012

Proceedings
of the International Conference of Aerospace Sciences
"AEROSPATIAL 2012"
11 - 12 October, 2012
Bucharest, Romania

BUCHAREST
2012

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of the International Conference of Aerospace Sciences
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AEROSPATIAL 2012

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Bucharest, 11-12 October, 2012

GRAPHIC PROGRAM

Hour	11 October 2012			Hour	12 October 2012		
$8.^{00} - 9.^{00}$	REGISTRATION *Coffee Break*			$8.^{00} - 9.^{00}$	REGISTRATION *Coffee Break*		
$9.^{00} - 9.^{30}$	OPENING SESSIONS			$9.^{00} - 9.^{30}$	Plenary lecture – Jacques Mandle		
$9.^{30} - 10.^{00}$	Plenary lecture – Olivier Pironneau			$9.^{30} - 10.^{00}$	Plenary lecture – Ruxandra Botez		
$10.^{00} - 10.^{30}$	Plenary lecture – Dan Mateescu			$10.^{00} - 10.^{30}$	Plenary lecture – Adriana Nastase		
$10.^{30} - 11.^{00}$	*Coffee Break*			$10.^{30} - 11.^{00}$	*Coffee Break*		
$11.^{00} - 11.^{20}$	*S1.1.1*	*S2.1.1*	*S4.1.1*	$11.^{00} - 11.^{20}$	*S5.1.1*	*S9. W1*	*S8.4.1.1*
$11.^{20} - 11.^{40}$	*S1.1.2*	*S2.1.2*	*S4.1.2*	$11.^{20} - 11.^{40}$	*S5.1.2*		*S8.4.1.2*
$11.^{40} - 12.^{00}$	*S1.1.3*	*S2.1.3*	*S4.1.3*	$11.^{40} - 12.^{00}$	*S5.1.3*		*S8.5.1.1*
$12.^{00} - 12.^{20}$	*S1.1.4*	*S2.1.4*	*S4.1.4*	$12.^{00} - 12.^{20}$	*S5.1.4*		*S8.5.1.2*
$12.^{20} - 12.^{40}$	*S1.1.5*	*S2.1.5*	*S4.1.5*	$12.^{20} - 12.^{40}$	*S5.1.5*		*S8.5.1.3*
$12.^{40} - 13.^{00}$	*S1.1.6*	*S2.1.6*	*S4.1.6*	$12.^{40} - 13.^{00}$	*S5.1.6*		*S8.3.1.5*
$13.^{00} - 14.^{00}$	*Lunch*			$13.^{00} - 14.^{00}$	*Lunch*		
$14.^{00} - 14.^{30}$	Plenary lecture – Charles Hirsh			$14.^{00} - 14.^{20}$	*S3.2.1*	*S9. W2*	*S8.3.2.6*
$14.^{30} - 15.^{00}$	Plenary lecture – Heribert Bieler			$14.^{20} - 14.^{40}$	*S3.2.2*		*S8.3.2.7*
$15.^{00} - 15.^{30}$	*Coffee Break*			$14.^{40} - 15.^{00}$	*S3.2.3*		*S8.3.2.8*
$15.^{30} - 15.^{50}$	*S1.2.7*	*S8.1.2.1*	*S4.2.7*	$15.^{00} - 15.^{20}$	*S3.2.4*	*S6.2.4*	*S8.3.2.9*
$15.^{50} - 16.^{10}$	*S1.2.8*	*S8.1.2.2*	*S4.2.8*	$15.^{20} - 15.^{40}$	*S3.2.5*	*S6.2.5*	*S8.3.2.10*
$16.^{10} - 16.^{30}$	*S1.2.9*	*S8.3.2.1*	*S4.2.9*	$15.^{40} - 16.^{00}$		*S6.2.6*	
$16.^{30} - 17.^{00}$	*Coffee Break*			$16.^{00} - 16.^{30}$	*Q & A*		
$17.^{00} - 17.^{20}$	*S1.2.10*	*S8.3.2.2*	*S6.2.1*	$16.^{30}$	*CLOSING SESSIONS*		
$17.^{20} - 17.^{40}$	*S1.2.11*	*S8.3.2.3*	*S6.2.2*				
$17.^{40} - 18.^{00}$	*S1.2.12*	*S8.3.2.4*	*S6.2.3*				
$18.^{00} - 18.^{20}$			*S7.2.1*				
$19.^{00}$	*DINNER*						

S1 - Section 1. Aerodynamics
S2 - Section 2. Flight Mechanics and Systems Integration
S3 - Section 3. Astronautics and Astrophysics
S4 - Section 4. Materials and Structures
S5 - Section 5. Systems, Subsystems and Control in Aeronautics
S6 - Section 6. Experimental Investigations in Aerospace Sciences
S7 - Section 7. ATS and full automation ATM
S8. Section dedicated to Caius Iacob Centennial reffering to the following topics:
- 8.1 Basic methods in Fluid Mechanics
- 8.2 Equations of Mathematical Physics
- 8.3 Mathematical Modeling
- 8.4 Dynamical Systems
- 8.5 Technical Applications

S9. Special Sections:
W1 Workshop – “Dissemination event of the new Strategic Research and Innovation Agenda (SRIA)” by ACARE
W2 Workshop – "NASA Official Team Building Program - How to Build Mission Critical Social Infrastructures in Aerospace Organizations" (Romanian Space Agency)

🟦 “ELIE CARAFOLI” Amphitheatre

🟧 “Nicolae TIPEI” Amphitheatre

🟥 “Subsonic Tunnel” Conference room

Note: The works are published in the volume into sections, in order of their presentation at the conference.

CONFERENCE PROGRAM

Thursday 11.10.2012 – “ELIE CARAFOLI” Amphitheatre

Hour: **$8.^{00}$ - $9.^{00}$** **REGISTRATION**

Coffee Break

Hour: **$9.^{00}$ - $9.^{30}$** **OPENING SESSIONS**

Welcome speech:

– Catalin NAE, General Manager, INCAS
– “Caius Iacob” Centennial Award

PLENARY SESIONS

Chairman:

Catalin NAE

Hour: **$9.^{30}$ - $10.^{00}$**

PL 1 **Olivier PIRONNEAU** (Université Pierre et Marie Curie - Paris VI, LJLL, Paris, France), ***Optimal Shape Design for Airplane Aerodynamics***

Hour: **$10.^{00}$ - $10.^{30}$**

PL 2 **Dan MATEESCU** (McGill University, Montreal, Canada), ***ANALYSIS OF THE EFFECT OF GROUND PROXIMITY ON THE STEADY AND UNSTEADY FLOWS PAST AIRFOILS AT LOW REYNOLDS NUMBERS***

Hour: **$10.^{30}$ - $11.^{00}$**

Coffee Break

Thursday 11.10.2012 – “ELIE CARAFOLI” Amphitheatre

Section 1: Aerodynamics

Thursday 11.10.2012. Morning session

S1.1 **Chairman:**

Marius STOIA-DJESKA
Valentin BUTOESCU

Hour: **$11.^{00}$ - $11.^{20}$**

S1.1.1 ***The flow about a system of two wings of a cycloidal rotor,*** Valentin BUTOESCU (INCAS - National Institute for Aerospace Research “Elie Carafoli”, Bucharest, Romania).

Hour: **$11.^{20}$ - $11.^{40}$**

S1.1.2 ***Exergy analysis of a supersonic ramjet propulsion system,*** Sorin G. BELDIE, Virgil STANCIU (“POLITEHNICA” University of Bucharest, Department of Aerospace Sciences, Romania).

Hour: **$11.^{40}$ - $12.^{00}$**

S1.1.3 ***Study of sinusoidal chevrons use in reducing noise pollution on single flow hot jets,*** Grigore CICAN (“POLITEHNICA” University of Bucharest, Department of Aerospace Sciences, Romania).

Hour: **12.^{00} - 12.^{20}**

S1.1.4 ***A Numerical Investigation of the Stall-Delay for Horizontal Axis Wind Turbine,*** Florin FRUNZULICA ("POLITEHNICA" University of Bucharest, Department of Aerospace Sciences, Romania and "Gh. Mihoc-Caius Iacob" Institute of Statistical Methematics and Applied Matematics of Romanian Academy, Romania), Razvan MAHU (TENSOR S.R.L., Bucharest, Romania), Horia DUMITRESCU ("POLITEHNICA" University of Bucharest, Department of Aerospace Sciences).

Hour: **12.^{20} - 12.^{40}**

S1.1.5 ***Experimental investigation of aerodynamic parameters of iced airfoil,*** Masoud MIRZAEI, Alireza DOOSTMAHMOUDI, Gholamhosein POURYOUSSEFI (K. N. Toosi University of Technology, Tehran, Iran).

Hour: **12.^{40} - 13.^{00}**

S1.1.6 ***Applications of adjoint formulations in aerodynamics,*** Marius STOIA-DJESKA, ("POLITEHNICA" University of Bucharest, Department of Aerospace Sciences, Romania).

Hour: **13.^{00} - 14.^{00}**

Lunch

Thursday 11.10.2012 – "ELIE CARAFOLI" Amphitheatre

Thursday 11.10.2012. Afternoon session

PLENARY SESIONS

Chairman:

Catalin NAE

Hour: **14.^{00} - 14.^{30}**

PL 3 **Charles HIRSCH** (Vrije Universiteit Brussel Faculty of Applied Sciences, Department of Mechanical Engineering, Bruxelles,-Belgium), ***Current Challenges of Virtual Prototyping in Aeronautics***

Hour: **14.^{30} - 15.^{00}**

PL 4 **Heribert BIELER** (Airbus operation GmbH; Bremen, Germany), ***Active flow control. Overview of R&T activities in European projects***

Hour: **15.^{00} - 15.^{30}**

Coffee Break

Thursday 11.10.2012 – "ELIE CARAFOLI" Amphitheatre

Section 1: Aerodynamics

Thursday 11.10.2012. Afternoon session

S1.2 **Chairman:**

Adriana NASTASE
Horia DUMITRESCU
Florin FRUNZULICA

Hour: **15.^{30} - 15.^{50}**

S1.2.7 ***Theoretical performances of double Gurney Flap equipped the VAWTs,*** Ion MALAEL (COMOTI - National Research & Development Institute for Gas Turbines, Romania), Radu BOGATEANU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania), Horia DUMITRESCU ("Gh. Mihoc-Caius Iacob" Institute of Statistical Methematics and Applied Matematics of Romanian Academy, Romania).

Hour: **15.^{50} - 16.^{10}**

S1.2.8 ***Concept of a very light small LO strike-fighter plane,*** Mihai-Victor PRICOP (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$16.^{10}$ - $16.^{30}$**

S1.2.9 ***Numerical Investigations on the Coanda Effect in a Coanda Ejector,*** Alexandru DUMITRACHE ("Gh. Mihoc-Caius Iacob" Institute of Statistical Methematics and Applied Matematics of Romanian Academy, Romania), Florin FRUNZULICA ("POLITEHNICA" University of Bucharest, Department of Aerospace Sciences, Romania and "Gh. Mihoc-Caius Iacob" Institute of Statistical Methematics and Applied Matematics of Romanian Academy, Romania), Horia DUMITRESCU ("Gh. Mihoc-Caius Iacob" Institute of Statistical Methematics and Applied Matematics of Romanian Academy, Romania).

Hour: **$16.^{30}$ - $17.^{00}$**

` ***Coffee Break***

Hour: **$17.^{00}$ - $17.^{20}$**

S1.2.10 ***CFD-study regarding the Roughness-Based Transition Control,*** Bianca SZASZ ("POLITEHNICA" University of Bucharest, Department of Aerospace Sciences).

Hour: **$17.^{20}$ - $17.^{40}$**

S1.2.11 **Unsteady effects at the interface between impeller-vaned diffuser in a low pressure centrifugal compressor,** Sterian DANAILA ("POLITEHNICA" University of Bucharest, Faculty of Aerospace Engineering, Romania), Mihai Leonida NICULESCU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$17.^{40}$ - $18.^{00}$**

S1.2.12 ***Analytical and numerical analysis of interaction of synthetic jet actuator with boundary layer,*** Maria ALEXANDRESCU, Nicusor ALEXANDRESCU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$19.^{00}$**

DINNER

Thursday 11.10.2012 – "Nicolae TIPEI" Amphitheatre

Section 2: Flight Mechanics and Systems Integration

Thursday 11.10.2012. Morning session

S2.1 **Chairman:**
Cornel OPRISIU
Dan DUMITRIU
Achim IONITA

Hour: **$11.^{00}$ - $11.^{20}$**
S2.1.1 **PIO (Pilot Induced Oscillation) Criteria for Rotorcraft Pilot Coupling (RPC) in roll axis investigation,** Andreea AFLOARE, Achim IONITA (STRAERO - Institute for Theoretical and Experimental Analysis of Aeronautical Structures, Bucharest, Romania).

Hour: **$11.^{20}$ - $11.^{40}$**
S2.1.2 **The workflow for an airplane structure aeroelastic analysis. Flight loads transfer from a CFD XFLOW simulation to a MSC PATRAN MODEL,** Mircea BOCIOAGA (Magic-Engineering, Brasov, Romania).

Hour: **$11.^{40}$ - $12.^{00}$**
S2.1.3 **Scale effect on the aircraft dynamic stability, consistent similarity aproches,** Stefan BOGOS, Catalin NAE, Cornelia NITA (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$12.^{00}$ - $12.^{20}$**
S2.1.4 **Simulations of optimal trajectories of missiles in the pitch plane,** Dan DUMITRIU (Institute of Solid Mechanics of the Romanian Academy, Bucharest, Romania).

Hour: **$12.^{20}$ - $12.^{40}$**
S2.1.5 **CONTRIBUTION TO THE UNDERSTANDING OF AIRCRAFT FLIGHT EVENTS,** Cornel OPRISIU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania), Nicolae APOSTOLESCU, Constantin OLIVOTTO, Simion TATARU (AEROSPACE CONSULTING Bucharest, Romania).

Hour: **$12.^{40}$ - $13.^{00}$**
S2.1.6 **Advanced Solution for Double-Flutter Air-car,** Constantin SANDU (Turbomecanica, Bucharest, Romania), Dan BRASOVEANU (Computer Science Corporation, Washington, USA).

Hour: **$13.^{00}$ - $14.^{00}$**
Lunch

Thursday 11.10.2012 – "Nicolae TIPEI" Amphitheatre

Section 8. Section dedicated to Caius Iacob Centennial

S8.1. Basic methods in Fluid Mechanics

Thursday 11.10.2012. Afternoon session

*S8.1***.** **Chairman:**

Constantin POPA
Gheorghe JUNCU
Stelian ION

Hour: **$15.^{30}$ - $15.^{50}$**

S8.1.2.1 **A detailed laminar flow field within the normal shock wave considering variable specific heats, viscosity and Prandtl numbers,** Corneliu BERBENTE, Sorin BERBENTE, Marius BREBENEL ("POLITEHNICA" University of Bucharest, Romania).

Hour: **$15.^{50}$ - $16.^{10}$**

S8.1.2.2 **Analysis of the Microscopic – Macroscopic Structure in Real Fluid Flows**, Stefan N. SAVULESCU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania – scientific collaborator and Florin BALTARETU (Technical University of Civil Engineering, Bucharest, Romania).

Thursday 11.10.2012 – "Nicolae TIPEI" Amphitheatre

Section 8. Section dedicated to Caius Iacob Centennial

S8.3 Mathematical Modeling

Thursday 11.10.2012. Afternoon session

S8.3. **Chairman:**
Constantin POPA
Gheorghe JUNCU
Stelian ION

Hour: **16.^{10} - 16.^{30}**
S8.3.2.1 **Numerical investigation of the zero's of some dispersion relations appearing in sound attenuation problems in rectangular lined ducts, carrying a gas flow**, Agneta Maria BALINT, Robert SZABO, Mirela DARAU (Physics Faculty, West University of Timisoara, Romania).

Hour: **16.^{30} - 17.^{00}**
Coffee Break

Hour: **17.^{00} - 17.^{20}**
S8.3.2.2 **Numerical investigation of the zero's of some dispersion relations appearing in sound attenuation problems in circular lined ducts carrying a gas flow,** Agneta Maria BALINT, Loredana TANASIE (Physics Faculty, West University of Timisoara, Romania).

Hour: **17.^{20} - 17.^{40}**
S8.3.2.3 **Propagation of the initial value perturbation in a circular lined duct carrying a gas flow,** Stefan BALINT (West University of Timisoara, Computer Science Department, Romania), Agneta Maria BALINT (Physics Faculty, West University of Timisoara, Romania).

Hour: **17.^{40} - 18.^{00}**
S8.3.2.4 **Mathematical Models and Numerical Simulations for the Blood Flow in Large Vessels,** Balazs ALBERT (Babes Bolyai University, Cluj-Napoca, Romania). Titus PETRILA (AEROSPACE CONSULTING Bucharest, Romania).

Hour: **19.^{00}**
DINNER

Thursday 11.10.2012 – "Subsonic Tunnel" Conference room

Section 4: Materials and Structures

Thursday 11.10.2012. Morning session

S4.1 **Chairman:**
Marin SANDU
Daniela BARAN
Victor MANOLIU

Hour: **$11.^{00}$ - $11.^{20}$**
S4.1.1 **Zn composite plating in semi-industrial scale: preparation and characterization of ZnPTFE coatings**, Linda DIBLÍKOVÁ, Martina PAZDEROVÁ (Výzkumný a zkušební letecký ústav, a.s.; Aerospace Research and Test Establishment, Department of Testing Laboratories, Prague, Czech Republic), Jan KUDLÁČEK (Czech Technical University in Prague, Czech Republic).

Hour: **$11.^{20}$ - $11.^{40}$**
S4.1.2 **NANOCOMPOSITES AS ADVANCED MATERIALS FOR AEROSPACE INDUSTRY,** Ion DINCA (AEROSPACE CONSULTING, Bucharest, Romania), Cristina BAN, Adriana STEFAN, George PELIN (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$11.^{40}$ - $12.^{00}$**
S4.1.3 **Microstructered ceramic materials: from phononic crystal to SAW devices,** Cristina PACHIU, Octavian LIGOR (National Institute for R&D in Microtechnologies - IMT, Bucharest, Romania).

Hour: **$12.^{00}$ - $12.^{20}$**
S4.1.4 **The behavior at quick thermal shock of multilayer ceramic protections,** Gheorghe IONESCU, Victor MANOLIU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania), Elvira ALEXANDRESCU (COMOTI - Romanian Research And Development Institute for Gas Turbines, Bucharest, Romania), Adriana STEFAN, Alexandru MIHAILESCU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$12.^{20}$ - $12.^{40}$**
S4.1.5 **Low Cost Lightweight Sandwich Panel with a Special Cross Screen Type Structure as Core,** Adriana SANDU, Marin SANDU, Dan Mihai CONSTANTINESCU ("POLITEHNICA" University of Bucharest, Department of Strength of Materials, Romania).

Hour: **$12.^{40}$ - $13.^{00}$**
S4.1.6 **New multiconvolutional approach for uncertainty estimation. Case study for the strain test result uncertainty estimation,** Ion PENCEA ("POLITEHNICA" University of Bucharest, Materials Science and Engineering Faculty, Department of Metallic Material Science and Physical Metallurgy, Romania), Victor MANOLIU, Gheorghe IONESCU (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$13.^{00}$ - $14.^{00}$**
Lunch

Thursday 11.10.2012 – "Subsonic Tunnel" Conference room

Section 4: Materials and Structures

Thursday 11.10.2012. Afternoon session

S4.2 **Chairman:**

Simion TATARU
Cristina PACHIU
Adriana STEFAN

Hour: **$15.^{30}$ - $15.^{50}$**
S4.2.7 **Experimental study on cutting force in milling 90Cr180 material**, Tabita-Dana IUGA, Cristina NECULACHE, Emilia-Roxana FLOREA ("POLITEHNICA" University of Bucharest, Faculty of Engineering and Management of Technological Systems, Romania).

