FINAL Report

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Workshop on Transition and Unsteady Aspects of Turbomachinery Flows

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Abstract

A workshop was organized on the topic of the title and held on August 17-20, 2003 at the Syracuse University Minnowbrook Conference Center in Blue Mountain Lake, New York. Attendance was by invitation only, forty-seven guests attended and thirty presentations were made. Support was received from NASA Glenn Research Center, the US Air Force Office of Scientific Research, the European Office of Aeronautical Research and Development, the Asian Office of Aeronautical Research and Development and Syracuse University. This workshop was the fourth in a triennial series beginning in 1993. A publication under a NASA CP 2004-212913 will be issued and include all abstracts. No full written papers were required. This report includes a list of attendees and the program of presentations. The next workshop is scheduled for August 20-23, 2006.
Minnowbrook IV
August 2003
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PROGRAM
MINNOWBROOK IV
TRANSITION AND UNSTEADY ASPECTS OF TURBOMACHINERY FLOWS
17-20 AUGUST 2003

Sunday - 17 August 2003

3.00 pm Minnowbrook Center Open to Participants / Registration Begins
3.30-5.30 pm Visit to Adirondack Museum (optional)
6.00 pm Dinner
8.00 pm Welcome - Organization, Goals and Focus of Workshop
John LaGraff - Syracuse University
8.15 pm Louis Povinelli - Keynote Speaker (30 minutes) - NASA Glenn
Current Issues in Unsteady Turbomachinery Flows
9.00 pm Social get together

Monday - 18 August 2003

7.00 am Breakfast

Session 1 - Industry Panel
Moderator: Reza Abhari - ETH, Zurich

8.00 am Industry Panel:
Simon Gallimore – Rolls-Royce
Jochen Gier - MTU
Brent Gregory – Alstom
Greg Heitland- Honeywell
Om Sharma – Pratt and Whitney
Aspi Wadi – General Electric
10.15 am BREAK
Session 2 - Turbines
Moderator: Jayant Sabnis – Pratt and Whitney

10.45 am  Vassilis Theofilis - Nu-Modeling Inc.
On 2D Basic States in LPT Flows and their 3D Instability

11.00 am  Reza Abhari - ETH, Zurich
Influence of End Wall Leakage On Secondary Flow Development in Axial Turbines

11.15 am  Ralph Volino - US Naval Academy
Active and Passive Flow Control on Low Pressure Turbine Airfoils

11.30 am  George Huang - University of Kentucky
Experimental and Numerical Investigation of Transitional Flows as Affected by Passing Wakes/ Using Experimental Data from a Transitional Boundary Layer Experiment to Discuss Transition Modelling: with Application to the Low-pressure Turbine (Terry Simon material)

11.45 am  Discussion

12.30 pm  LUNCH

Session 3 - Blade Cooling, Heat Transfer and By-Pass Transition
Moderator: Jochen Gier- MTU

2.00 pm  Robert Boyle - NASA Glenn
Effects of Free-Stream Turbulence on Turbine Blade Heat Transfer

2.15 pm  Paul Durbin - Stanford University
Bypass Transition Via Continuous Modes: Unsteady Effects on Film Cooling

2.30 pm  Richard Anthony – AFRL Wright-Patterson AFB
High Frequency Surface Heat Flux Imaging of Bypass Transition

2.45 pm  Oleg Ryzhov - UC Davis
Skin Friction and Heat Flux Oscillations in Upstream Moving Wave Packets

3.00 pm  Discussion

3.45 pm  BREAK
Session 4 - Roughness and Receptivity
Moderator: Simon Gallimore – Rolls-Royce

4:00 pm Howard Hodson - Cambridge University
Transition Mechanisms and Use of Surface Roughness to Enhance the Benefits of Wake Passing in LP Turbines

4.15 pm Eli Reshotko - Case Western Reserve University
Transient Growth Approach to Roughness-Induced Transition

4.30 pm Ed White - Case Western Reserve University
Roughness and Freestream Turbulence-Induced Transient Growth as a Bypass Transition Mechanism

4.45 pm Mark Johnson - University of Liverpool
Receptivity Calculations for Transition Prediction