Hour: **$15.^{50}$ - $16.^{10}$**
S4.2.8 **Manufacturing technologies of a multifunctional unmanned aircraft made of composite material,** Bogdan MOGA (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$16.^{10}$ - $16.^{30}$**
S4.2.9 **Airtech Europe Sarl – Company profile (www.airtech.lu)**, Wolfgang STRATMANN - General Manager (AIRTECH EUROPE Sarl, ZI Haneboesch, Luxembourg), Razvan Dragos ZLATAN (POLYchem Chemicals-Romania, 19, Dudesti- Pantelimon St., Bucharest, Romania)

Hour: **$16.^{30}$ - $17.^{00}$**
Coffee Break

Thursday 11.10.2012 – "Subsonic Tunnel" Conference room

Section 6: Experimental Investigations in Aerospace Sciences

Thursday 11.10.2012. Afternoon session

S6.2 **Chairman:**

Ion FUIOREA
Adrian PISLA

Hour: **$17.^{00}$ - $17.^{20}$**

S6.2.1 **Costs and benefits of applying the rules of aerospace management as a model for microeconomics and macroeconomics management,** Aurelian Virgil BALUTA, ("Spiru Haret" University, Bucharest, Romania).

Hour: **$17.^{20}$ - $17.^{40}$**

S6.2.2 **Mechanical aplications within the helicopter flight simulators,** Adrian PISLA, Dan OPRUŢA (Technical University in Cluj-Napoca, Romania).

Hour: **$17.^{40}$ - $18.^{00}$**

S6.2.3 **Validation of an on-board microphone system for the measurement of the exterior noise of a helicopter,** Silviu Emil IONESCU (COMOTI - Romanian Research And Development Institute for Gas Turbines, Bucharest, Romania), Nico van OOSTEN (ANOTEC CONSULTING, S.L., c/ Rector Jose Vida Soria, Motril - Granada, Spain), Fausto CENEDESE (AGUSTA - WESTLAND, Italy).

Thursday 11.10.2012 – "Subsonic Tunnel" Conference room

Section 7: ATS and full automation ATM

Thursday 11.10.2012. Afternoon session

S7.2 **Chairman:**
Aurelian Virgil BALUTA

Hour: **18.^{00} - 18.^{20}**
S7.2.1 **AEROSPACE MANAGEMENT IN NIGERIA,** Taofik OLAYIWOLA, Dubem Victor OBANYE (Lattix Aviation Nigeria Limited. Murfala Muhamed Airport, Lagos, Nigeria).

Hour: **19.^{00}**
DINNER

Friday 12.10.2012 – “ELIE CARAFOLI” Amphitheatre

Hour: **8.^{00} - 9.^{00}** **REGISTRATION**

Coffee Break

PLENARY SESIONS

Chairman:

Catalin NAE
Sorin RADNEF

Hour: **9.^{00} - 9.^{30}**

PL 5 **Jacques MANDLE** (Thales Avionics, France), ***Air data systems for commercial aircraft: history and perspectives***

Hour: **9.^{30} - 10.^{00}**

PL 6 **Ruxandra BOTEZ** (École de Technologie Supérieure, Montreal, Canada)**,** ***FMS optimization trajectories***

Hour: **10.^{00} - 10.^{30}**

PL 7 **Adriana NASTASE** (RWTH, Aachen University, Germany) ***The Multipoint Global Optimization of Flying Configuration with Leading Edge Flaps, in Supersonic Flow***

Hour: **10.^{30} - 11.^{00}**

Coffee Break

Friday 12.10.2012 – “ELIE CARAFOLI” Amphitheatre

Section 5: Systems, Subsystems and Control in Aeronautics

Friday 12.10.2012. Morning session

S5.1 **Chairman:**

Ruxandra BOTEZ
Ioan URSU
Mircea BOSCOIANU

Hour: **11.^{00} - 11.^{20}**

S5.1.1 **Wind tunnel validation of a closed loop morphing wing system,** Teodor Lucian GRIGORIE (University of Craiova, Romania), Ruxandra Mihaela BOTEZ, Andrei Vladimir POPOV (École de Technologie Supérieure, Montreal, Canada).

Hour: **11.^{20} - 11.^{40}**

S5.1.2 **Determining sensitivity of Data Envelopment Analysis method used in airport benchmarking**, Dan Cristian ION (“POLITEHNICA” University of Bucharest, Department of Aerospace Sciences, Romania), Mircea BOSCOIANU („Henri Coandă” Air Force Academy, Brasov, Romania).

Hour: **11.^{40} - 12.^{00}**

S5.1.3 **Aspects regarding the type of behavior of squeeze film dampers**, Laurentiu MORARU (“POLITEHNICA” University of Bucharest, The Aerospace Engineering Faculty, Romania).

Hour: **12.^{00} - 12.^{20}**

S5.1.4 **Mechatronic test bench for wing flight controls**, Ioan URSU, Minodor ARGHIR, Cristian VALEANU, George TECUCEANU, Adrian TOADER (INCAS - National Institute for Aerospace Research “Elie Carafoli”, Bucharest, Romania).

Hour: **12.^{20} - 12.^{40}**

S5.1.5 **Return from Orbit in Minimum Time Optimal,** Vasile ISTRATIE (AEROSPACE CONSULTING Bucharest, Romania) and Mircea DUMITRACHE (INCAS - National Institute for Aerospace Research “Elie Carafoli”, Bucharest, Romania).

Hour: **$12.^{40}$ - $13.^{00}$**

S5.1.6 **Flow control on aerodynamic airfoil using blowing jet on Coanda surface**, Florin FRUNZULICA ("POLITEHNICA" University Bucharest, The Aerospace Engineering Faculty, Bucharest, Romania), Alexandru DUMITRACHE ("Gh. Mihoc – C. Iacob" Institute of Statistical Mathematics and Applied Mathematics of the Romanian Academy, Bucharest, Romania), Octavian PREOTU (University of Craiova, Romania).

Hour: **$13.^{00}$ - $14.^{00}$**

Lunch

Friday 12.10.2012 – “ELIE CARAFOLI” Amphitheatre

Section 3: Astronautics and Astrophysics

Friday 12.10.2012. Afternoon session

S3.2 **Chairman:**
Teodor-Viorel CHELARU
Ion STROE

Hour: **$14.^{00}$ - $14.^{20}$**
S3.2.1 ***Attitude Control Law Design for Small Satellites Using Gradient Method,*** Teodor-Viorel CHELARU (“POLITEHNICA” University of Bucharest, Research Center for Aeronautics and Space, Bucharest, Romania), Adrian – Mihail STOICA (“POLITEHNICA” University of Bucharest, Research Center for Aeronautics and Space, Bucharest, Romania), Adrian CHELARU (INCAS - National Institute for Aerospace Research “Elie Carafoli”, Bucharest, Romania).

Hour: **$14.^{20}$ - $14.^{40}$**
S3.2.2 ***Attitude Determination of CUBESAT: Design, Modeling and Simulation,*** Najam Abbas NAQVI (Northwestern Polytechnical University - NPU, Xi’an, China), Arshad HINA (Institute of Space Technology - IST, Islamabad, Pakistan), YanJun LI (Northwestern Polytechnical University - NPU, Xi’an, China).

Hour: **$14.^{40}$ - $15.^{00}$**
S3.2.3 **Intuitive expressions of mechanical movement in the three-bodies problem,** Sorin Stefan RADNEF (INCAS - National Institute for Aerospace Research “Elie Carafoli”, Bucharest, Romania).

Hour: **$15.^{00}$ - $15.^{20}$**
S3.2.4 **Calculus of a compass robotic arm using Lagrange equations in non-inertial reference frames,** Ion STROE, Andrei CRAIFALEANU (“POLITEHNICA” University of Bucharest, Department of Mechanics, Romania).

Hour: **$15.^{20}$ - $15.^{40}$**
S3.2.5 **Controlled procedure for re-entry vehicles using the kinematic energy of the space ship,** Sorin Stefan RADNEF (INCAS - National Institute for Aerospace Research “Elie Carafoli”, Bucharest, Romania).

Hour: **$16.^{00}$ - $16.^{30}$**
Q & A

Hour: **$16.^{30}$**
CLOSING SESSIONS

Friday 12.10.2012 – "Nicolae TIPEI" Amphitheatre

S9. Special Sections

W1 Workshop – "Dissemination event of the new Strategic Research and Innovation Agenda (SRIA)" by ACARE

Friday 12.10.2012. Morning session

W1. **Chairman:**
Constantin OLIVOTTO
Stefan BOGOS

Hour: **$11.^{00}$ - $13.^{00}$**

S9 W1 **"Dissemination event of the new Strategic Research and Innovation Agenda (SRIA)" by ACARE,** Dave YOUNG (EUROCONTROL, Brussels, Belgium).

Hour: **$13.^{00}$ - $14.^{00}$**

Lunch

Friday 12.10.2012 – "Nicolae TIPEI" Amphitheatre

S9. Special Sections

W2 Workshop – "NASA Official Team Building Program - How to Build Mission Critical Social Infrastructures in Aerospace Organizations" (Romanian Space Agency)

Friday 12.10.2012. Afternoon session

W2. **Chairman:**

Constantin OLIVOTTO
Stefan BOGOS

Hour: **14.^{00} - 15.^{00}**

S9 W2 **"NASA Official Team Building Program - How to Build Mission Critical Social Infrastructures in Aerospace Organizations",** Dragos BRATASANU (Romanian Space Agency, Bucharest, Romania).

Friday 12.10.2012 – "Nicolae TIPEI" Amphitheatre

Section 6: Experimental Investigations in Aerospace Sciences

Friday 12.10.2012. Afternoon session

S6.2 **Chairman:**

Ion FUIOREA
Doru SAFTA

Hour: **$15.^{00}$ - $15.^{20}$**

S6.2.4 **ON DYNAMICS AND STABILITY OF DB HOMOGENEOUS PROPELLANT ROCKET MOTOR OPERATING PROCESS AT GRAIN LOW INITIAL TEMPERATURES,** Doru SAFTA (MTA - Military Technical Academy, Bucharest, Romania), Titică VASILE (MTA - Military Technical Academy, Bucharest, Romania), Ioan ION (University "Eftimie Murgu", Resita, Romania).

Hour: **$15.^{20}$ - $15.^{40}$**

S6.2.5 **A POINT OF VIEW UPON RAYLEIGH DAMPING HYPOTHESIS,** Ion FUIOREA, Lica FLORE, Dumitrita GABOR (Institute for Theoretical and Experimental Analysis of Aeronautical Structures, STRAERO, Bucharest, Romania).

Hour: **$15.^{40}$ - $16.^{00}$**

S6.2.6 **The importance of Air Quality in Aerodynamic Test Tunnels,** Marius PANAIT (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$16.^{00}$ - $16.^{30}$**

Q & A

Hour: **$16.^{30}$**

CLOSING SESSIONS

Friday 12.10.2012– "Subsonic Tunnel" Conference room

Section 8. Section dedicated to Caius Iacob Centennial

8.4 Dynamical Systems

Friday 12.10.2012. Morning session

*S8.4.*__Chairman:__

Corneliu BERBENTE
Constantin POPA
Ioan SEBESAN

Hour: **$11.^{00}$ - $11.^{20}$**
S8.4.1.1 **Lyapunov exponents for dynamical systems as a tool for studying fluid-structure interaction problems,** Daniela BARAN (INCAS - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania).

Hour: **$11.^{20}$ - $11.^{40}$**
S8.4.1.2 **FREE COMPRESSION TUBE. APLICATIONS,** Ioan RUSU (ELECTRICA SERV, Ploiesti, Romania).

Friday 12.10.2012– "Subsonic Tunnel" Conference room

Section 8. Section dedicated to Caius Iacob Centennial

S8.5 Technical Application

Friday 12.10.2012. Morning session

*S8.5.*__Chairman:__

Corneliu BERBENTE
Constantin POPA
Ioan SEBESAN

Hour: **$11.^{40}$ - $12.^{00}$**
S8.5.1.1 **Considerations on study the aerodynamic of pantographs railway vehicles**, Ioan SEBESAN, Sorin ARSENE ("POLITEHNICA" University of Bucharest, Faculty of Transports, Romania).

Hour: **$12.^{00}$ - $12.^{20}$**
S8.5.1.2 **Iterative Methods for Numerical Solution of Non – Linear Multi - Component Mass Transfer Equations,** Gheorghe JUNCU ("POLITEHNICA" University of Bucharest, Faculty of Chemical Engineering, Romania), Aurelian NICOLA (Ovidius University of Constanta, Faculty of Mathematics and Informatics, Romania), Constantin POPA (Ovidius University of Constanta, Faculty of Mathematics and Informatics, Romania), Elena STROILA (Research Center for Navy, Constanta, Romania).

Hour: **$12.^{20}$ - $12.^{40}$**
S8.5.1.3 **A magnetorheological suspension system for high speed railway vehicles**, Ioan SEBESAN ("POLITEHNICA" University of Bucharest, Faculty of Transports, Romania), Gheorghe GHITA (IMS-AR Institute of Solid Mechanics of the Romanian Academy, Bucharest, Romania), Dan BAIASU (Atelierele CFR Grivita SA, Bucharest, Romania).

Friday 12.10.2012 – "Subsonic Tunnel" Conference room

Section 8. Section dedicated to Caius Iacob Centennial

S8.3 Mathematical Modeling

Friday 12.10.2012. Morning session

S8.3 **Chairman:**

Dan POLISEVSCHI
Gelu PASA
Ruxandra STAVRE

Hour: **12.^{40} - 13.^{00}**

S8.3.1.5 **How one establishes a working program for a pulsatory liposome?**, Dumitru POPESCU ("Gh. Mihoc – C. Iacob" Institute of Statistical Mathematics and Applied Mathematics of the Romanian Academy – Bucharest, Romania and University of Bucharest, Department of Anatomy, Animal Physiology and Biophysics, Faculty of Biology, Romania), Ecaterina MARIEŞ (University of Bucharest, Department of Anatomy, Animal Physiology and Biophysics, Faculty of Biology, Romania).

Hour: **13.^{00} - 14.^{00}**

Lunch

Friday 12.10.2012 – "Subsonic Tunnel" Conference room

Section 8. Section dedicated to Caius Iacob Centennial

S8.3 Mathematical Modeling

Friday 12.10.2012. Afternoon session

S8.3 **Chairman:**

Dan POLISEVSCHI
Gelu PASA
Ruxandra STAVRE

Hour: **14.^{00} - 14.^{20}**

S8.3.2.6 **Homogenizing a low viscosity flow through a fractured porous media**, Isabelle GRUAIS (University of Rennes 1 (Université de Rennes 1), Unité de Formation et de Recherche Mathématiques, Institut de Recherche Mathématiques de Rennes, Rennes, France), Dan POLISEVSCHI ("Simion Stoilow" Institute of Mathematics of the Romanian Academy, Bucharest, Romania).

Hour: **14.^{20} - 14.^{40}**

S8.3.2.7 **Surfactant effects in Landau-Levich problem,** Gelu PASA ("Simion Stoilow" Institute of Mathematics of the Romanian Academy, Bucharest, Romania).

Hour: **14.^{40} - 15.^{00}**

S8.3.2.8 **Viscous fluid-thin elastic structure interaction: asymptotic modeling,** Ruxandra STAVRE ("Simion Stoilow" Institute of Mathematics of the Romanian Academy, Bucharest, Romania).

Hour: **15.^{00} - 15.^{20}**

S8.3.2.9 **The parameter domain for a bio-accumulation model with error measurements,** Stefan-Gicu CRUCEANU and Dorin MARINESCU ("Gh. Mihoc – C. Iacob" Institute of Statistical Mathematics and Applied Mathematics of the Romanian Academy, Bucharest, Romania).

Hour: **15.^{20} - 15.^{40}**

S8.3.2.10 **Mathematical Modelling of Soil Erosion Process**, Stelian Ion ("Gh. Mihoc – C. Iacob" Institute of Statistical Mathematics and Applied Mathematics of the Romanian Academy, Bucharest, Romania).

Hour: **16.^{00} - 16.^{30}**

Q & A

Hour: **16.^{30}**

CLOSING SESSIONS

CONTENTS

***Note*: The works are published in the volume into sections, in order of their presentation at the conference.**

PLENARY LECTURES

Analysis of the effect of ground proximity on on the steady and unsteady flows past airfoils at low Reynolds numbers

Dan MATEESCU[1]
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Montreal, QC, Canada,
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***Abstract**: This paper presents the analysis of the steady and unsteady flows past fixed and oscillating airfoils at low Reynolds numbers in the proximity of the ground. Various flight evolutions of the micro-air-vehicles take place in the proximity of the ground or a ceiling, which require the aerodynamic solutions in these conditions at the low Reynolds numbers. The unsteady flow problem is solved in a rectangular computational domain, obtained from the physical domain by time-dependent coordinate transformations for various sub-domains, in which the boundary conditions are efficiently and rigorously implemented. Solutions for the aerodynamic coefficients of airfoils executing pitching oscillations in the proximity of the ground at low Reynolds numbers are obtained with an efficient numerical method, developed by the author and his graduate students, for the time-accurate solution of the Navier-Stokes equations. This second-order accurate method in time and space uses a special decoupling procedure based on the continuity equation, which reduces the problem to the solution of scalar tridiagonal systems of equations, enhancing substantially the computational efficiency of the method. The influence of various flow parameters (distance to the ground, Reynolds number, airfoil relative thickness and camber, and the amplitude and frequency of oscillations) on the steady and unsteady aerodynamic coefficients (lift, drag, pitching moment and lift-to-drag ratio) and on the flow separation in the proximity of the ground is thoroughly studied.*

***2000 Mathematics Subject Classification**: 76, 76G25, 76D05, 76M20, 65M06, 35Q30*

***Keywords**: Unsteady flows, Ground effect, Low Reynolds number, Subsonic Aerodynamics, Computational Aerodynamics, Viscous Flows*

1. INTRODUCTION

Certain flight evolutions of airplanes occur in the proximity of the ground, which has an important effect on their aerodynamic characteristics. The effect of ground or ceiling proximity is especially important for the unmanned micro-air-vehicles (MAV) which are flying at low Reynolds numbers in various indoors environments and in tunnels [Davis *et al*. 1996], sometimes close to the ground, the ceiling or to the walls.

This aim of this paper is to present the analysis of the steady and unsteady flows past airfoils at low Reynolds numbers in the proximity of the ground (to date there are no previously published studies on this topic by other authors).

The airfoil aerodynamics at low Reynolds numbers is dominated by viscous effects and flow separation phenomena, and is very challenging and different from those of conventional aircraft. Several authors [Kunz & Kroo 2000] found that many successful aerodynamic codes developed for the normal range of the Reynolds number are not well suited for very low Reynolds numbers. The steady flows past airfoils at low Reynolds numbers (between 1000 and 6000) have been studied by Kunz & Kroo [2000], by using the INS2D code developed at NASA Ames based on an upwind finite differencing scheme developed by Rogers & Kwak [1990], and by Mateescu and Abdo [2004, 2010], who developed a method using artificial compressibility and a central finite difference formulation on stretched staggered grids.

The unsteady flows past oscillating airfoils at low Reynolds numbers have been recently studied by Mateescu *et al*. [2011].

However, the previous studies considered only the isolated airfoils (in free flight, far from the ground) and they cannot be used for the case of the flight evolutions of the micro-air-vehicles taking place in the proximity of the ground, a ceiling or a wall.

This paper presents the analysis of the effect of the ground on the steady and unsteady flows past fixed or oscillating airfoils at low Reynolds numbers. The unsteady flow problem is solved in a rectangular computational domain, obtained from the physical domain by time-dependent coordinate transformations for various sub-domains, in which the boundary conditions are efficiently and rigorously implemented.

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[1] Doctor Honoris Causa, FCASI, AFAIAA, Erskine Fellow, Professor

Air data systems for commercial aircraft: history and perspectives

Jacques MANDLE

Technical Directorate, Thales Navigation Unit
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Abstract: *Since 60's, there has been a considerable evolution in Air Data Systems. At the beginning, the system was dual, with a standby channel, all pneumatically driven. Analogue and digital electronics introductions have drastically improved the systems, both in terms of performance, complexity and affordability. Sensors and probes become more and more integrated, with the concept of "integrated probe", which has been chosen for some of the new existing aircraft programs. This integration arrives to some limits, due to the integration of a temperature sensing element seen on some programs.*
The quite recent requirements for dissimilarity also bring the necessity of different principles. The recent advances in LIDAR airspeed sensing systems are a significant step towards proving dissimilarity. Some concept evolution in non-optic techniques, such as ultrasonic probes or non-conventional Pitot tubes can also greatly contribute to this requirement.

1. DEFINITION

An Air Data System (ADS) provides the aircraft velocity and position (altitude) in the air referential. It uses measures from external probes, such as:

- Total Pressure (Pt)
- Static Pressure (Ps)
- Temperature (Total or Static) (TAT or SAT)
- Angle of attack (AOA)

Then, the computers measure the basic parameters using sensors, compute and compensate the information, and distribute the main parameters such as:

- Computed airspeed CAS and Mach Number
- Pressure Altitude
- Angle of Attack

to the flight deck and the flight control systems.

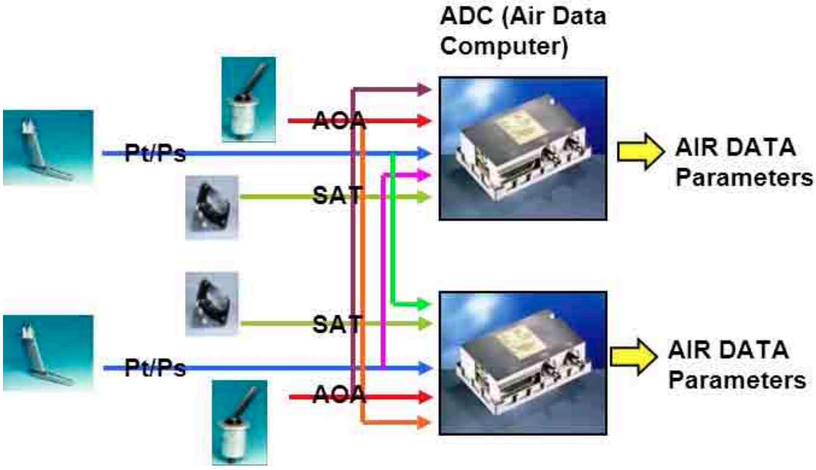

Figure 1: Air Data System

2. HISTORIC EVOLUTION

a. System

The first mention of such a system can be found in the archives of the French Royal Academy of Science. The article is entitled: Description of a machine measuring water speed in streams and vessel wakes, by Henri Pitot, November 12th 1732 [1].

The Multipoint Global Shape Optimization of Flying Configuration with Movable Leading Edges Flaps

Adriana NASTASE

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***Abstract**: The aerodynamical global optimized (GO) shape of flying configuration (FC), at two cruising Mach numbers, can be realized by morphing. Movable leading edge flaps are used for this purpose. The equations of the surfaces of the wing, of the fuselage and of the flaps in stretched position are approximated in form of superpositions of homogeneous polynomes in two variables with free coefficients. These coefficients together with the similarity parameters of the planform of the FC are the free parameters of the global optimization. Two enlarged variational problems with free boundaries occur. The first one consists in the determination of the GO shape of the wing-fuselage FC, with the flaps in retracted position, which must be of minimum drag, at higher cruising Mach number. The second enlarged variational problem consists in the determination of the GO shape of the flaps in stretched position in such a manner that the entire FC shall be of minimum drag at the second lower Mach number. The iterative optimum-optimorum (OO) theory of the author is used for the solving of these both enlarged variational problems. The inviscid GO shape of the FC is used only in the first step of iteration and the own developed hybrid solutions for the compressible Navier-Stokes partial-differential equations (PDEs) are used for the determination of the friction drag coefficient and up the second step of iteration of OO theory.*

***Key Words:** Aerodynamical global shape optimization, Multipoint design by morphing, Supersonic flow, Hybrid and meshless solutions for the three-dimensional compressible Navier-Stokes PDEs*

1. INTRODUCTION

Let us consider an FC, which shall optimal fly at two different supersonic cruising Mach numbers over sea and land. It can be realised by morphing, using movable leading edge flaps, like the birds in gliding flight. The determination of the GO shape of FC with flaps in retracted and in stretched positions lead to two enlarged variational problems with free boundaries. The OO theory developed by the author is a strategy for the determination of the GO shape of FC inside of a class of elitary FCs defined by their chosen common properties. Two elitary FCs belong to the same class, if their surfaces are expressed in form of superpositions of polynomes with the same maximal degree, their planforms can be related through affine transformation, they fulfill the same constraints and their surfaces are optimized in classical way by considering the similarity parameters of planform constant. A lower-limit hypersurface of the inviscid drag functional $C_d^{(i)}$ as function of the similarity parameters ν_i of the planform is defined, namely:

$$(C_d^{(i)})_{opt} = f(\nu_1, \nu_2, ..., \nu_n). \qquad (1)$$

Each point of this hypersurface is obtained by solving a classical variational problem with given boundaries (i.e. a given set of similarity parameters). The position of the minimum of this hypersurface, which is numerically determined, gives us the best set of the similarity parameters and the FC's optimal shape, which corresponds to this set, is at the same time the global optimized FC's shape of the class.

This OO theory was used by the author for the inviscid global optimization of the shapes of three models, with respect to minimum drag, at the cruising Mach numbers $M_\infty = 2,\ 2.2,\ 3.0$, respectively, it is: Adela (a delta wing alone) and two fully-integrated delta wing fuselage FCs, Fadet I and Fadet II.

More recently, an iterative OO theory was developed in order to compute the friction drag coefficient, to perform the viscous global optimal design and to take care of the requests of the structure in its early steps of iteration, via weak interaction.

2. DETERMINATION OF THE INVISCID GLOBAL OPTIMIZED SHAPE OF THE WING-FUSELAGE CONFIGURATION, WITH FLAPS IN RETRACTED POSITION

Firstly, the enlarged variational problem of the determination of the inviscid GO shape of the integrated wing-fuselage FC with the flaps in retracted position is considered. It shall have a minimum inviscid drag at

Section 1. Aerodynamics

A Numerical Investigation of the Stall-Delay for HAWT

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Abstract: *The stall-regulated horizontal axis wind turbine (HAWT) at low tip speed ratio (TSR ≤ 3.0) can operate in stall regime and can undergo stall delay phenomenon during operation. One challenge for researchers is to understand this phenomenon because it is important to control peak power output. In the present work we investigated the flow characteristics and stall delay phenomenon of a stall regulated HAWT rotor due to blade rotation in steady state non-yawed conditions. An incompressible Reynolds-averaged Navier-Stokes (RANS) solver is applied to carry out the separate flow cases at high wind speeds from 11 m/s to 25 m/s with an interval of 2 m/s. The computational results are compared with the experimental data and predicted values derived by a new stall-delay model proposed by Dumitrescu-Cardos.*

Keywords: *HAWT, stall-delay, computational fluid dynamics, RANS.*

INTRODUCTION

The design process of a wind turbine blade requires accurate and reliable prediction methods for the full range of machine's operating conditions. But at low values of tip-speed ratio (TSR ≤ 3.0) the stall-controlled turbine blades can operate with stall and can undergo stall delay phenomenon during operation on the inboard regions of span. The understanding of the stall regime is important to control peak power output for stall-regulated turbines.

Blade element and momentum methods (BEM) are the traditional design approach to calculate drag and lift forces of wind turbine rotor blades. The major disadvantage of these theories is that the airflow is reduced to axial and circumferential flow components. Therefore, correction models for rotational effects are often used in the case of the stall controlled rotors as a constant rotational speed.

At inboard locations, there is a strong interaction between the fast rotating flow of wake and the 3-D boundary layer close to the blade surface rotating with an angular velocity smaller than that of the fluid [1,2]. This behaviour is visible from the streamlines over the blade surface during operation in deep stall [3].

Physically, the phenomenon of stall-delay can be described as a three step process: rise a strong wake by clustering of vortices shed from the inboard blade span at tip-speed ratio TSR=3.0, pressure redistribution along the airfoil chord a constant circulation of the start regime (TSR=3.0 - incipient stall regime) for increased suction pressure at TSR< 3.0, followed by spanwise circulation (or lift) decay involving the stretching of separation bubble surface all the way to the trailing edge for increasing radius beyond that blade section the flow is separated over the whole airfoil and the leading-edge stall occurs [4].

In present work the flow characteristics and stall delay phenomenon of a stall regulated wind turbine rotor due to blade rotation in steady non-yawed conditions are investigated.

HAWT - TEST CONFIGURATION

The Phase VI rotor is a stall-regulated wind turbine with the generated power being limited due to blade stall [6,7].

The blade is designed using the NREL S809 airfoil profile, with a linear taper and a nonlinear twist. The blade pitch is 3 deg towards feather relative to the rotor plane, there is no coning, and the blades are rigidly attached to the hub. For our analyses the wind speed is varied between 11 and 25 m/s and, the rotor is turning at a constant rotational speed 72 rpm.

The wind turbine hub, nacelle, tower and ground are not included in present simulations.

Theoretical performances of double Gurney Flap equipped the VAWTs

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Abstract: *A Gurney flap is simply a flat plate attached perpendicularly to the lower surface of an airfoil or wing trailing edge. A T-strip or double Gurney flap is attached to both the upper and lower surfaces. T-strips are used to modify the lifting characteristics of the baseline airfoil for vertical axis wind rotor turbines. Generally, T-strips have been used during developmental flight test as simple add-on "fixes" to improve the performances of existing aircraft vertical tails. This paper aims to investigate the performances of VAWTs equipped with T-strip on blades trailing edge.*

Keywords: *Gurney Flap, VAWT, CFD, T-strip*

1. INTRODUCTION

In this study we use some devices on a trailing edge of a standard airfoil NACA 0012 trying to increase the lift coefficient. A Gurney flap [1] is simply a flat plate attached perpendicularly to the lower surface of an airfoil and in this case we also used in the airfoil upper surface. This trailing edge device is illustrated below in figure 1. Liebeck's [2] results showed a significant increment in lift compared to the baseline airfoil. In general, the drag of the airfoil increases with the addition of the Gurney flap, but often the percentage increase in lift is greater, resulting in an increased lift-to-drag ratio and therefore a better efficiency and performance.

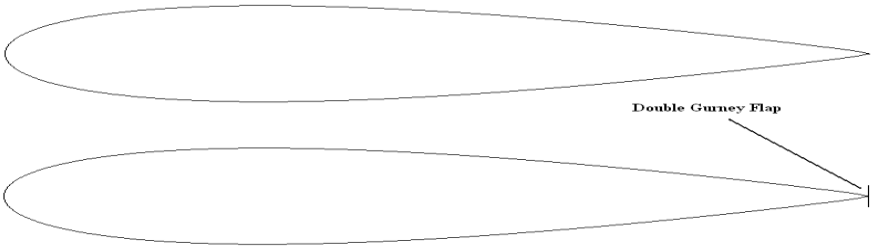

Figure 1. Airfoil with and without Gurney Flap

Normally, a device like Gurney Flap is used for increase the lift coefficient of airfoils. Typical applications studied have been on wind turbine blades.

Using double Gurney Flap this became on T-strip device. T-strips have been used to improve the performance of aircraft vertical tails [3].

Despite being used on a number of aircraft vertical tails, very little studies exist in the literature on the effect of trailing edge T-strips. In this study we used this double Gurney Flap on a airfoil for vertical axis wind turbine.

The Darrieus turbine is the most common VAWT invented in 1931[4]. The biggest turbine that was built had a rated power of 4 MW [5].In the 70s, Peter Musgrove[6] study this concept and with some help from several researchers they developed the straight-bladed Darrieus turbine, also called H-Darrieus.In the electricity generation market the HAWT type has currently a large predominance.

Unsteady effects at the interface between impeller-vaned diffuser in a low pressure centrifugal compressor

Sterian DĂNĂILĂ[1], Mihai Leonida NICULESCU[2]

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sterian.danaila@upb.ro
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mniculescu@incas.ro

Abstract: *In this paper, Proper Orthogonal Decomposition (POD) is applied to the analysis of the unsteady rotor-stator interaction in a low-pressure centrifugal compressor. Numerical simulations are carried out through finite volumes method using the Unsteady Reynolds-Averaged Navier-Stokes Equations (URANS) model. Proper Orthogonal Decomposition allows an accurate reconstruction of flow field using only a small number of modes; therefore, this method is one of the best tools for data storage. The POD results and the data obtained by the Adamczyk decomposition are compared. Both decompositions show the behavior of unsteady rotor-stator interaction, but the POD modes allow quantifying better the numerical errors.*

Key Words: *Unsteady Rotor-Stator Interaction; Adamczyk decomposition; POD; CFD; Compressor, URANS, Flow Field Reconstruction.*

1. INTRODUCTION

In the centrifugal compressors, the fluid flow is very complicated due the unsteady and turbulence effects, having time scales that vary considerably. This complexity makes difficult, both experimental and numerical analysis. Usually, in the practical applications, in the reference frame linked to the studied row, a steady flow is assumed. Furthermore, one can decompose the flow in two components: the main flow and the secondary flow respectively. The second flow corresponds to the physical flow with non-zero rotor velocity. In the secondary flow, vortices generate the losses due to the entropy increase, leading to three-dimensional behavior of the flow. C. Dano [1] indentifies the sources of unsteady phenomena in turbomachinery flows. Because the rotor-stator interaction can affect dramatically the turbomachinery performance, we paid it a special attention in this paper. The majority of researchers that studied this interaction from the numerical point of view focused their research on transonic turbomachinery; therefore, there is very few information about the rotor-stator interaction for low velocity turbomachinery. Moreover, a recent study [2] showed important discrepancies between experimental and numerical results for a low-pressure centrifugal stage. Unfortunately, this study did not succeed to identify the effects that caused the major discrepancies between experimental and numerical. Up to now, the Fourier transform is a common tool for the analysis of periodic and non-periodic signals. Some recent studies [3,4] clearly showed that POD is a more efficient method to extract the dominant modes involved in unsteady flow field. Unfortunately, these studies applied POD only for one-dimensional decompositions. In order to take the full advantage of POD method, we have applied it for decomposition of full three-dimensional flow field. For this reason, we have considered that it is useful to study the rotor-stator interactions in a low-pressure centrifugal stage, using both Adamczyk and proper orthogonal decomposition.

2. NOMENCLATURE

e	internal energy (J/kg)
f_e	external acceleration (m/s^2)
F_x, F_y, F_z	vectors of convective components of flux
G_x, G_y, G_z	vectors of diffusive components of flux
h	static enthalpy (J/kg)
I	rothalpy (m^2/s^2)
p	static pressure (Pa)

SECTION 2. Flight Mechanics and Systems Integration

PIO (Pilot Induced Oscillations) Criteria for Rotorcraft Pilot Coupling (RPC) in roll axis investigation

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Abstract: *Advances in Flight Control System (FCS), cockpit controllers and aircraft effectors with a significant level of automation in generally have intention to relieve pilot workloads and to allow operations in degraded weather and visibility conditions. Fixed and rotary wing pilots are being confronted with potential instabilities or with annoying limit cycles oscillations, knowing that Aircraft- and-Rotorcraft-Pilot Couplings (A/RPC) that arise from the effort of controlling vehicle with high response actuators. Research experience concerning pilot-in-the-loop handling qualities show that understanding, predicting and suppressing of inadvertent or sustained rotorcraft oscillations has received less attention until the last two decades. This paper develops the existing bandwidth - phase delay PIO I Category criteria on aircraft to analyze rotorcraft oscillatory or divergent behavior from adverse pilot vehicle coupling. Bandwidth-phase delay criteria can be used to evaluate rotorcraft susceptibility to PIO Categories I. The proposed criteria are applied to the analysis of a medium weight helicopter model and a/the closed – loop parameter is assessed through numerical simulation.*

Key Words: *Pilot Induced Oscillations, bandwidth, phase delay, roll axis criteria, pilot model, Bode diagram*

Abbreviations/Nomenclatures

ω_{BW}	"bandwidth" frequency
τ_p	phase delay parameter
ω_{180}	frequency for neutral stability
$\omega_{BWphase}$	bandwidth frequency as defined by phase
ω_{BWgain}	amplitude corresponding to ω_{180} plus 6 dB
Φ_M	phase margin
$\frac{p_{pk}}{\Delta\phi}$	roll attitude quickness
p	roll rate
A_1	lateral cyclic control
L_p, $L_{\theta_{1c}}$	damping and control derivatives
p_s	steady-state roll rate
$\Delta\phi$	discrete attitude change
$\hat{t}_1$	normalized time
φ	roll angle
K_p	pilot gain
T_L	lead
PIO	Pilot Induced Oscillations
AFCS	Automatic Flight Control System
A/RPC	Aircraft /Rotorcraft Pilot Coupling
PAO	Pilot Assisted Oscillations
RPC	Rotorcraft Pilot Coupling
PVS	Pilot Vehicle System

Scale effect on the aircraft dynamic stability, consistent similarity aproches

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Abstract: *To increase the level of confidence concerning with dynamic stability of a real aircraft in the preliminary design stage, it is proposed an identification technique of the results from a flying mock up scale model. The airplane model is an advanced aircraft configuration, developed for low drag and noise. This aircraft was a romanian proposal in an international European research program: HELENA-Highly Environmental Low Emission Next generation regional Aircraft. A boundary element method provides the aerodynamic derivatives. Similarity coherent criteria are presumed for the dimensions, mass, inertia and cinematic characteristics between the real aircraft and the scale mock up model. Comparison between the real aircraft and the scale model plane show the same values for the damping factors for Longitudinal and Lateral-Directional stability. Factored values with a constant are obtained for the time characteristics in longitudinal and lateral modes.*

1. INTRODUCTION

The aircraft stability analysis requests as input data, aircraft mass, inertia and the detailed aerodynamic coefficients and derivatives. The classical assumptions for the general equations of the unsteady aircraft motion analysis imply: uncoupling “longitudinal” and “lateral”, small perturbation and linear equations of the motion. Sometimes this theoretical hypothesis, together with an uncertainty on the input data, would produce unsatisfactory results for the longitudinal and lateral-directional flying qualities.

Airplanes must be designed to satisfy the Level 1 for Flying Quality requirements with all systems in their normal operating state. If, for an already built aircraft, after the first flight test program, an unsatisfactory stability has been recorded, important and expensive changes have to be done. The following example show that British certification requirements relating to the Dutch roll damping in engine-out go-around, forced Boeing to increase the height of the tail fin on all 707 variants, as well as add a ventral fin. A study about the effects of these modifications was detailed in [1]. The airplane model used in this study is an advanced aircraft configuration, developed for low drag and noise, that has been proposed in an international European research program: HELENA-Highly Environmental Low Emission Next generation regional Aircraft. It has specific features: forward swept wings with winglets, twin vertical tails and Contra Rotating Open Rotors that are shielded by horizontal tail, fig.1.

This paper aims to achieve a study for increasing the quality of the results concerning with stability of this advanced aircraft configuration, using the results from a flying mockup. The scale ratio of the scale mockup related to the full aircraft was 1/20. The content of this report completes the topics from [2] and [3] and details how to translate the recorded stability parameters from a flying mockup to the real aircraft.

2. THE AERODYNAMIC MODEL

The following is a short presentation about a specific practical method regarding with the evaluation of the pressure distribution on the outside surface of the aircraft. It is assumed a general steady subsonic motion composed by a translation with $\vec{V}_\infty$ velocity and an aircraft rotation with angular velocity $\vec{\omega}(p,q,r)$. Also it is assumed a potential flow, without viscous effects and there are accepted the “aerodynamics” approaches of the geometry according with “small perturbations”. The potential theory is used to get the solution. The three-dimensional boundary value problem is solved using the “boundary element method”, [7].

The “boundary” element method is a specific method, developed especially for differential equations of Laplace or Poisson type. The way to solve the potential equation is by using singularities of source type, vortices or doublets in order to form the integral equation that describes the potential. The figure 1 is a representation of the aerodynamic mesh for HELENA aircraft model, “Full scale”, that was used in this present evaluation.