5:00 pm Discussion

6.30 pm DINNER

8.00 pm Session 5 - Working Group Meeting 1

Tuesday - 19 August 2003

7.00 am Breakfast

Session 6 - Flow Control
Moderator: David Ashpis - NASA Glenn

8.00 am Israel Wygnanski-Univ of Arizona
On Streamwise Vortices on a Curved Wall

8.15 am Tom Corke - University of Notre Dame
Plasma Actuators for Separation Control of Low Pressure Turbine Blades

8.30 am Lennert Hultgren - NASA Glenn
Boundary Layer Separation Control under Low-Pressure Turbine Airfoil Conditions Using Glow Discharge Plasma Actuators

8.45 am Hermann Fasel - University of Arizona
Numeric Simulation of Active Flow Control for Low Pressure Turbine Blades

9.00 am Discussion
9.45 am  BREAK

**Session 7 - Separation Bubbles, Calmed Regions and Spots**
Moderator: Israel Wygnanski – University of Arizona

10.15 am  Avi Seifert - Tel Aviv University  
Effect of Elevated Free-Stream Turbulence on Active Control of a Separation Bubble

10.30 am  Paul Gostelow - University of Leicester  
Wakes, Calming and Transition Under Strong Adverse Pressure Gradients

10.45 am  Jean Hourmouziadis - Technische Universitat Berlin  
Phase Shift of Separation Bubble Transition in Unsteady Flow

11.00 am  Frank Smith - University College, London  
Modelling Spots: The Calmed Region, Pressure Gradient Effects and Background

11.15 am  Discussion

12.00 pm  LUNCH

**Session 8 - Compressor Stall, Unsteady Interactions and Low Reynolds Numbers**
Moderator: Aspi Wadia – General Electric

1.30 pm  Greg Walker - University of Tasmania  
Modelling of Unsteady Transitional Flow on Axial Compressor Blades

1.45 pm  Thomas Praisner – Pratt & Whitney  
Challenges in Predicting Component Efficiencies in Turbomachinery with Low Reynolds Number Blading

2.00 pm  Jorge Seume - University of Hanover  
Observations on the Causal Relationship Between Blade Count and Developing Rotating Stall in a Four Stage Axial Compressor

2.15 pm  Torsten Fransson - EKV/KTH, Stockholm  
Experimental and Numerical Study of Non-Linear Interactions in Transonic Nozzle Flow

2.30 pm  Mike Dunn - Ohio State University  
Influence of Clocking and Vane/Blade Spacing on Unsteady Surface Pressure

2.45 pm  Discussion
3:30 pm  BREAK

**Session 9 - Transition Calculations and Turbulence Modelling**
Moderator: Greg Heitland - Honeywell

4.00 pm  Wolfgang Rodi - Karlsruhe Universitat
DNS and LES of Transition on Turbine Blades

4.15 pm  Roddam Narasimha – Indian Institute of Science
Review of Recent Research in Bangalore on the Transition Zone

4.30 pm  Jeffrey Crouch - Boeing Commercial Aircraft Group
Predicting Unsteady Buffet Onset Using RANS Solutions

4.45 pm  Eric Dick - University of Ghent
Transition Modeling with a Dynamic Intermittency Transport Equation

5.00 pm  Discussion

5.45 PM  **Session 10 - Working Group Meeting 2**

7.00 pm  DINNER

8.30 pm  **Session 11 - Working Group Meeting 3**

**Wednesday - 20 August 2003**

7.00 am  Breakfast

**Session 12 - Wrap-up Session**
Moderator: Paul Gostelow - University of Leicester

8.00 am  Report of ad-hoc working groups
Ted Okiishi – Iowa State University

8.45 am  Report of Industry Panel Group (Group Spokesman TBA)

9:15 am  Wrap-up discussions/Observations
Roddam Narasimha – Indian Institute of Science

9.45 am  John LaGraff – Syracuse University
Conclusion of workshop

10.00 am First van leaves for Syracuse Airport
10.30 am   Second van leaves for Syracuse Airport
11.30 am   Box lunches for remaining participants
12 noon    All must vacate center.