Inverse Dynamics Simulations of Missile Motion in the Pitch Plane

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Abstract: *This paper presents some inverse dynamics simulations of missile motion in the pitch plane, based on a simplified direct dynamics model of a single-stage missile, modeled as a point mass, thus neglecting the rotational inertia. These inverse dynamics simulations represent an intermediate stage towards the desired goal of achieving optimal trajectories of missiles. A trajectory optimization formulation based on Pontryagin's Maximum Principle (PMP) has already been developed by the author in a previous paper presented at the Annual Symposium of the Institute of Solid Mechanics SISOM 2012. The inverse dynamics simulations presented here set the stage for the trajectory optimization, by providing useful information concerning some different non-optimal trajectories, in terms of missile flight trajectories, power consumptions and fuel spent, missile angle of attack evolution, etc.*

Key Words: *missile, direct dynamics, inverse dynamics, power consumption, fuel spent, angle of attack evolution, trajectory optimization.*

1. INTRODUCTION

This paper concerns some inverse dynamics simulations of missile motion in the pitch plane. These inverse dynamics simulations are aimed to set the stage for missile trajectory optimization, performed using a formulation based on Pontryagin's Maximum Principle [1],[2]. Several authors have already used Pontryagin's Maximum Principle to achieve missile/spacecraft optimal guidance [3]-[8], more precisely the missile must reach the required final fixed target (required final state – position and velocity), while using minimum thrust.

A simplified dynamic model is considered here, with the single-stage missile modeled as a point mass, this mass being variable. The rotational inertia is thus neglected. Another simplification is to decompose the 3D motion in 2D motions, under some simplifying assumptions [9]. Thus, the inverse dynamics simulations concern here only a missile flight in the vertical plane, called also pitch plane. The proposed simplified model approximates quite well the missile dynamics in the pitch plane, comprising only three differential equations: one for the $\vec{x}$ component of the velocity vector, one for the $\vec{z}$ component and one for the mass.

2. MISSILE DIRECT DNAMICS EQUATIONS

The single-stage missile is modeled as a point mass, thus neglecting the rotational inertia. Thus, no dynamic moment equation (rotation equation) is considered here. The mass of the missile is variable during the flight, due to fuel consumption.

A 2D missile motion in the vertical plane (pitch plane) is considered here. Figure 1 shows the motion of the missile in the pitch plane, indicating the coordinates used and also the forces acting on the missile.

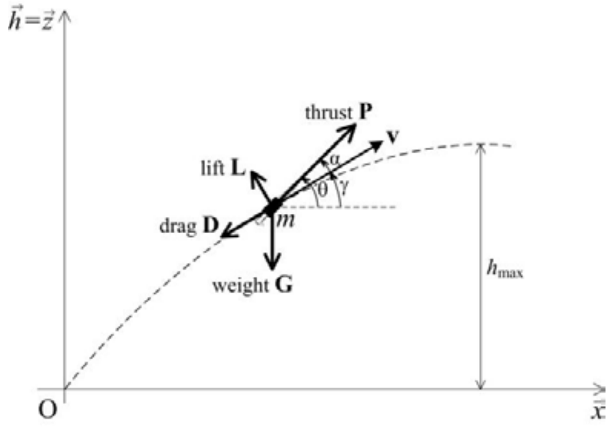

Fig. 1 – Missile motion in the pitch plane (coordinates and forces) [8]

Contribution to the understanding of an aircraft flight events

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Abstract. *This paper presents numerical method to approximately reconstruct the motion of an aircraft using FDR flight data. The study takes in consideration the fact that the number of data recorded on the FDR is in general lower than the number of data necessary for an exact reconstruction. The general differential equations and the associated boundary conditions are replaced by corresponding finite difference equations. The continuous time variable is replaced by discrete variable and the differential equations are solved iteratively in time increments starting from known initial conditions.*

Key words: *FDR data, mathematical model, flight data interpretation*

1. INTRODUCTION

In general the most powerful tool in the hand of the aeronautic accident investigators is from some years the FDR-the flight data recorder (nominated generally the "the black box"). The data from the FDR after an accident are transferred to a solid state recording device and analyzed with numerous procedures typically defined for those type of investigations. There are many specialized software and procedures in special to obtain the airplane's attitude, instrument readings and other characteristics of the flight. In present even for same routine flight, whiteout incidents, many airlines made tests on the recorded data using Flight Data Analysis (FDA) programs, in order to study recorded flight data on a daily basis.

This work contributes to analyze, in an objective manner, the premises of a flight incident of an aircraft and will help to identify, investigate, and correct the factors that create future accident. A proposed graphical animation enables the investigating team to visualize the moments of the flight.

Some results can be stored in text files or video file.

2. METHODS OF COLLECTION AND RECORD FOR THE FLIGHT DATA AND GENERAL ELEMENTS OF A FLIGHT DATA RECORDER

In present for a large class of aircrafts the installation of a Flight Data Recorder (FRD) is mandatory. The FDR is a separate unit installed on an aircraft, capable to record in time a large number of aircraft's in flight parameters. The main purpose of an FDR system is to collect and record data from a variety of sensors on a special storage medium designed to survive any accident. In present this system is combined with a device capable to record conversation in the cockpit, radio communications between the cockpit crew and the ground station. The total system is called currently "black box "and the unit is mounted separately in an envelope capable to resist at impact with ground at big speed and to the heat of an intense fire.

Today FDR systems can record hundreds of parameters and the data parameters type can be in different formats: binary, nominal, interval-scaled. Before proceeding to the analysis of flight data, an important preprocessing step must be made. An essential step in data preprocessing is the engineering units conversion where the raw binary data is mathematically processed to obtain the relevant engineering unit. Also, the data preprocessing is required to ensure validity of the data and consists in removal wrong data corrupted by measurements, data normalization and data reconstruction.

The Data acquisition System centralize and form the data coming from sensors, onboard computers and other instruments and then transfer it to FDR via a dedicated digital link (serial link ARINC 573 or 717). There are four types of input data:

- Discrete (logical status detection, indicators, switches, relays);
- Analogue (potentiometer);
- Synchronization transmitters;
- Digital bus (ARINC 429).

Advanced Solution for Double-Flutter Air-car

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Abstract:*At present a battle is taking place for creation of an air-car (or 'aero-automobile' or 'personal plane') which to substitute the classic car. In 2004 the authors presented a new type of aircraft called Sonic Double-Flutter Aircraft (SDFA) [1]. In that solution the lift was created by oscillation of a Kevlar net combined with multiple blades oscillation (called 'double-flutter effect'). The energy was injected in the net middle by an oscillating engine.*
This paper presents a more advanced concept of double-flutter aircraft. Instead of Kevlar net, a flexible grid made of composite material is used. On grid ribs a number of blade pairs are articulated. When a piston or oscillating engine vibrates grid center, the oscillation amplitude of grid edges becomes very large when grid proper frequency is reached. On the passive move (upward) the blade pairs are kept closed by dynamic air pressure and inertia forces. On the active move (downward) the blade pairs are kept closed by the same forces. Air is pushed downward periodically creating lift. Take-off, flight, landing and crash-landing would be computer-controlled. Such a flying machine will be easily to be manufactured in series production with a low manufacturing cost.

Key words: *air-car, air car, aero-car, aero car, plane, personal plane, flying automobile, double flutter, sonic, sonic double flutter aircraft, SDFA, transversal wave generator*

1. THE PRESENT STATE OF THE ART

Designing a practical air-car is a hard task. Many air-car designs were proposed during the last decades, but they do not accomplish simultaneously all the necessary features of the right flying machine. Some designs have wings like planes or rotating wings like helicopters or multiple propeller see figs 1& 2 [1].

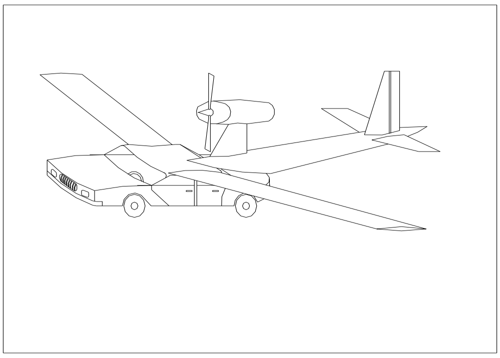

Fig. 1- Air-car design with wings

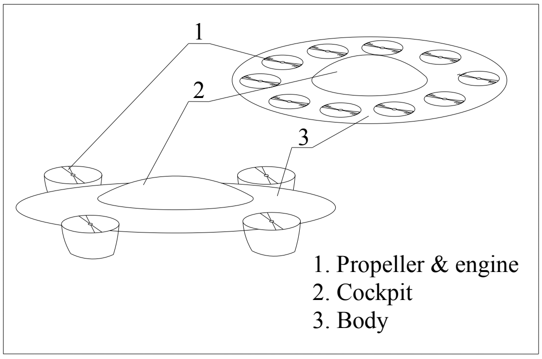

Fig. 2-Air-car design with multiple propellers

These solutions do not allow vertical take-off and landing or are not reliable and crush resistant or have a low ratio of lift to engine power.

2. THE SONIC DOUBLE FLUTTER AIRCRAFT

In our paper [1] some basic requirements were identified for air-car:

1. Controlled flight. A reliable onboard computer should analyze all pilot commands and flight conditions in real time in order to reject all unsafe commands;
2. Vertical take-off and landing. A practical air-car must be compatible with the current layout of cities, towns and villages;
3. High flight efficiency;
4. Airflow speed and noise must be kept below reasonable limits;
5. Craft structure must be crash resistant;

Section 3. Astronautics and Astrophysics

Attitude Control Synthesis for Small Satellites Using Gradient Method

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Abstract: *The paper presents some aspects for synthesis of small satellites attitude control. The satellite nonlinear model presented here will be with six degrees of freedom. After movement equation linearization the stability and command matrixes will be established and using gradient and Monte Carlo methods the controller will be obtained. Two attitude control cases will be analysed: the reaction wheels and the micro thrusters. The results will be used in project European Space Moon Orbit - ESMO founded by European Space Agency in which POLITEHNICA University of Bucharest is involved.*

Key Words: *nonlinear model, small satellites, Monte Carlo methods, mathematical model*

NOMENCLATURE

ξ - Rotation angle around body X_B axis

η - Rotation angle around body Y_B axis

ζ - Rotation angle around body Z_B axis

ψ - Attitude angle around z axis

θ - Attitude angle around y axis

ϕ - Attitude angle around x axis

$\boldsymbol{\omega}_{BI}$ -Angular velocity of the body frame relative to the inertial frame expressed in body frame;

$\boldsymbol{\omega}_{RI}$ -Angular velocity of the reference frame relative to the inertial frame expressed in relative frame;

$\boldsymbol{\omega}_{RIB}$ -Angular velocity of the reference frame relative to the inertial frame expressed in body frame;

$\boldsymbol{\omega}_{BR}$ -Angular velocity of the body frame relative to the reference frame expressed in body frame;

A, B, C, E - Satellite inertia moments;

m - Satellite Mass;

a - Major semi axis of elliptical satellite orbit;

e - Eccentricity of elliptical satellite orbit;

t - Time;

$\mathbf{r}$ - Position vector of satellite relative to origin of the inertial frame – centre of the Earth;

T -Orbital period;

$\mathbf{v}$ - Velocity;

V_{Ix}, V_{Iy}, V_{Iz} - Velocity components expressed in inertial frame;

X_B, Y_B, Z_B - Body frame;

X_R, Y_R, Z_R - Reference frame;

X_I, Y_I, Z_I -Inertial frame

x_I, y_I, z_I - Satellite coordinate expressed in inertial frame.

1. INTRODUCTION

It is indisputable that today, the use of satellites is the spatial program main goal, due to their importance in terms of telecommunications, remote sensing and navigation that they provide. During a satellite mission, the

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Calculus of a compass robotic arm using Lagrange equations in non-inertial reference frames

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Abstract: *Lagrange equations for motions with respect to large size non-inertial frames (planets, orbital stations), that are not influenced by the relative motion of the studied parts, are presented in the first part of the paper.*
For the calculus of the internal forces, a new method based on Lagrange equations in non-inertial reference frames is presented. If an internal force has to be determined, a supplementary mobility is considered in the system. The internal force corresponding to the new mobility is found if zero mobility is imposed. In the second part of the paper, the application of the method is illustrated by determining the bending moment in a Compass Robotic Arm. The geometry of this system is inspired from the European Robotic Arm (ERA). The geometry of the open loop mechanism is studied, but the method can be also used for closed loops. Results regarding internal forces for the known motion of the robotic arm are obtained by numerical simulations. The models and the elaborated method allow the solving of a large number of problems concerning the systems of bodies' dynamics.

Key words: *Lagrange equations, non-inertial reference frame, compass robotic arm*

1. INTRODUCTION

Solving of dynamics problems in non-inertial frames presents difficulties regarding the choice of the reference systems. As a general rule, the equations of motion are written with respect to inertial frames. An inertial reference system is chosen, as well as a local one, important for the study of the relative motion, with respect to a large size non-inertial frame, such as a planet or an orbital station. For a material point acted by the weight $m\bar{g}_0$ and by the resultant $\bar{F}$ of the applied and constraint forces, the fundamental equation of the dynamics (Newton's law), in inertial frame, is

$$m\bar{a} = \bar{F} + m\bar{g}_0 . \tag{1}$$

With respect to the local frame, equation (1) is corrected by two terms – the transport force and Coriolis' force:

$$m\bar{a}_r = \bar{F} + m\bar{g}_0 + \bar{F}_t + \bar{F}_C , \tag{2}$$

where

$$\bar{F}_t = -m\bar{a}_t , \quad \bar{F}_C = -m\bar{a}_C . \tag{3}$$

On the surface of a planet or aboard an orbital station, an equilibrium state is established between the weight and transport forces, which allows it to define a local weight or a local gravitational acceleration [0].

The local weight is

$$m\bar{g}_l = m\bar{g}_0 + \bar{F}_{t0} , \tag{4}$$

where $\bar{F}_{t0}$ denotes the transport force at equilibrium.

In particular, if

$$\bar{g}_l = \bar{0} \tag{5}$$

the imponderability state is installed.

2. LAGRANGE EQUATIONS IN NON-INERTIAL FRAMES

The inertial reference system (T_0), with origin O_0 is considered, as well as the non-inertial one (T), with the origin in O (Fig. 1). The motion of the movable frame is defined by the velocity $\bar{v}_O$ of the origin O and by the angular velocity $\bar{\omega}_0$ of system (T), with respect to the inertial one (T_0).

Controlled procedure for re-entry vehicles using the kinetic energy of the space ship

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Abstract: *The common procedure to re-entry into the atmosphere is to decrease the kinetic energy, in a well stated way, till a convenient value for a final landing following a specific manoeuvre. This research shows how to use the kinetic energy to modify the orbit of the space-ship so to attain the height and velocity of a geostationary point/ orbit, using a small engine with impulsive or continuous thrust to control the velocity and the trajectory. From such an orbit the space-ship will use the spacelift technology to arrive at a height (below 60km) and velocity (below 1M) convenient to a common procedure for landing. There are presented global scientific and technical considerations and a more detailed mechanical model to study the corresponding manoeuvres.*

Key Words: *re-entry vehicles, geostationary orbit, spacelift*

1. INTRODUCTION

The paper deals with the recovery problem of orbital space objects (satellites, spaceships) considering that the spacelift may be operative (in a technical acceptation!) and using the current kinetic energy as a base to increase it to the value necessary for the geostationary orbit (denoted by GS). This way, it is possible to avoid the jeopardy of a ballistic reentry by decreasing the kinetic energy. The procedure presumes two stages:

1. Spaceship flies from a given orbit to the geostationary orbit
2. The descent to a low height and with a slow speed using the spacelift

For the analysis of the proposed procedure we state:

a. Physical properties of the environment:
  -space environment with isotropic properties that fits in with the use of a spherical coordinate system
  -neglect of drag along the velocity direction
  -potential gravity field
  -thrust components, along the local axes frame, considered as control variable

b. Requirements for the spaceship flight:
  -stable spaceship flight/ mechanical movement after starting the manoeuvre
  -minimum fuel consumption for the manoeuvre
  -on line control laws synthesis that are to be used as real control laws
  -synthesis method that admit great/ large and almost unforeseeable disturbances of spaceship’s state variables

Steps for solving the problem

1. Reduced problem to:	-2 material points (spaceship, the Earth) -impulsive transfer between two orbits -continuous control force for orbits transfer
2. Detailed problem to:	-continuous control force to follow a given trajectory -optimal and stable flight evolution
3. Realistic problem for:	-movement of the spaceship as a rigid body -continuous control force to follow a given trajectory -optimal and stable flight evolution

2. GLOBAL CONSIDERATIONS REGARDING THE MANOEUVRE

A global overview is derived using the mechanical model for the movement of the two material points (spaceship and the Earth) and the impulsive change of the velocity to perform the transfer between two orbits. This is in fact the basic reduced problem for such manoeuvres to obtain the general data necessary for space mission planning.

SECTION 4. Materials and Structures

Zn composite plating in semi-industrial scale: preparation and characterization of Zn-PTFE coatings

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Abstract: *Zinc coatings with dispersed polytetrafluorethylene particles (Zn-PTFE composite coatings) were produced by zinc electrolytic plating in weakly acid bath in semi-industrial scale. The technology was built on the results of the series of laboratory experiments which enabled us to determine an optimal setting of process conditions. Those conditions had significant effect on the incorporation of PTFE particles into zinc matrix and, consequently, on the friction and corrosion properties of Zn-PTFE coatings. The composition of Zn-PTFE coatings was analyzed by microscopic analysis and infrared spectroscopy and the properties of the coatings were studied by tribological experiments and corrosion tests. The results confirmed the positive effect of PTFE on friction properties of Zn-PTFE coatings and showed that the corrosion resistance of Zn-PTFE coatings was similar to Zn coatings without PTFE. The application of such coatings is suggested for the production of bolt joints, pins, bearings, and components with threads, i.e. any moving and rolling components of chassis, landing gears or engines used in automotive or aircraft structures.*

1 INTRODUCTION

Composite coatings consist of matrix and different types of particles dispersed in it. The combination of the properties of the components gives rise to specific mechanical, physical and chemical characteristics of the resulted composite coating which cannot be achieved by each component separately [1]. Composite coatings with metal matrix can be synthesized by electrolytic composite plating. In general, this way enables inert particles suspended in a metal plating bath to codeposit with the metal, i.e. to be incorporated into metal matrix growing on a substrate. The advantages of such technology are lower economical, power and time requirements. Moreover, lower thickness of composite coatings compared with multi-layered coatings ensures more precise fit of structural elements.

Our research has aimed at the development of a new composite coating based on zinc matrix with dispersed PTFE particles (Zn-PTFE coating). There are several reasons for using zinc based composite coatings. Zinc has excellent corrosion resistance and zinc electroplating is the most widely used surface treatment in mechanical engineering, including aerospace and automotive applications. Its share is about 20 % in the Czech Republic and it is similarly high in the rest of European countries [2]. Moreover, we started this research because there has been almost none R&D concerning zinc and PTFE. According to literature search there is only one reference to electrolytic codeposition of Zn-PTFE coating [3]. However, outdated type of plating bath and high temperature were used in the procedure. PTFE particles are commonly incorporated into nickel matrix in the field of research [4,5,6] as well as industrial application [7]. PTFE significantly improves friction properties and wear resistance of the coatings.

2 MATERIALS AND METHODS

Mild steel sheets (50x150x5 mm) were used as substrates for coating deposition. The sheets were pretreated by series of consequential steps which are described in chapter 3. Plating was done in weakly acid bath for zinc plating without or with addition of 60 wt% PTFE dispersion (particle size in the range of 0.05 to 0.5 μm). A dispersant and a brightener were added to the bath in order to maintain PTFE dispersion and ensure gloss of coatings, respectively. The bath was stirred for 60 min prior to each experiment and during the experiment as well. The electroplating was run as rack plating.

Samples were prepared from bath containing 5% of PTFE dispersion at current density 1 A/dm^2 applied for 30 minutes. These samples were labelled Zn5PTFE. Samples with zinc coating without PTFE were prepared under the same conditions except the addition of PTFE. Surface treatment was used for each type of

Nanocomposites as advanced materials for aerospace industry

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Abstract: *Polymer nanocomposites, consisting of nanoparticles dispersed in polymer matrix, have gained interest due to the attractive properties of nanostructured fillers, as carbon nanotubes and layered silicates. Low volume additions (1- 5%) of nanoparticles provide properties enhancements comparable to those achieved by conventional loadings (15-40%) of traditional fillers.*

Structural nanocomposites represent reinforcement structures based on carbon or glass fibers embedded into polymeric matrix modified with nanofillers.

The most important application of nanocomposites are structural composites, in aerospace field, as, laminates and sandwich structures. Also, they can by used as anti-lightning, anti-radar protectors and paints.

The paper presents the effects of sonic dispersion of carbon nanotubes and montmorrilonite on the mechanical, electrical, rheological and trybological properties of epoxy polymers and laminated composites, with carbon or glass fiber reinforcement, with nanoadditivated epoxy matrix.

One significant observation is that nanoclay contents higher than 2% wt generate an increase of the resin viscosity, from 1500 to 50000- 100000 cP, making the matrix impossible to use in high performance composites.

Also, carbon nanotubes provide the resin important electrical properties, passing from dielectric to semi-conductive class. These effects have also been observed for fiber reinforced composites.

Contrarily to some opinions in literature, the results of carbon nanotubes or nanoclays addition on the mechanical characteristics of glass or carbon fiber composites seem to be rather low.

Keywords*: carbon nanotubes, nanoclays, fiber composites, mechanical strength*

I. INTRODUCTION

Composites materials consist of a fibrous reinforcements bonded together with a matrix material. Fibers are the reinforcing agents that allow the stiffness and strength of the material to change with direction of loading. Fiber reinforcement properties such as high strength and stiffness and low density combined with the ones of the polymeric matrix such as good shear properties and low density as well result in high performance features for the entire composite.

A composite properties depend on the characteristics of the components that form it as well as on the compatibility between the matrix and the reinforcing agents. The components are chosen on the basis of the characteristics required by the application where the composite is used. In any high-tech structural application, where strength, stiffness, durability and light weight are required, epoxy resins are seen as the standard of performance for the matrix of the composite.

This is why in aircraft and aerospace applications, as well as offshore racing boats, epoxies have been the norm for years. [1]

The use of composite structures in both commercial and general aviation aircraft has been increasing primarily because of the advantages composites offer over metal (e.g. lower weight, better fatigue performance, corrosion resistance, tailorable mechanical properties, better design flexibility, lower assembly costs) [1].

While most of the Airbus A 380 fuselage is aluminium, composite materials comprise more than 20% of its airframe. [2] Boeing 787 Dreamliner is 80% composite by volume and Each 787 contains approximately 35 short tons of carbon fiber reinforced plastic (CFRP), made with 23 tons of carbon fiber. [3]

The main disadvantage of polymeric composite materials is represented by the nonvisible impact damage, the repairing process being different from the one applied for metal structures.

The behavior at quick thermal shock of multilayer ceramic protections

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Abstract: *Protective layers of "hot parts" of the turbo engines as well as co generative systems of energy industry are exposed to a combination of factors wear which may act together at high values.*

The main goal of the paper is the behavior of some advanced layers, duplex and triplex, multifunctional, ceramics in relation to the most complex wear factor and disturbing as well, the quick thermal shock.

The quick thermal shock test installation designed and constructed by the INCAS covers the domain of some high gradients of heating/cooling and is currently integrated in a network of European infrastructure that evaluates the properties of functional layers for turbo engines.

It is emphasized the micro structure changes induced inter and intra facial, gradually, in the elaborated ceramic structures and on this base the ranking and selecting of these for the application on natural parts.

Key words: *turbo engines, wear factors, quick thermal shock, thermal fatigue, TBC*

1. INTRODUCTION

Gas turbine generators work at mechanical and thermal superior limits, plus the corrosive effects of chemical fuels. The temperature in commercial aircraft turbines can reach 1500°C [1].

For extreme operational conditions occurring in aircraft flight, engine stop in flight, missing landing, etc., for other equipment, machine power and metallurgical industry is very important to know the behavior of materials at high heating and cooling speeds.

From all the wear factors that work simultaneously on the "hot parts" (blades, adjustable nozzles, burning chamber, diffuser) of the turbo engines – temperatures above 1500ºC, quick thermal shock, pyrolyze particle erosion to speeds above Mach 3, corrosion, adhesion, etc.-the thermal factor acts most disturbing.[2]

In the case of "hot parts" of turbo engines, temperatures vary depending on flight operation rules on taking off, landing, intermediate cruising, engine stop in flight, missing landing, etc.

The increases in thermal efforts for short duration, can have considerable value and lead to plastic deformation of the material.

The use of protective systems in the case of "hot parts" of turbo engines is absolutely necessary in view of the operating at high temperatures.

2. EXPERIMENTS

Taking into account the extreme operational conditions of the "hot parts" of the turbo engine appeared to be necessary to study the material behavior at high rate speeds of heating-cooling, at quick thermal shock.

2.1. Materials

For experiments were used multilayer samples composed of stainless steel support, bonding layer MeCrAlY and ceramic thermal barrier coating (TBC) layer.

2.2. Methods and instrumentation

To assess structural changes due to thermal shock, thermal barrier coatings were tested at quick thermal shock and then were investigated by electron microscopy.

Layers of protection were obtained by depositing successive the bonding layer and ceramic layer with

Low Cost Lightweight Sandwich Panel with a Special Cross Screen Type Structure as Core

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Abstract: *Two thin plates with a stabilizing medium placed between them, i.e. a sandwich plate, can be an ideal component for large and lightweight structures with increased strength, stiffness and stability.*

This paper proposes a new lightweight sandwich panel with aluminium skins and a core made from vertically aligned tubes of polypropylene placed in the nodes of a cross screen type structure. As a reference construction, the panel with the skins joined only by means of polypropylene bushes (without supplementary stiffeners) is considered. The assembling of components is made by bonding the sandwich with an universal structural adhesive. All used materials were tested in traction in order to establish the elastic modulus, the yielding limit and the ultimate stress. Also, strain gauge measurements were done to evaluate the Poisson’s ratios of the materials.

Finite element analyses were undertaken in order to characterize the behaviour of the considered panel as having supported edges, and loaded under lateral pressure.

Keywords: *sandwich panel, grid type core, finite element analysis*

1. INTRODUCTION

The typical sandwich structure consists of two thin high strength face sheets between which is bonded a relatively thick, low density and low strength core. Thus, the sandwich structure is characterized by light weight and high flexural strength.

The most extensively used honeycomb core sandwich structure in the aerospace industry is the one with aluminum face sheets and aluminium or titanium honeycomb core.

Because the honeycomb has thin walled cells with the generatrix perpendicular to the face, the bonding between the core and the face sheets can be achieved only by line contact. Consequently, the integrity of the bonding is seriously affected in time as a result of corrosion.

To avoid this drawback and to enhance the strength and stability of sandwich plates, honeycomb cores made from polypropylene with large cells and relatively thick wals can be used.

A convenient technology is to use polypropylene bushes placed side by side and bonded together after plasma based treatment. As a result, a core with a geometry similar to the honeycomb one, but more resistant, is obtained [1], [2].

Sandwich panels can be designed as multifunctional structures that allow the heat exchange along their cores having, in the same time, superior mechanical performances.

A multifunctional sandwich panel combining the structural efficiency with the good thermal transfer based on the use of a truncated square honeycomb core was proposed and evaluated in paper [3]. In fact, the sandwich panel faces are inter-connected by mean of a matrix of spacers with cross-shaped section (Figure 1a). Other solution, similar to that one which is presented in Figure 1b, consisting of vertically aligned Al-Si alloy tubes as core and carbon fibre composite face sheets, was proposed in [4].

To evaluate the performances of this kind of panel, out-of-plane compression and three-point bending tests were performed.

In our paper, two enhanced solutions with the core consisting of square stiffening grids with cylindrical bushes placed in the nodes (Figures 2 and 3) will be analyzed.

To permit the air flow into the panel and a convenient heat transfer, several holes will be made in the middle plane of the bushes and of the stiffening strips and also along the border of the panel.

The stiffness and the strength of the structure are little affected by these holes because of their placement in the middle plane of the panel (where the equivalent stresses have little values).

If the panel has only a structural role, their perforation is not necessary. Consequently, in this study the holes will not be considered.

New multiconvolutional approach for uncertainty estimation. Case study for uncertainty estimation of the compression strength test results

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Abstract: *One of the main components of the risk management in aircraft industry is based on the consistency and conformity of products or services. Laboratories play an important role in conformity assessment of products or services. It is well established that the value obtained in any quantitative measurement is only an approximation of the true value. Thus, iso/iec 17025 recommends reporting the results of quantitative measurement together with its associated uncertainty having a specified significance level. The appropriateness of uncertainty estimation of a test result depends on many factors among the probability density function (pdf) of the measurand is critical. The literature is abundant of examples where to the measurands are assigned normal pdfs without no clear evidence. The paper addresses the proper assignment of a pdf to a specific measurand and provides a study case for the uncertainty estimation of the stress-strain test results using the pdf of the mean derived by a multiconvolutional procedure of the uniform pdfs. The authors state that the multiconvolutional approach is the best fitted for the cases there are no complete knowledge about the uncertainty budget of the test process. The paper provides the forms of 2 up to 5 times convolved uniform pdfs.*

1. INTRODUCTION

The important decisions should be based on the facts and test results having a certain degree of confidence, usually greater than 95%. This is, obviously, for aviation where the decisions needs, ideally, a 100% degree of confidence about the tests results or other factors taken into consideration for designing or construction of planes, missile etc. The research in the aeronautical field shows a great concern for uncertainty estimation of the performance of the aircraft parts and as an entire vehicle. [1—4]. "Design concerns using available information to make intelligent decisions leading to optimal solutions, in the process of aircraft design based modeling and simulation, there exists a ***vast amount of uncertainty***, which causes model-based predictions to differ from reality".[2]. Some authors addressed deficiencies in current approaches to aerospace systems design. They identified a lack of disciplinary knowledge of sufficient fidelity about the product, to the presence of uncertainty at multiple levels of the aircraft design hierarchy, and to a failure to focus on overall affordability metrics as measures of goodness [3, 4]. In this respect, design solutions are desired which are robust to uncertainty and are based on the maximum knowledge possible. One of the most important test domain for aeronautic is mechanical testing. In this fiel, L Legendre considers that much progress has yet to be made regarding the quantification and interpretation of uncertainties in mechanical testing.[5].

2. METROLOGICAL CONSIDERATIONS

A test is a measurement process well documented, fully implemented and permanently supervised [6]. In a test process, the environmental and operational conditions will either be mentioned at standard values or be measured in order to apply correction factors and to express the result in standardized conditions. The test process yields a value as the estimate for the conventional true value of the measurand. In principle, this value is the sample mean $\overline{y}$ or simply y. As standards strongly recommend the y value must be reported together with its expanded (extended) uncertainty U for a specific confidence level (typically 95%) as follows [7-9]:

Manufacturing Technologies of a Multifunctional Unmanned Aircraft Made of Composite Materials

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Abstract: *Due to its versatility, the unmanned aircraft is increasingly common in equipping modern armies, where it has demonstrated its effectiveness in real conditions of war being used in military conflicts in recent years. It is also used in other fields such as police, agriculture, meteorology, market of radio-controlled aircraft hobby, etc. This paper presents a summary of technological design and theoretical and practical realization of a multifunctional unmanned aircraft for aerial reconnaissance and surveillance. The interest for developing a sustainable technological approach that will be described in the present paper occurred as a result of the domain novelty and also of the preponderance of composite materials used for building this UAV.*

Key Words: *UAV, composite materials, multifunctional unmanned aircraft, aerial reconnaissance*

1. INTRODUCTION

The paper describes the technological achievement namely the procedures and manufacturing operations for the aircraft subassemblies, along with their design and specific molds used for the obtaining procedures. The purpose of this paper is to obtain aircraft parts with high dimensional precision made of advanced composite materials, thus facilitating a high performance of the UAV without reaching substantial manufacturing cost.

Fig. 1 General view of the plane [1]

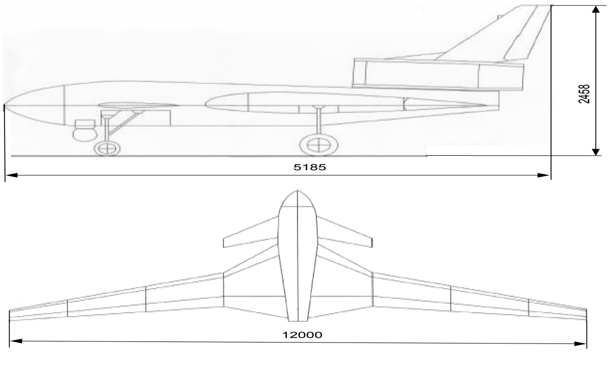

Fig. 2 Plane overall dimensions [1]

2. MATERIALS USED IN THE MAIN COMPONENTS OF AIRCRAFT

2.1 Materials for manufacturing the fuselage subassemblies

The half-fuselages are built from NMHSM sandwich panels (Honeycomb Sandwich Nonmetallic Materials) with a thickness of 10 mm. Sides panels are 0.6 mm in thickness and made of Kevlar / epoxy composite. The NOMEX type nonmetallic core has a thickness of 8.8 mm [12], [13]. These materials were chosen because the fuselage was intended to have a high lifetime resource and to be transparent to radar (electromagnetic)

Section 5. Systems, Subsystems and Control in Aeronautics

Wind tunnel validation of a closed loop morphing wing system

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***Abstract:** The objective of the research presented here was to develop a new morphing mechanism using smart materials such as Shape Memory Alloy (SMA) as actuators. These smart actuators deform the upper wing surface, made of a flexible skin, so that the laminar-to-turbulent transition point moves closer to the wing trailing edge. The ultimate goal of this research project was to achieve drag reduction as a function of flow condition by changing the wing shape. The transition location detection was based on pressure signals measured by optical and Kulite sensors installed on the upper wing flexible surface. Depending on the project evolution phase, two architectures were considered for the morphing system: open loop and closed loop. The open loop architecture of the controller was used as an inner loop of the closed loop structure. Both of the control architectures were validated in wind tunnel tests in parallel with the transition point real time position detection and visualization. In the closed loop controller architecture, the information about the external airflow state received from the pressure sensors system was considered and the decisions have been taken based on the transition point position estimation.*

1. MORPHING WING PROJECT

The work presented in this paper was performed under the 7.1 Consortium for Research and Innovation in Aerospace in Quebec (CRIAQ) collaborative project between academia and industries. The project was developed by the École de Technologie Supérieure (ETS), as project leader, in collaboration with École Polytechnique of Montreal, Institute for Aerospace Research of the National Research Council Canada (IAR-NRC), Bombardier Aerospace, and Thales Avionics. This collaboration called for both aerodynamic modeling as well as conceptual demonstration of the morphing principle on real models placed in the wind tunnel, i.e. of a morphing wing. The main objective was to promote large laminar regions on the wing surface, by delaying the transition location toward the trailing edge, with impact on the drag force decrease; the drag reduction on a wing can be achieved by changing the airfoil shape as a function of flight condition, which has a direct effect on the laminar-to-turbulent flow transition location.

The wing model had a rectangular plan form (0.5 m – chord, and 0.9 m - span) and was equipped with a flexible upper surface skin, actuated by using two shape memory alloys actuators. The two shape memory alloys actuators shape memory alloy (SMA) executed the displacement at the two control points on the flexible skin to realize the desired airfoil shapes, (Fig 1 [1]).

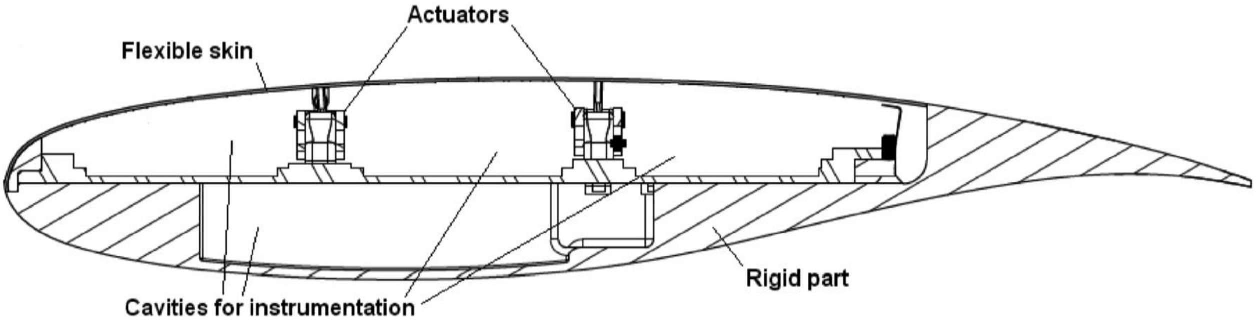

Fig. 1 Cross section of the morphing wing model

In order to locate the laminar-to-turbulent flow transition some optical and Kulite pressure sensors were installed on the upper wing flexible surface.

Depending on the project evolution phase, two architectures were considered for the morphing system: open loop and closed loop. The difference between these two architectures was the using of the transition point as a feedback signal for the control system.

To achieve the aerodynamic imposed purpose in the project, thirty five optimized airfoils were found for the airflow cases combinations of Mach numbers and angles of attack.

Determining sensitivity of Data Envelopment Analysis method used in airport benchmarking

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Abstract: *In the last decade there were some important changes in the airport industry, droved by the liberalization of the air transportation market. Until recently airports were considered infrastructure elements, and there were evaluated only by traffic values or maximum capacity. Gradual orientation towards commercial led to the need of finding another ways of evaluation, more efficiency oriented. The existing methods for assessing efficiency used for other production units were not proper for airport use due to specific features and high complexity of airport operations. In the last years there were some papers that proposed Data Envelopment Analysis as a method for assessing operational efficiency in order to conduct benchmarking. This method offers the possibility of dealing with a large number of variables of different types, which represents the main advantage of this method and recommends it as a good benchmarking tool for airports management. This paper goal is to determine the sensitivity of this method in relation with its inputs and outputs. A Data Envelopment Analysis is conducted for 128 airports worldwide, in both input- and output-oriented measures, and the results are analysed against some inputs and outputs variations. Possible weaknesses of using DEA for assessing airports performance are revealed and analysed against this method advantages.*

Keywords: *airport benchmarking, airport efficiency, Data Envelopment Analysis, DEA sensitivity, airport operational performance.*

1. INTRODUCTION

Airport industry has undergone major changes in terms of management. Airports role changed from simple infrastructure elements into profit orientated business. This started in the middle '80 with the privatization of British airports and took many forms like transfer to local authorities, total or partial privatization, sale of shares or external management contract, etc. This transformation of the airports was determined by the need of self-financing, national budgets being unable to fully support all airports operating expenses. Changing an airport orientation towards commercial is not a simple task, because there is little knowledge about administration of an airport as a profit orientated business. Traditionally, the airport was considered no more than an infrastructure element, like a highway, and was evaluated accordingly, by the maximum capacity and by recorded traffic over a certain amount of time (day, month, year). It is obvious that this way of assessing performance is not proper for a business and other evaluating methods were needed. However, the airport business has some particular aspects that make it different from other business. First of all, the initial capital is huge and the airports assets are expensive, fixed and unconvertible. Second, the airports have no control over the demand of air transportation in its area (unlike the airlines which can operate wherever there is a demand and leave the unprofitable routes). At last, the airports experience high fixed operating costs, that tends to increase financial problems whenever the air traffic drops. Given these particularities we may say that the airport business is special and needs extra care from its managers.

Naturally, this commercialization trend leaded to the need for methods for assessing airports performance. Classical performance indicators for business, like net profit, were somehow improper for this task, given the fact that not all airports are operating in the same conditions. Some airports benefit from local or central authorities' assistance through direct or indirect subventions, free of charge services such as ATC, security, ambulance or fire fighting, total or partial tax exemption, etc. This assistance is justified by the important role of the airport in the economy of a region, and, in some cases, by the social role. We don't intend to debate the necessity or the fairness of these measures in this paper, we are just pointing the fact that in the airport business financial performance can be misleading and therefore other efficiency measures are needed. Another way to determine efficiency is the output/input ratio. This is also difficult to use because an airport is using a wide range of inputs to "produce" a number of different outputs. In order to successfully

Aspects regarding the type of behavior of squeeze film dampers

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Abstract: *Squeeze film dampers (SFD) are devices used to control vibrations in rotating machinery; a SFD consists in a thin oil film installed within the supports of rotating machines in order to tune their dynamic coefficients to minimize rotors' vibrations level. Squeeze film dampers can be used in conjunction with any type of bearing supports; however, they are most often used to tune the dynamic properties of ball bearing-based supports of aviation turbines. Ball bearings provide very high stiffness and very low damping, so, in many cases the ball bearings housing (which contains the outer race of the ball bearings) is installed in (in other words, surrounded by) an oil film that improves the overall performances of rotor's support. The oil film of SFDs can be affected by cavitation, which is in turn function of the oil supply and sealing systems; the current paper presents some aspects regarding the modeling of SFD and the impact of the SFDs' behavior upon the dynamic of SFD supported rotors.*

Key Words: *Squeeze film dampers (SFD), hydrodynamic bearings, rotor dynamics*

1. INTRODUCTION

Good behavior of turbomachinery requires adequate shaft dynamics, which in turns require carefully designed shaft supports. Tuning the properties of the shaft supports in modern high speed turbines is a difficult task; when the shafts must be supported by rolling elements bearings (which is the case of the aviation jet engine shafts, where safety regulations restrict the use of sliding bearings), designers must use additional devices to adjust the stiffness and damping of the shaft supports to the levels required by the good behavior of the machine; in other words, to reduce the very high stiffness provided by the ball bearings and to add damping, which ball bearings provide in very small amounts.

Squeeze Film Dampers (SFD) are devices used for adjusting the properties of shaft's supports. They can be used in conjunction with any type of bearing supports; however, SFDs are most often used to tune the dynamic properties of ball bearing-based supports of aviation turbines. The ball bearings housing of ball-bearings-SFD supported rotors (i.e the part of the housing which contains the outer race of the ball bearings) is installed in (in other words, surrounded by) an oil film that improves the overall performances of rotor's support. To avoid hydrodynamic bearings stability problems, the rotation of the outer race of the ball bearing (i.e. the journal of the SFD) is restricted, usually by mechanical devices. Various types of springs can also be utilized to further tune the stiffness of the rotor's supports. Figure 1 shows a schematic of a SFD with springs.

A great amount of research have been dedicated to SFDs, which have been reviewed, for example, in Refs. 0, 0 however, many aspects regarding the design and modeling of these devices are still subject to open research. The oil film of SFDs can be affected by cavitation, which is in turn function of the oil supply and sealing systems; the current paper presents some aspects regarding the modeling of the SFD and the impact of the SFDs' behavior upon the dynamic of SFD supported rotors.

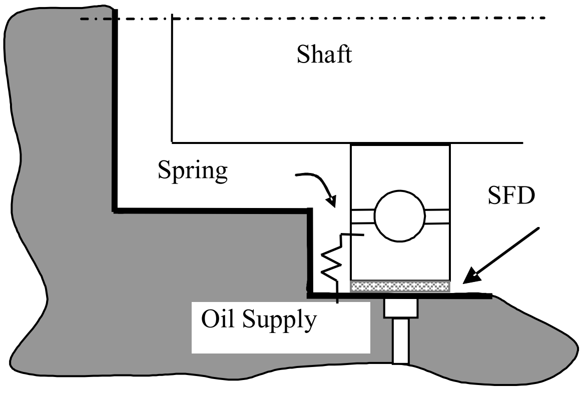

Fig. 1 SFD with springs

Mechatronic test bench for wing flight controls

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Why do you want to climb Mount Everest? „Because it's there” (G. Mallory)

Abstract*: A mechatronic test bench for wing flight controls was performed. The following flight controls of a specimen of cantilevered wing are actuated from a control desk: a) aileron and flight spoilers; b) speed brake for ground aerodynamic braking; c) high-lift devices: leading edge devices (slats) and trailing-edge flaps. Further, the stand will be developed as a wing load control ground demonstrator.*

Keywords: *mechatronics, wing flight controls, Boeing 737, hydraulic servoactuators, brushless servomotor, applied control synthesis, LabVIEW.*

1. INTRODUCTION

A mechatronic test bench for actuating flight controls was conceived and performed, mainly by INCAS Mechatronics Department. Thus, it all started with a simple idea, that of using a wing at hand, instead of building one only as a means, what would have been both outside the main purpose and too expensive. Thus, so far, the flight controls of a specimen of naturally cantilevered wing of Boeing 737-200, purchased from RomAero SA, Bucharest, are actuated as a mechatronic system from a control desk. It will be further developed as a wing load control ground demonstrator. This paper presents some details of this achievement.

2. MAIN OBJECTIVES AND ASSOCIATED TECHNICAL CHALLENGES

It is easy to understand that buying a wing from a decommissioned aircraft involved some disadvantages and risks. In fact, the entire project began by cutting a Boeing 737 wing at the level of the engine nacelle; the later was maintained as enhancing mounting structure. Performing a mechatronic test bench for wing flight controls meant achieving step by step of the following goals:

a) design and realization of hydraulic power supply and distribution
b) design and realization of the platform of wing power control units, namely:
  - control units for high-lift devices: trailing edge flaps control unit and leading edges (slats) control unit (in conjunction)
  - aileron and flight spoilers control unit (in conjunction)
  - speed brake for ground aerodynamic braking
c) design and implementation of command, control, acquisition, recording and visualization systems

The main issues and the technical challenges which had to be solved were:

♦ design and implementation of console type mounting structure of the wing and of two floors of walkways for access to its entire surface (Fig. 1)
♦ identification of a complex network of pipes, cables and wires, starting from an intricate network visible on the surface of cutting (Fig. 2)
♦ verifying the functionality of all components of hydraulic actuation of flight controls
♦ filling of missing elements and replacement of defective items

Fig. 1 − General view of the wing on the test bench

Fig. 2 − From where we started ... a part of sectioned wing

Return from Orbit in Minimum Time Optimal

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Abstract: *This work studies the return in minimum time optimal orbit of the surveyor vehicle (from the target vehicle) at a given point The optimum controls to be determined are the angles of the thrust with coordinates axis and states variables which are the coordinates and velocities; the surveyor vehicle being equipped with a low thrust installation, their motion equations being written in the three-dimensional space, in relative motion; the space origin being the target vehicle. Initial conditions give are for coordinates and velocities, and final conditions for coordinates. The optimization of this problem (Lagrange type, applying the Pontriagin maximum principle) is solved using shooting solution of a TPBV problem with free final-time. The calculations were performed for circular and elliptical orbits around the Earth.*

1. INTRODUCTION

A interception problem [1] is solved an the planar case, with time constrained, single impulse return trajectories followed by low trust, power limited return trajectories that minimize the total propellant consumed. This work is an extension of work [2] in which is studying the problem minimum time optimal rendezvous, the optimal controls being the angles of the thrust with coordinates axis, two space vehicles on circular and elliptical orbits, the surveyor vehicle being equipped with a low thrust installation, their motion equations being written in 3D, in relative motion; the space origin being the target vehicle. Also, this problem is an extension of problems [3,4] in which in these problem was solved the problem minimum fuel optimal rendezvous.

2 PROBLEM FORMULATION. MOTION EQUATIONS OF THE STATE

Considering the $OXZY$ inertial planeocentric system of axes and the $Axzy$ system (the z axis in the direction of the vectorial radius $\boldsymbol{r}_0$ - position vector of target, the x axis is counter rotating, and the y axis perpendicular on them) related to the A target which evolves on an already known circular or elliptical orbit, (Fig. 1), starting from Newton's 2nd law (because the motion takes place out of the atmosphere the aerodynamic forces are neglected, and we divided by the mass),

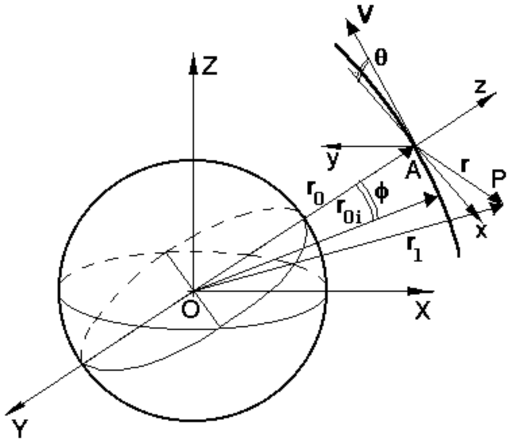

Fig. 1 Motion geometry

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Flow control on (aerodynamic) airfoil using jet blowing on a Coandă surface

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Abstract: *Flow control on aerodynamic airfoil has been studied since the early twentieth century, one of the precursors being Prof. Ion Stroescu. Basically, he applied flow control wing (FCW) to increase the circulation (lift) of an airfoil using concepts derived from the conventional blowing and suction procedures.*

If we consider the effect discovered by H. Coandă, the effect that has his name and consists in the tendency of a thin fluid jet to remain attached to a convex curved surface, we obtain one of the best known methods of flow control on an airfoil with or without high-lift devices.

The advantage of the "Coandă" effect includes reducing the complexity and weight of high-lift systems (used mainly on aircraft during take-off or landing phase).

The numerical study was performed on three typical configurations using the two-dimensional RANS solver supplemented with the $k-\omega$ *SST turbulence model.*

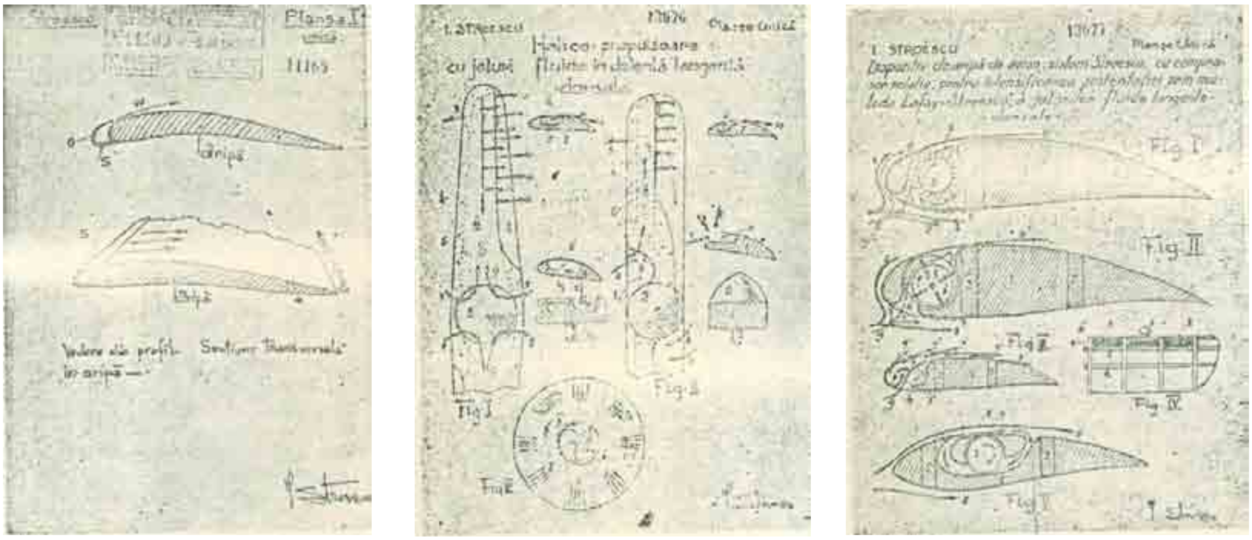
Key Words: *Coanda effect, flow control, RANS.*

1. INTRODUCTION

Flow control on airfoils was studied as early as the beginning of the twentieth century, one of the precursors being Prof. Ion Stroescu.

Practically, he applied the flow control on the wing, a concept derived from the conventional blowing and suction procedure, to increase circulation (lift) of an airfoil.

The device involves a series of high velocity thin jets, blowing high impulse air, tangentially to an airfoil surface ("Gas squirts, tangential to the leading edge upper part", patent No. 11169 dated January 9th, 1925 – [1]) (figure 1).



Blowing on the leading edge *Blowing on the trailing edge* *Increasing circulation on the upper side of airfoil*

Fig. 1 - Flow control proposed by Prof. Ion Stroescu

Section 6. Experimental Investigations in Aerospace Sciences

Costs and benefits of applying the rules of aerospace management as a model for microeconomics and macroeconomics management

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Abstract: *Aerospace management has developed strongly after the emergence of aerospace science application in everyday life of man. Economics is often looking for a tested model to apply. This paper presents a few rules and some possible applications of aerospace management that are likely to be taken in microeconomic and macroeconomic management, including project management. For every rule of aerospace management which I recommend to be taken in microeconomic or macroeconomic management there are benefits and costs attached. Arguments from the history of decisions on issues of macroeconomics and microeconomics are presented. The paper emphasizes the importance of correct and operational information systems as well as the need for the decisions to be taken by those who have the complete set of data for each case. The management conclusions are exploited for macroeconomic and microeconomic management in an area that has greatly expanded due to a strong restriction: an error in aerospace science applications can be a disaster.*

1. INTRODUCTION

This paper falls under the category ‘interdisciplinary studies’. It is an inventory of certain principles and rules in the field of aerospace which are or should be applied in macroeconomics, microeconomics and project management.

This paper could have had the subtitle ‘The gap between the aerospace management and economic management’ or ‘how much we lose if we fail to capitalize the rules of space management’.

The aerospace activity started, just like other highly complex and technical (at large) fields, with a few daring people who soared in an area of the unknown. That gate opened to knowledge has given way to the future civilization, to progress in many directions, to some new innovations in multiple areas of human action. ‘With each step they established the foundation of an ever richer set of rules which are guiding us today’ (Kenneth Fischer: 2009).

Certain similarities between the evolution of aerospace and economic management suggested that there should be deeper connections between the two components of contemporary science. For example, going beyond the slogan that you cannot invest in what you cannot watch from your own office of economic management corresponds to the transition from the direct flight to instrument-based flight. In both cases the improvement of the mechanisms of transmission of the information flow required by the management, both of the enterprise and of the flight, was the chance of progress.

2. PRINCIPLES, METHODS AND RULES SPECIFIC FOR AEROSPACE MANAGEMENT APPLICABLE TO ECONOMY MANAGEMENT

2.1 An important issue of the flight procedures is in the aerospace field the *timely preparation of the maneuver.* It is unconceivable for a pilot to trigger a maneuver of the aircraft without observing rigorous procedures timely thought and established. In general, the preparation of the maneuver and the maneuver itself are practiced until assimilation and full understanding. Ground simulations are made so as the pilot might perform within the programmed parameters both the preparation of the maneuver and the maneuver itself. This principle is reflected differently in macroeconomic and microeconomic management.

Policies are elements of continuity in a company. Even when the shareholders and partners are changed the object of the company and internal policies usually remain unchanged. When the change of the company evolution direction occurs, careful analyses are made and measures are taken to prepare the new activities or the new resources involved in performing the activities of the company. According to the accounting prudential rules the restructuring is recommended to be treated as part of the investment process.

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Mechanical applications within the helicopter flight simulators

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Abstract: *The research activity oriented on the development of complex components within the robotics, machine-tools, terrestrial, naval and aerial vehicles leads to an accumulation of knowledge regarding the design, manufacturing and mathematical modelling of mechatronic solutions.*

One of the latest projects is having as main goal the achievement of an HMS - Helicopter Mechanical Simulator, to enable modelling construction and testing structural, control and human behaviour solutions.

The HMS address to different aspects connected with domains like robotics, sensors, mechatronic systems, structural behaviour, modules control, digital instrumentation, human behaviour, virtual reality and digital immersion.

In the paper are shown some results concerning the alternate force distribution within the cockpit structure, considering the basic forces induced in flying and the basic forces induced within the flight simulation process.

Key words*: Robots, Helicopter Mechanical Simulator, forces transmission*

INTRODUCTION

The robots are having different mechanical structures and must work with specific “skills” in different environments. A robotised mechanical structure may be conceived as an open kinematic chain (serial robots) or a closed kinematic chain (parallel robots) with generally 4-6 DOF (DOF- degree of freedom).

Within scenarios the inverse kinematics IKP is more difficult to be solved for serial robots than for parallel robots, but if for the serial robots we have generalized mathematical models the parallel robots need a mathematical model for each type of structure.

Based on the experience to deal with parallel robots, in 2006 an ambitious project starts, to create a robotised platform, singularities free, with the most appropriate dynamic model for developing a helicopter mechanical simulator. The aim was to create the possibility to test components in dynamic conditions, to create an enhanced reality visual system and to provide special effects and conditions for emergency cases.

The flight simulator history is as old as the aviation itself. From the beginning, in flight simulators the parallel kinematic was used. For a plane flight simulator 4DOF are enough. In the helicopters flight simulation, is more challenging, all 6DOF are needed. That was one of the reasons for the decision to create an application based on the helicopter mechanical simulation and from here to other facilities.

In our case the simulation platform was named HMS – Helicopter Mechanical Simulator and having a real IAR 316 cockpit. The methodology used in developing and utilization of the HMS is the PLM (product/process life management) combined with dynamic modelling generated with CAD/CAE/CAM/PDM systems provided by Siemens PLM.

In 2006 the U.S. Army Research Institute for the Behavioural and Social Sciences in Arlington, Virginia [McC 2006], made public a report as an answer to the raise question: Do Army Helicopter Training Simulators Need Motion Bases?

As long as our interest in the simulator development is for research on topics such as modular-vehicle, interface design, subsystems design and the development of handling qualities and evaluation the aim of our work is to develop robotic structures and control that made possible to test components in dynamic conditions; to valorised enhanced reality visual systems but also to provide special effects and induced conditions for emergency cases.

The pilots training, retraining or testing was not considered. Nevertheless information and data including simulator learning, pilot preferences force-cueing systems and Perceptual Control Theory are not neglected that may be beneficial under certain conditions, such as tasks involving disturbances in motion.

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Validation of an on-board microphone system for the measurement of the exterior noise of a helicopter

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Abstract: *Until now microphones on the exterior of helicopters have mainly been used to measure the influence of airborne noise (in particular boundary layer noise) on interior cabin noise or as error signal sensors in active rotor noise control systems. In these applications, there are quite relaxed requirements for the microphone type and its location.*

In the application envisaged in the ANCORA project, however, the transfer function between on-board and ground noise will have to be determined in order to provide accurate information for the validation of prediction models. This requires a correct measurement of the absolute noise levels on-board over a wide frequency range. This implies a much more strict selection of the microphone type to be used and its location on the helicopter exterior, avoiding areas where important influence of rotor flow or forward speed is encountered. In ANCORA the use of surface microphones is envisaged for this purpose, together with a boom microphone with nose cone.

Before the full flight test campaign with both ground and on-board microphones, test flights were performed to select the optimum microphone positions. The present paper describes the process by which the selected microphones were validated for this purpose and the main results of the initial test flights.

1. INTRODUCTION

The application of on-board microphones on the exterior of the helicopter fuselage is not straight-forward. Especially the use of surface microphones to capture the noise signal at source is innovative and still open for research and development in the field. A detailed study was thus necessary in order to validate the surface microphones and their positions on the helicopter.

Based on the results of the survey, together with the aerodynamic experience of AgustaWestland, several potentially positions were selected and tested during two pre-test flights.

In order to verify the on-board noise system, measurement tests have been realized under representative flight conditions to obtain comparative analysis of surface microphones and different microphone nose-cones. All these tests provided information about the influence of flow generated noise on recorded broadband noise and also the potential masking of any tones. Based on results of these measurement tests, the final locations of microphones have been determined.

Another important aspect of these preliminary tests was to highlight and solve before the final test campaign, any potential issues related to this type of application.

Different nose-cones among the various models available were verified, because it is known from wind-tunnel experience that the use of nose-cones is rather sensitive to the flow incidence angle. For this reason some tests have been performed with representative angles of attack installed on a dedicated device on automobile, so as to check their influence on the noise recorded. Based on the results of this study it can be concluded that the envisaged use of on-board microphones is feasible.

2. DEFINITION OF THE ON-BOARD MICROPHONES CHAIN AND INITIAL VALIDATION TESTS

Since the on-board microphone system has two different models of surface microphones, the goal of the first test was to check these acoustic transducers in same conditions. Thanks to the courtesy of INCAS (National Institute for Aerospace Research "Elie Carafoli") from Romania, these surface microphones have been checked inside the subsonic wind tunnel.

A point of view upon Rayleigh damping hypothesis

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Abstract: *The paper presents some considerations regarding to the different ways of application of Rayleigh hypothesis in damping characterization of an elastic structure for vibration analysis.*

Both harmonic and transient analyses were considered for stationary and nonstationary loading schemes. The main objective was to determinate the dumping dependency with respect to different frequency ranges and the method to implement in numerical simulations.

The theoretical considerations were validated by vibratory experiments performed on the real structure that was analyzed.

1. INTRODUCTION

The study was a part of a project dealing with an aircraft engine starting test bench. The main task of the design team was to analyze the dynamic answer of the supporting frame during the starting, acceleration, deceleration and normal functioning regimes under the cyclic loading forces that are supposed to act. The cycling forces are a result of the unbalanced centrifugal forces of the rotating machines that will be mounted on the supporting frame.

In order to indentify the vibratory answer of the structure, the study was initially developed on a reduced scale model (fig. 2.1) in order to identify the damping characteristics and it took place in three types of analysis:

- **Modal analysis** dedicated for identification of the eigen modes of the supporting frame (dynamic deformed shapes and frequencies).
- **Harmonic analysis** performed in order to define the real values of the eigen frequencies and the amplitude factor values in specific damping conditions.
- **Transient analysis** to clarify the mechanical behavior of the frame during the starting process of the rotating machines especially when the resonance interval will be crossed.

The analysis was performed by using finite element method inside ANSYS code.

2. THE FRAME NUMERICAL MODEL

The numerical model of the frame was a result of the trade off process during the design process that supported some adjustments to assure the accepted answer according to the initial design restrictions.

2.1. THE GEOMETRIC MODEL

The CATIA geometric model of the frame was imported in ANSYS code and adapted for the numerical analysis. According to the types of elements that was intended to be used for modeling the geometry was described by points, lines and volumes as presented in figure 2.2.

Fig. 2.1 The reduced scale supporting frame

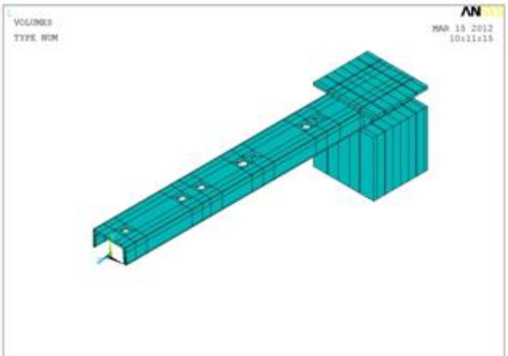

Fig. 2.2 The geometric model of the frame

Implications of air quality in high speed wind tunnel testing

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Abstract: *The paper discusses the implications of air quality used in the high speed wind tunnels on the quality of the obtained results, and the possible error sources in experimental data arising from a poor assessment of air parameters. The importance of moisture content control in the test air used in high speed blowdown wind tunnels is paramount as it can change the flow type from monophasic to biphasic or even three phasic (gas, liquid and ice particles/abrasive formations) in some extreme cases, changing the whole flow physics set of phenomena and exhibiting new properties that are not in accordance with the scaling theories currently used when conducting normal wind tunnel work.*

An often overlooked or took for granted air quality can be one of the most insidious error sources in a wind tunnel experimental program. Not only is that it not apparent from the normally collected data- that almost always contains only force and moment information, and sometimes pressure- but can lead to some hard to diagnose undesired behavior that is apparent in the result processing stage of the raw data, forcing laborious approximate corrections or even test repeats.

An extreme case of a poorly conditioned flow arose quite unexpectedly in the 50’s when the Canadian specialists built a high speed test tunnel designed to reach Mach 4, 3 but took no special precautions lined to measuring the temperature in the flow. The flow expansion in the test section led to a very large drop in temperature, as dictated by the general laws of gases (1), in their case temperatures dropping below 70 K and thus the nitrogen in the air started to liquefy. All of the sudden the flow was no longer monophasic but bi-phasic – a fluid containing gas and liquid, the specific heat was no longer a constant but a function and regions of different densities appeared in the flow, changing its aspect. Because of these facts, the similarity conditions could not be realized until a massive heating installation was used to suppress the phenomena. In cryogenic wind tunnels the cooled gas flow is under strict supervision; in some only nitrogen is used, in others other compounds than air to ensure that the flow remains monophasic and thus the similarity conditions can be achieved.

$$pV = \nu RT \tag{1}$$

Equation 1 gives the law of perfect gases that gives the condition for a gas to be considered thermally perfect, considering the unit volume (V=1):

$$P = \frac{RT}{\nu} \tag{2}$$

where R is the gas constant and has a particular value for each gas, given by the ratio of the universal gas constant $\bar{R}$ to the molecular weight MW, as:

$$R = \frac{\bar{R}}{MW} \tag{3}$$

For basic low speed wind tunnel operation, a simplified theoretical apparatus is used, and the working gas is generally considered to be thermally perfect, with the notable exception of high pressures or very low temperatures, such as those encountered in cryogenic or plasma arc tunnels. It comes as a necessity that the specific heats are treated as constant. In reality, they suffer variations as temperature conditions change, and more complex computational procedures are available for the cases when these differences are important.

What is important for the purpose of this work is how the specific heats c_p and c_v , that are profoundly affected by “working gas quality” interfere in a basic calculation for the Mach number in the high speed wind tunnels.

The typical working gas in a high speed wind tunnel contains a trace amount of water vapor (most of it is extracted through various means), compressor oil vapor, rust and sand particles that come from the inner walls of the flow expander (Laval nozzle), tanks and compressors ahead of the test section.

S8. Section dedicated to “Caius Iacob” Centennial reffering to the following topics:

8.1 Basic methods in Fluid Mechanics

8.2 Equations of Mathematical Physics

8.3 Mathematical Modeling

8.4 Dynamical Systems

8.5 Technical Applications

Section 8.1 Basic methods in Fluid Mechanics

A detailed laminar flow field within the normal shock wave considering variable specific heats, viscosity and Prandtl numbers

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Abstract: *The gas flow field within an 1D normal shock wave at variable specific heats, viscosity and Prandtl numbers with temperature is considered. At* Pr = 0.75 *and constant specific heats and viscosity, the already known analytical solution in a somehow different form is found. At some distance from the wave, the flow is isoenergetical (constant total enthalpy). In order to see if the isoenergetical character of flow within the shock wave is maintained, a method to correct the solution for variable Prandtl number is developed. The obtained solution is close to an analytical one and proves that the deviation from the constant enthalpy hypothesis is less than 0.5%. An interesting thing pointed out is the coexistence of the supersonic and subsonic regimes within the shock wave. Examples of application for air at two Mach numbers are given.*

Keywords: *Prandtl number, dimensionless temperature, stagnation enthalpy, isoenergetical flow*

1. INTRODUCTION

The occurrence of a normal shock wave is possible if a supersonic flow is slowed down by an obstacle or by a counter pressure (Fig.1).

Although important quantitative aspects (pressure, density and velocity jumps) can be expressed without using directly the viscosity, the shock formation is due to it.

If the Navier-Stokes equations are used, more information is obtained, and the important role of the viscosity in such a narrow region is highlighted.

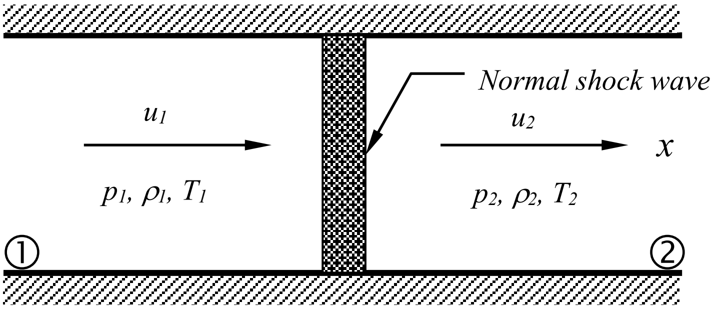

Fig. 1 – The normal shock wave

An analytical solution is known in case of constant specific heats and viscosity [1], for a fixed value of Prandtl number Pr = 0.75, when the total enthalpy is constant throughout the flow field. Due to the high value of the Reynolds number, the shock wave thickness is very small, which explains the good results obtained by treating it as a simple jump.

In case of considering this simple situation, the effect of variation of specific heats was first introduced numerically [2]. Then, the maintaining of the analytical expressions for pressure, temperature and density ratios etc. in terms of an equivalent Mach number was pointed out [3]. Now, along with the specific heats variable with temperature, the effect of viscosity (also variable) is introduced, correcting the assumption Pr = 0.75 as well.

2. THE BASIC EQUATIONS

One writes the conservation equations for steady viscous laminar flow in 1D. By adopting the usual notation u, ρ, p, T for velocity, density, pressure and temperature, one has [4], [5], [6]:

$$d(\rho u)=0;\quad \rho u=\text{const.};\quad \rho_1 u_1=\rho_2 u_2\ \ (\mathit{continuity}) \tag{1-a}$$

Analysis of the microscopic-macroscopic structure in real fluid flow

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Abstract: *This paper presents new results concerning the physical coexistence of the molecular chaos and the continuous determinism in real fluid flows. By using the FLUONS mathematical devices [1], the authors investigate the existence of a physical process called MOLECULAR COHERENCE. This particular kind of structure equilibrium needs the fulfilment of the conditions required by the increasing entropy and the minimum of the kinetical as well as the informational energy. Qualitative and quantitative results concerning the fluctuations in real fluid flows support this new point of view in Fluid Mechanics.*

1. INTRODUCTION

As was shown in our previous papers [1][2], the coordinate transformation and the FLUON expression reveal interesting aspects of the fluctuations associated to a given mean velocity distribution. We continue to exploit the mathematical properties of these FLUONS in a much profound sense, namely the coexistence of the physical molecular chaos and the determinism of the continuous fluid flows. Essentially, let's consider the $f(\eta)$ normalized distribution ($0 \le f \le 1, 0 \le \eta \le 1$) as an order zero FLUON expression, indicated by the notation $F^{(0)}(\eta)$.

For the various order of FLUONS expressions, namely $F^{(k)}(\eta)$, where $k = 0,1,2,\ldots,N$, we get the algorithm:

$$F^{(k)}(\eta) = \frac{\int_0^\eta \eta \cdot F^{(k-1)}(\eta)\, d\eta - \eta \left[\int_0^1 F^{(k-1)}(\eta)\, d\eta - \int_0^\eta F^{(k-1)}(\eta)\, d\eta \right]}{\int_0^1 \eta \cdot F^{(k-1)}(\eta)\, d\eta} \tag{1}$$

In the figure 1 (a, b, c) we show some examples of various $F^{(0)}(\eta)$ discrete and continuous distributions leading to about the same $F^{(1)}(\eta)$, $F^{(2)}(\eta)$, $F^{(3)}(\eta)$ distributions. This very interesting feature of the expressions $F^{(0)}$, $F^{(1)}$, $F^{(2)}$, … concerning the tendency towards typical $F^{(k>2)} \sim \eta(2-\eta)$ distribution in spite of the great variety of the continuous or discrete $f = F^{(0)}$ distributions needs a complete and correct mathematical treatment.

This remains, however, beyond the aims of the present paper.

Physically, the linear combination of the integrals $\int_0^\eta \eta^m f\, d\eta$ and of the constants $\int_0^1 \eta^m f\, d\eta$ involved in the $F^{(k)}$ distributions leading to about the same distribution $\left(F^{(k+1)} - F^{(k)} \cong 0\right)$ raises a lot of questions.

Firstly, the very ordered or very disordered macroscopic boundary conditions imposed to real flows with undisturbed pressure, temperature, density and viscosity, but with eventually various degrees of wall roughness or impurities require the fulfillment of the entropy principle[b] for a given system. This condition – a given system – is very important, because it needs a definite amount of macroscopic energy which ensure the normalization of $0 \le F^{(k)}(\eta) \le 1$ and of $0 \le \eta \le 1$. Let's mention, in this respect, the turbulent spot and the biological cell.

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[b] We consider here the Boltzmann law.

New theoretical and applicative mathematical methods in the study of the fluids with free surfaces movement[a]

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In memoriam Acad. Caius Iacob (1912 - 1992)

Abstract: *We have known the preoccupations and the realizations of Acad. Caius Iacob and also all members who were leaded by him in the jets theory domain, with applications in hydro-aero-dynamics. In this paper are presented new results, methods and problems applicative.*

1. *The inverse methods which lead to the Riemann – Hilbert boundary problems, and singular integral equations for the analytical functions. Here we solve the problems regarding of the fluids flow in the curvilinear obstacles presence, regarding of the profiles optimization for the minimal or maximal drag. The drag forces are expressed by the nonlinear integral operators and the extremum of the functional is made by using the parametrical or the Jensen inequalities. The applications are for the aerodynamics profiles, brake deflectors, bow problem, wind turbines, ship sails, jets theory, etc.*
2. *The usage of the analytical generalized functions (p,q) analytic in the study of compressible fluids with axial symmetry flow. In this part are presented some solving methods and the mathematical modeling for the fluids from magneto-gas-dynamics (plasma jets) in the case of the parallel fields leading to the Beltrami equations. We remark some methods for the finding of the complex hydrodynamic axial symmetric potential in the case of the plane movements.*

For the both problems in the case of applications, we make some comparisons with the classical results refer to these methods for curvilinear profiles. Here are highlighted the exact solutions or the analytical – numerical methods for the boundary problems using the analytical or generalized analytical functions theory.

The author and his collaborators have highlighted in this important field more than 50 scientifically papers recognized in national and international publications; they pay tribute of gratitude to the scientific advisor Acad. Caius Iacob.

1. INTRODUCTION

The studies and the applications of the fluids movement with free surfaces in the curvilinear profiles' presence have an important complexity in hydro-aerodynamics. These theoretical and applicative mathematical methods were studied by: Helmholtz, Ciaplâghin, Von Mises, Iacob, Falcovich, Gurevich, Cisotti, Villat, Birkhoff, Gelborg, Vâlcovich, Hureau, etc. The results of the Romanian school in the field of fluid mechanics led by Acad. Caius Iacob were remarkable. Among the results obtained in the jets theory and in the study of fluids movement are remembered the research obtained by Simona Popp, Alex Nicolau, M. Lupu, T. Petrilă, A. Carabineanu, E. Scheiber and other authors from the new generations.

The complexity of the solving of these problems is given by the existence of the boundaries, the curvilinear profiles from the physical plane. The boundary problems of Dirichlet and Riemann - Hilbert type can not be directly solved. This is the reason that is considered an helpful canonical plane like the Levi - Civita semicircle or the half plane. It is known the hodographic method Ciaplâghin - Iacob - Falcovich (C-J-F) in the case that the boundaries are straight lines (segments), plane surfaces, dihedral angles.

New results are obtained with the "inverse method" for the incompressible fluids in the case of curvilinear obstacles. Here is presented the generalization and the extension of this method noting on the profile the measure and the angle of the speed. On the real axis are obtained some dual singular integral equations, easy to solve. Next is presented the geometrical optimization of the profiles for the aerodynamic forces (the coefficient of drag and of the lift).

The stationary potential plane flow of an inviscid fluid is considered in the absence of mass forces. Relating the velocity field $\vec{v}=u\vec{i}+v\vec{j}, u=u(x,y), v=v(x,y)$, to the frame in the physical flow domain $D_z, z=x+iy$, then within the hypothesis as well as from the continuity equation $div\vec{v}=0$ and the condition for an irrotational flow $(rot\vec{v}=0)$,we have [1]

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[a] Presented at the Romanian Academy, 10 October 2012

[b] Prof. Dr. (m.c. AOSR)

8.2 Equations of Mathematical Physics

On the gravitation theory[a]

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1. INTRODUCTION

In this paper we try to formulate a gravitational theory, that have on its basis Isaac Newton's (1642-1727) idea [1][2], who interrogated how he explains himself the gravitational effect answered *hypotesis non fingo* this being the philosopher's occupation, but he as a science man, he deals only to discover the Mechanics laws.

However interrogated in intimate manner, how can he to explain the gravitation, he supposes that this may be owed to an ether fluid more fine, that being attracted by the bodies is condensed on these, attracting only the other less bodies.

In this aim we shall consider two plane sources to calculate the attraction force.

2. THE CASE OF PERMANENT AND PLANE MOTIONS

Using the complex variable functions, specific to the plane and potential motions,

$$f(z)=\varphi(x,y)+i\psi(x,y) \tag{1}$$

where the complex variable is $z=x+iy=re^{i\theta}$ and the real part being the potential of the two velocity components, but the imaginary part being the stream lines potential, then we shall have:

$$u=\varphi'_{x}=\psi'_{y}, \qquad v=\varphi'_{y}=-\psi'_{x} \tag{2}$$

From (2) by introducing the two velocity components in the mass conservation equation, one sees that the velocity potential is an harmonic function

$$u'_{x}+v'_{y}=\varphi''_{x^2}+\varphi''_{y^2}=\underset{x,y}{\Delta}\varphi=0 \tag{3}$$

also the motion being irotational, one has that the stream lines function is harmonic

$$\text{rot}\vec{v}=\begin{vmatrix}\vec{i} & \vec{j} & \vec{k}\\ \dfrac{\partial}{\partial x} & \dfrac{\partial}{\partial y} & \dfrac{\partial}{\partial z}\\ u & v & w\end{vmatrix}=\vec{k}\left(v'_{x}-u'_{y}\right)=0, \quad \rightarrow \quad \underset{x,y}{\Delta}\psi=0 \tag{4}$$

3. THE COMPLEX RESULTANT CALCULATION

To calculate the complex resultant $\vec{R}=R_{x}\vec{i}+R_{y}\vec{j}$ due to the pressure p exerted on a circle C [3]

$$\bar{R}=R_{x}-iR_{y}=\frac{i\rho}{2}\oint_{C}\left|\frac{\mathrm{d}f}{\mathrm{d}z}\right|^{2}\mathrm{d}z \tag{5}$$

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[a] Presented at the Romanian Academy, 10 October 2012

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8.3 Mathematical Modeling

Numerical investigation of the zeros of some dispersion relations appearing in sound attenuation problems in rectangular lined ducts carrying a gas flow

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Abstract: *We investigate here the zeros of a dispersion relation occurring in problems of sound attenuation in rectangular lined ducts. These cannot be straightforwardly found, since formulating the dispersion relation involves solving a differential equation that has only known numerical solutions for realistic mean flow profiles. In order to overcome this difficulty we consider approximate dispersion relations, obtained by replacing the unknown function in the differential equation, with corresponding Taylor polynomials.*

1. INTRODUCTION

Together with pollution, noise emission is one of the major impediments for increasing the number of operating aircraft, thus prompting for research and innovation towards a more environmentally friendly aircraft.

The on-going research is two-fold: on the one hand side it goes towards revolutionary solutions [1, 2], on the other hand it aims at improving existing technology, in particular, developing further the acoustic liners that are applied in different regions of the engine and engine duct in order to absorb produced sound.

Physical experiments in this direction are expensive and laborious, while simulations based on mathematical models are cheaper and faster, but useless unless faithful to reality, making the quality of the model essential.

A better understanding of various aspects in the model has motivated a series of studies of different geometries ranging from rectangular, cylindrical axisymmetric, annular to varying-cross-section ducts, and different types of mean flow profiles starting with the simple uniform flow up to more realistic smooth boundary layers. The idea is to simplify the problem in various ways and observe predominant features.

We proceed in Section 2 with describing the model under use here, and a short justification for the choice. In Section 3 we proceed by deducing an approximate dispersion relation based on a Taylor polynomial about an ordinary point of the equation. We discuss the benefits and drawbacks of this choice.

2. THE MATHEMATICAL MODEL

Focusing on the duct inlet, we choose a 2D rectangular geometry carrying a uniform flow with a parabolic boundary layer in the neighborhood of the walls (see Fig.1).

Acoustic pressure, density and velocity are well described by the Euler equations linearized around a stationary base flow $(p_0, \rho_0, \mathbf{v}_0)$, with a mean flow of the type $\mathbf{v}_0 = (U(y), 0)$,

$$\frac{1}{c_0^2}\left(\frac{\partial p'}{\partial t} + U\frac{\partial p'}{\partial x}\right) + \rho_0\frac{\partial u'}{\partial x} + \rho_0\frac{\partial v'}{\partial y} = 0 \tag{2.1}$$

$$\rho_0\left(\frac{\partial u'}{\partial t} + U\frac{\partial u'}{\partial x} + \frac{\mathrm{d}U}{\mathrm{d}y}v'\right) + \frac{\partial p'}{\partial x} = 0 \tag{2.2}$$

$$\rho_0\left(\frac{\partial v'}{\partial t} + U\frac{\partial v'}{\partial x}\right) + \frac{\partial p'}{\partial y} = 0 \tag{2.3}$$

where we have used the fact that acoustic perturbations are generally speaking isentropic, and therefore $p' = c_0^2 \cdot \rho'$.

Numerical investigation of zeros of some dispersion relations appearing in sound attenuation problems in a circular lined duct

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Abstract: *In this paper the zeros of some dispersion relations appeparing in sound attenuation problems in circular lined ducts, carrying a gas flow, are investigated numerically. To find the values of frequencies for which the dispersion relations vanish is not easy at all. That is beacause these relations contain the solution of an initial value problem which depends on the unknown frequency and can not be found explicitly. In order to overcome this difficulty we consider approximate dispersion relations, obtained by replacing in the shear flow the solution of the initial value problem by its Taylor's polynomial approximate. For numerical computations typical aeronautical examples are considered.*

1. INTRODUCTION

Acoustic liners are used to line the surface of ducts, carrying a gas flow, in order to attenuate sound emissions; for example, the exhaust pipes of automobiles or the intakes and bypass ducts of turbofan aircraft engines. At take-off, the most important source of aircraft noise is the turbofan aero-engine. Sound produced by interaction of the fan and stator, by interaction of fan with mean flow, and the fan alone when its blade tips rotate supersonically, propagates through the inlet and bypass duct of the engine. Due to the practical importance of the sound attenuation, in the last 60 years more than five hundred papers were published concerning the subject. The papers [1]-[23] and those referred herein represent just a small part of the scientific literature.

In our paper the lined duct is infinitely long, straight and circular. The flowing fluid is an inviscid non-slipping and compressible perfect gas. The radial and circumferential components of the mean flow velocity are equal to zero and the axial component depends only on the distance to the duct axis. The pressure and the density of the mean flow are assumed to be constant. For the homogeneous linearized Euler equations (around this mean flow) mode type solutions are searched, which satisfy the boundary conditions corresponding to the liner-perturbation interaction of mass-spring-damper type. The general framework of the paper is very similar to that in Rienstra- Vilenski paper [13]. The novelty concerns mainly the use of approximate dispersion relations for the determination of the frequencies for which the dispersion relations vanish.

2. PRELIMINARY RESULTS

Assume that an inviscid non-heat-conducting, compressible perfect gas flows inside an infinitely long, straight and circular lined duct of radius R (Fig. 1).

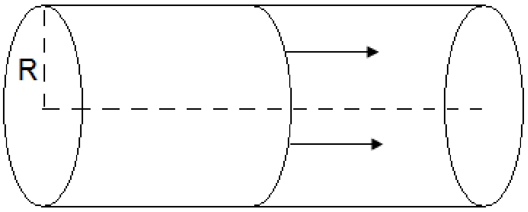

Figure 1: Gas flow in a straight circular lined duct

The equations for the mass conservation, the radial, circumferential and axial components of the momentum and energy, respectively, are [13]:

$$\frac{\partial \rho}{\partial t}+\frac{1}{r}\cdot\frac{\partial(r\rho v)}{\partial r}+\frac{1}{r}\cdot\frac{\partial(\rho w)}{\partial \theta}+\frac{\partial(\rho u)}{\partial x}=0 \tag{1}$$

Propagation of the initial value perturbation in a cylindrical lined duct carrying a gas flow

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Abstract: *For the homogeneous Euler equation linearized around a non slipping mean flow and boundary conditions corresponding to the mass-spring-damper impedance, smooth initial data perturbations with compact support are considered. The propagation of this type of initial data perturbations in a straight cylindrical lined duct is investigated. Such kind of investigations is missing in the existing literature. The mathematical tools are the Fourier transform with respect to the axial spatial variable and the Laplace transform with respect to the time variable. Functional framework and sufficient conditions are researched for that the problem be well-posed in sense of Hadamard and the Briggs-Bers stability criteria can be applied.*

1. INTRODUCTION

Assume, as in [1], that an inviscid non-heat-conducting, compressible perfect gas flows inside an infinitely long, straight and cylindrical lined duct of radius R (Fig. 1.).

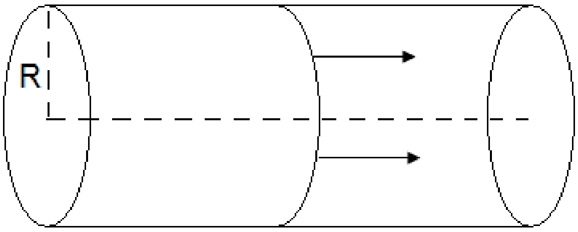

Figure 1: Gas flow in a straight cylindrical lined duct.

Let x, r and θ the axial, radial and circumferential coordinates, u, v and w the projections of the velocity vector on the coordinate axes x, r and θ respectively, ρ and p, the density and the pressure. The equations for conservation of mass, and radial, circumferential and axial components of momentum and energy are [1]:

$$\frac{\partial\rho}{\partial t}+\frac{1}{r}\cdot\frac{\partial(r\rho v)}{\partial r}+\frac{1}{r}\cdot\frac{\partial(\rho w)}{\partial\theta}+\frac{\partial(\rho u)}{\partial x}=0 \tag{1}$$

$$\rho\cdot\left(\frac{\partial v}{\partial t}+v\cdot\frac{\partial v}{\partial r}+\frac{w}{r}\cdot\frac{\partial v}{\partial\theta}+u\cdot\frac{\partial v}{\partial x}-\frac{w^2}{r}\right)=-\frac{\partial p}{\partial r} \tag{2}$$

$$\rho\cdot\left(\frac{\partial w}{\partial t}+v\cdot\frac{\partial w}{\partial r}+\frac{w}{r}\cdot\frac{\partial w}{\partial\theta}+u\cdot\frac{\partial w}{\partial x}+\frac{v\cdot w}{r}\right)=-\frac{1}{r}\cdot\frac{\partial p}{\partial\theta} \tag{3}$$

$$\rho\cdot\left(\frac{\partial u}{\partial t}+v\cdot\frac{\partial u}{\partial r}+\frac{w}{r}\cdot\frac{\partial u}{\partial\theta}+u\cdot\frac{\partial u}{\partial x}\right)=-\frac{\partial p}{\partial x} \tag{4}$$

$$\frac{\partial p}{\partial t}+v\cdot\frac{\partial p}{\partial r}+\frac{w}{r}\cdot\frac{\partial p}{\partial\theta}+u\cdot\frac{\partial p}{\partial x}+\gamma\cdot p\cdot\left(\frac{1}{r}\cdot\frac{\partial(rv)}{\partial r}+\frac{1}{r}\cdot\frac{\partial w}{\partial\theta}+\frac{\partial u}{\partial x}\right)=0 \tag{5}$$

Mathematical Models and Numerical Simulations for the Blood Flow in Large Vessels

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***Abstract**: We are proposing a non-Newtonian, Cross type rheological model for the blood flow, taking also into account the viscoelastic behavior of the vessel walls. The mathematical equations and the appropriate boundary conditions are considered in cylindrical (axisymmetric) coordinates. Numerical experiments in stenosed artery and in artery with aneurysm (using COMSOL 3.3), illustrate the performances of the model.*

1. INTRODUCTION

Blood is a relevant example of a non-Newtonian fluid. The shear rate dependent viscosity and the viscoelastic behavior come from the elastic structure of red cells which move in a viscous fluid. The Navier-Stokes theory [1] is acceptable for modeling blood flow in large arteries. However the effect of red cells on the viscosity becomes more important at low shear rates ($< 100\ s^{-1}$) near the center of the large vessels or in separated regions of recirculating flow. Furthermore, in unsteady flows, the wall shear stress may be considerably small. In these cases, the viscosity μ cannot be considered as a constant, but as a decreasing function of the shear rate $\dot{\gamma}$.

The purpose of this work is to investigate a model for blood which allows, by taking into account an accurate calculation of the magnitude and variation of the wall shear stress, the detection of the early stages of vascular lesions, such as stenosis and aneurysms. Wall shear stress is believed to have a special importance in the rupture of aneurysms [2].

For blood we accept a non-Newtonian rheological behavior with a variable coefficient of viscosity under the conditions of an unsteady (pulsatile) flow regime connected with the rhythmic pumping of the blood by the heart. As the same time we admit the incompressibility and homogeneity of the blood while its flow is laminar and the exterior body forces are neglected. The vessel wall is considered to be viscoelastic.

The proposed mathematical model has been numerically tested in the case of the blood flow in large arteries with stenosis and aneurysm taking into consideration viscoelasticity of the limiting walls.

Viscoelastic materials have time-dependent response to stresses. If the stress time is below the characteristic relaxation time of the constitutive material, we remark elastic effects. But if stress time is higher than the characteristic relaxation time, viscous response is noticed [3].

2. MATHEMATICAL MODEL

Accepting the axial-symmetric behavior of the blood flow in the considered vessel, the axis of symmetry being *Oz*, the flow domain Ω in cylindrical coordinates (r,θ,z) at any moment *t* is defined by

$$\Omega(t) \equiv \{(r,\theta,z)/r < R+\eta(z,t),\quad \theta \in [0,2\pi), z \in (0,L)\},$$

where *R* and *L* are, respectively, the (initial, at rest) radius and the length of the envisaged vessel tube while $\eta(z,t)$ is the classical deformation (displacement) at the considered moment of the vessel wall.

In the half meridian plane θ = *const*, if *u* and *v* are the components of the blood velocity on the directions *r* and *z* respectively while *p* is the pressure (assessed versus a reference pressure p_{ref}), then, in the absence of the exterior forces, the mass conservation principle (the continuity equation) is

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How one establishes a working program for a pulsatory liposome?

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Abstract: *In this paper, we have considered the problem of the pulsatory lipid vesicle. In certain conditions, the vesicle swelling start again and it's the evolution of a lipid vesicle under positive osmotic stress may be a cyclic process. We have named it as a pulsatory lipid vesicle. The length time of each cycle increases with the rank of the cycle. Also, it is very important for biotechnological applications to know more about the solute amount delivered during each cycle.*
The pulsatory liposome may be regarded as a two stroke engine using the osmotic solute as a fuel. It is energized initial by establishment of transmembrane gradient of osmotic solute. The osmotic solute plays the role of fuel, which is consumed due to its deliver in external medium. But the consumed fuel is usefulness material for biotechnological applications. The aim of this paper is to establish a working program for this biomicroengine. This in equivalent with the endowing of the lipid vesicle with intelligent properties.

2010 Mathematics Subject Classification: *92 Biology and other natural sciences*

Keywords: *Pulsatory liposome; Dynamical parameters; Usefull parameters.*

1. INTRODUCTION

Recently, a sequence of 30–40 pores was observed in the same giant vesicle, a pore at a time, which can appear in vesicles stretched by optical induced mechanical tension [1, 2].

The pore appearance in plane lipid bilayer may be influenced by thickness fluctuations [4, 5, 8] or by structural defects [4, 6, 7].

In the lipid vesicle the pore appearance, may be favored by mechanical tension induced by different ways [10, 11].

The pore appearance in lipid bilayers following some controlled processes may be an usefull and interesting way for transmembrane transport [3, 5].

In the last our papers we have made an analysis of the two stages of a cycle from working life of a pulsatory liposome (swelling and relaxation) and we have written about how a lipid vesicle has to release the drug molecules, in a well-controlled fashion [12-17]. It must work as a pulsatory liposome. Its energy is supplied by the concentration gradient across membrane of an impermeant solute.

There are two very interesting biotechnological applications which request the increase of membrane permeability: gene therapy and targeted special substances delivery [12, 16, 17].

In this paper we will define the dynamic parameters characterizing a cycle of the periodical activity of a pulsatory vesicle and will point out how the pulsatory liposome may be programmed to work. Before the two part highlighted before, we placed a subchapter which contains a description of the phenomenological base of the running of a pulsatory liposome.

2. PHENOMENOLOGICAL BASE OF A PULSATORY LIPOSOME

Let us consider a liposome filled with aqueous solution containing an osmotic solute. The initial state of the liposome is characterized by smooth and unstretched lipid membrane and by the internal solute concentration. It is considered as equilibrium reference state. This liposome is inserted into a bath with a hypotonic aqueous medium. Such, the reference state become the initial state of the liposome dynamics. Due to osmotic pressure, created by the transmembrane gradient of solute concentration, water molecules inflow inside to liposome, across its membrane.

The osmotic flow of solvent determines: 1) the swelling of the liposome; 2) the stretching of liposome membrane; 3) the dilution of the internal solution. Also, the surface tension increases in the same time with the liposome expansion.

8.4 Dynamical Systems

Lyapunov exponents for dynamical systems as a tool for studying fluid-structure interaction problems

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Abstract: *Solutions of some dynamic systems emphasize the existence of a strong dependence of the initial conditions, described in the phase plane by attractors with a complicated geometrical structure. The complexity of the geometrical structures of such attractors leads to the notion of strange attractor. Strange attractors are defined in many ways, but we adopt here the definition of Holmes and Guckenheimer, an attractor is strange if it contains a homoclinical transversal orbit. The main objectives of this paper are to state the general framework of the fluid-structure interaction problems and to develop a tool for computing Lyapunov exponents, in order to analyze stability aspects of this problem. As an example, the maximum Lyapunov exponent is used to determine if there is a strong dependence on the initial conditions in the panel flutter problem.*

INTRODUCTION

Analysis of coupled fluid-structures is required to understand and optimize the behavior of such systems. Aeronautical structures represent a typical example of a coupled fluid structural problem. To solve such problems different strategies have been proposed and the selection of the most efficient approach depends on the characteristic of the problem. A decisive role in the selection of the considered approach is played by the model employed in the mathematical description of the fluid. For example, if the fluid is modeled by an acoustic approximation, a potential formulation can be used to solve the problem [3, 2]. If the fluid is modeled using Navier-Stokes equations or Euler equations, in literature two cases are considered: a weak interaction between the fluid and the structure when the both domains barely deform and the second case corresponds to a strong coupling and both domains can undergo large deformation. The main approaches are: simultaneous and iterative procedures. When simultaneous approach is considered the fluid and solid equations are established and solved together while in iterative methods the equations are solved separately and the solution variables are passed iteratively from one field to the other until convergence is achieved. The main objectives of this paper are to present the coupled field equations, to discuss different approaches, and because such problems are a source of chaotic motions, as an example in the panel flutter problem (stated in a very simple manner) we use the maximum Lyapunov exponent as a tool to detect chaotic motions. For the general presentation we follow [13]. The panel flutter problem follows [4] and [15].

GENERAL PROBLEM FORMULATION

The solid structure is usually described in Lagrangian formulation (a particle is followed in its movement) and for the fluid flow analysis the Eulerian formulation is usually considered (one is interested in the behavior of the fluid at a particular position in space). When considering a fluid flow interacting with a solid structure the fluid domain changes as a function of time and an arbitrary Lagrangian-Eulerian (ALE) description is needed [13]. Following [13] we describe in the following lines the general fluid-structure equations (solid structures can undergo large deformations and the fluid equations are Navier-Stokes or Euler equation).

EQUATIONS OF MOTION

a) Structural Equations

The Lagrangian equations of motion of the structure are:

$$\rho \frac{\partial^2 \mathbf{u}}{\partial t^2} = \nabla \cdot \tau + \mathbf{f}^{\mathrm{B}} \tag{1}$$

8.5 Technical Applications

Considerations on study the aerodynamic of pantographs railway vehicles

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Abstract: *Improvement of electrical railway traction vehicles, involves among others things achieve a good capture of the current and of the voltages of contact line through pantographs.*

The aerodynamic forces and dynamic forces on interaction pantograph - stranded, increase with the speed of movement and may have harmful effects on ensuring of proper contact. This can lead to worsening of the switching and can even at detachment of pantograph.

This article presents some aspects of aerodynamic pantograph.

1. INTRODUCTION

Once with the increase movement speed for railway vehicles, it is necessary and an analysis of resistance to advancing data from aerodynamic phenomena.

Starting from the general form of resistance to advancing of railway vehicles [1, 2], also known as Davis's relationship (1), we see that aerodynamic phenomena of a vehicle, increase resistances with the speed square at its displacement, which becomes more evident at high velocity.

$$R_t = a + b \cdot v + c \cdot v^2 \tag{1}$$

where R_t – total resistance to progress of the train;
a – mechanicalresistances at rolling caused by axle loads;
b·v – the resistances at advancing non aerodynamic
$c \cdot v^2$ – the resistances at advancing aerodynamic.

Regarding the analysis on the resistances at advancing, caused by the aerodynamic phenomena, electric rail vehicles might decompose in:

- the resistances caused by design form of the box vehicle
- the resistances caused by equipment located on the roof

2. THEORETICAL ASPECTS CONCERNING THE DETERMINATION OF AERODYNAMIC RESISTANCE

From the literature [2, 3, 4], explicit parameter „**c**" of the third term of the second degree polynomial for determining resistance to forward for rail vehicles traveling at speeds up to 300 km / h is done with relation number 2:

$$c = \frac{C_x \cdot S \cdot \rho}{2} \tag{2}$$

where C_x – air drag coefficient of sliding (also known as the coefficient of air penetration) (dimensionless);
S – front surface of the vehicle in cross section (m^2);
ρ – density of air moving vehicle$\left(\frac{kg}{m^3}\right)$
C_x front of the vehicle drag coefficient is determined in turn by equation (3):

$$C_x = \frac{2 \cdot F_x}{\rho \cdot S \cdot \overline{v}^2} \tag{3}$$

where F_x – the frontal sliding force (N);
$\overline{v}$ – velocity of the fluid $\left(\frac{m}{s}\right)$

A magnetorheological suspension system for high speed railway vehicles

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Abstract: *High speed railway vehicles features a specific lateral oscillation resulting from the coupled lateral displacement and yaw of the wheelset which leads to a random oscillatory movement of the wheelset along the track, transferred to the entire vehicle. The amplitude of this oscillation is strongly dependant on vehicle's velocity. Over a certain value, namely the critical speed, the instability phenomenon so-called hunting occurs. To raise the vehicle's critical speed different designs of the suspension all leading to a much stiffer vehicle can be envisaged. Different simulations prove that a stiffer central suspension will decrease the passenger's comfort in terms of lateral accelerations of the carboy. The authors propose a semi-active magneto rheological suspension to improve the vehicle's comfort at high speeds. The suspension has as executive elements hybrid magneto rheological dampers operating under sequential control strategy type balance logic. Using an original mathematical model for the lateral dynamics of the vehicle the responses of the system with passive and semi-active suspensions are simulated. It is shown that the semi-active suspension can improve the vehicle performances.*

Key Words*: mathematical model; railway vehicle; hunting oscillations; magnetorheological devices; semi-active suspension.*

1. INTRODUCTION

The railway vehicles feature a specific lateral oscillation resulting from the wheelset's construction: conical profiled wheels, rigidly mounted on the axle, having opposite conicities. The lateral displacement and yaw coupled oscillations of the vehicle's wheelset result in a random oscillatory movement of the axle along the tracks. This movement is transferred to the entire vehicle and it depends on the vehicle's velocity [1]. For each type of vehicle, if the speed exceeds a certain value, namely the critical speed, the vehicle's lateral oscillations become unstable, these oscillations being called hunting. Hunting may induce significant operation problems: running instability, poor ride quality and track wear. From this point of view, an adequate design of the railway vehicle suspensions holds an important role in maintaining the riding's comfort and safety parameters. Having in view the importance of the lateral oscillations phenomenon numerous authors have dedicated studies to this issue [2–11]. There are possibilities to increase vehicle's speed by an appropriate design of the passive suspension but this approach proves to have limits. By simulating the vehicle's response with the lateral dynamics mathematical model its performances for different designs of the passive suspensions are assessed. The identified solutions lead to much stiffer suspensions able to assure the stability of the wheelset movement at higher speeds but acquiring larger lateral oscillations of the carbody. The present paper will feature a simulation of the lateral comfort of the vehicle and will use these performance criteria to improve the vehicle's suspension concept by introducing semi-active damping devices. The appropriate control strategy of the semi-active suspension will be selected to achieve the best ride quality performances.

2. THE LIMITS OF THE CLASSICAL SUSPENSIONS

With a view to studying the vehicle's response in horizontal plan, a mathematical model which simulates the lateral dynamics of a four axle railway vehicle [12, 13] was built up. It is assumed that all the elastic and damping elements forming the classical suspension systems are weightless and have linear characteristics.

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