日本ヘリコプタ協会
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日本ヘリコプタ協会
the Japan Chapter of AHS International

ＡＨＳ日本支部認定書

CHARTER

OF THE

American Helicopter Society

The Board of Directors
of the
American Helicopter Society
hereby acknowledges the establishment of the

JAPAN CHAPTER

To meet the goals and objectives of the by-laws;
for the purpose of advancing the practice and
application of the science of helicopters and
other aircraft developed in the area of Vertical
Take-Off and Landing (VTOL) devices.

Signed this fifteenth day of December
nineteen hundred and eighty-nine

president

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巻頭言　社会に受け入れられるヘリコプタを目指して

日本ヘリコプタ協会
会長　平本　隆

先日、親戚の見舞いにある病院に行った。病室から外を眺めていると、ヘリコプタが駐機していた。ドクターヘリである。病室は高い場所にあり、外の騒音は全く聞こえなかったが、ランプを点滅させた救急車がヘリポートに近づいているのが見えた。ヘリの出動であろうか。そのうち、メインロータが回転し、医師と思われる姿が機体に近づき、ヘリコプタが飛び立った。私が救急車に気付いてから離陸までほんの数分であった。その後、病室には３０分くらいいただろうか。ヘリコプタが戻ってきた。患者を待機していた救急車に移して、おそらく救急救命室に運んだのだろう。私が親戚と取り留めない話をしているわずかの間に一人の命が助けられたのである。この迅速さこそがヘリコプタの特質、救急救命への貢献である。ドクターヘリの実現、配備に関しては関係された方々の長い間の尽力があって成し遂げたものであり、その効果は社会に認められているところであるが、このシステムをより広く普及させることは、ヘリコプタに関連した組織だけの問題ではなく社会全体の責務である。必要とされる場所に容易に着陸するための法の仕組み、救急救命に必要な病院設備の充実、周辺住民への配慮と理解獲得等、広く解決しなければならない。日本の社会においては、あまりに個人の権利を強調するがため、いろいろな弊害が起こっているが、社会全体で解決すべき問題があることに気付かなければならない。子育てにしても、高齢者介護にしても、環境問題にしても国民全体が解決する意思を持たなければならない。ドクターヘリについても、たまたま命を救われた方だけのためにあるのではなく、その普及拡大は、社会が必要としているシステムとして社会全体で伸ばしていかなければならない。

この中で、我々ヘリコプタに関係する者は何をしなければならないのだろうか。外側から眺めている多くの人々からすれば、ヘリコプタは、「うるさい」、「危ない」、「邪魔」というように思われているかもしれない。我々は、こういった誤解を解き、環境にやさしい、役立つ性能を持った、社会全体から望まれるヘリコプタを供給しなければならない。最近のヘリコプタ開発の方向は、環境に配慮した将来構想が示されている。また、安全に対しては、米国で始められたIHST（International Helicopter Safety Team）活動が広まりつつあり、当ヘリコプタ協会でも検討チームを発足させ、日本における活動の準備を始めている。

ドクターヘリの普及により、ヘリコプタはより社会に近づかなければならなくなっており、そのために社会に受け入れられるヘリコプタを提供し、活動することが我々の任務になっていることを改めて認識している。

日本ヘリコプタ技術協会

2008年度活動報告

１．総会・講演会

- 日時：2008年7月1日（火）
- 場所：東京大学 山上会館
- 総会：2007年度活動報告および収支報告の件他の議案を決議。
- 講演会：
  1. Advanced Technologies for Helicopter Development.
     Dr. Yung H. Yu（Konkuk University）
  2. Active Vibration Reduction Study for Composite Helicopter Blades with Dissimilar Characteristics
     Dr. Sung N. Jung（Konkuk University）
  3. AHS Forum64 IHST Safety Session　報告
     古澤　正人　氏（セントラルヘリコプターサービス（株））
  4. 2008年 AHS Forum　報告
     梁　忠模　氏（宇宙航空研究開発機構（JAXA））
- 出席者：約50名

２．特別講演会

- 日時：2008年7月23日（水）
- 場所：宇宙航空研究開発機構（JAXA）航空宇宙技術研究センター飛行場分室
- 講演会：　カナダにおける航空宇宙研究開発活動の紹介
  - ・Aerodynamics Laboratory Programs
  - ・CFD Research & Development Activities within Rotary-Wing Program
  - ・Development of Engineering Turbulence Simulation Capability with High-Fidelity to Turbulence Physics using LES/DNS
  - ・Overview of the Activities of the Fixed Wing Group

  Dr. Hongyi Xu（Institute for Aerospace Research, National Research Council of Canada）
- 出席者：約30名

- 日時：2008年10月3日（金）
- 場所：航空会館801会議室
- 講演会： R&D and Innovations at Agusta Westland
  Dr. James M.Wang (Agusta Westland VP of Research & Development)

- 出席者：約20名

３．理事会・幹事会

- 理事会・幹事会を、平成20年7月1日（火）に開催された総会・講演会の前（午前中）に実施。2008年度活動計画および予算案等について討議した。
- 平成20年10月3日（金）に開催された特別講演会に先立ち、臨時理事会・幹事会を航空会館801会議室において実施。ＩＨＳＴへの取組について、及び Heli Japan 2010の実行委員会設置について討論した。
- 平成20年12月1日（月）川崎重工業・東京本社において、（１）各理事および幹事へのミッションの振り分け、（２）理事の名称変更について、（３）ホームページの機能拡大について協議した。
- 平成２１年４月１７日（金）に開催された第３３回定例研究会に先立ち、恵比寿スバルビル４０１会議室において実施。JHS 組織改革、Heli Japan 2010、IHST への取組みに関し、討議、現状報告を実施した。

４．定例研究会

第33回定例研究会

- 日時：2009年4月17日（金）
- 場所：恵比寿スバルビル　４０１会議室
- 講演会：
  1. ヘリコプタ制振技術への取組み
     杉村　佳春　氏　　　　（日本ムーグ株式会社）
  2. International Helicopter Safety Team － Overview Briefing
     Mark Liptak　氏　　　（FAA）
- 出席者：約50名

５．IHST委員会

- 平成20年8月26日（火）富士重工業（株）本社８０１会議室にて、以下について協議した。
  - ・IHST 検討委員会(経緯と最近の IHST からの働きかけ等)について(井星)
  - ・FAA から JCAB への要請
  - ・IHST の活動とモントリオール会議の概要について
  - ・国際ヘリコプター安全チームの取り組み

- 平成20年12月25日（木）富士重工業(株)本社５０３会議室にて、IHST の組織体制等 IHST の全般に関する理解を再確認するとともに、日本での活動の取組方法について議論した。
- 平成21年5月8日（金）富士重工業（株）本社 9階 第一応接室にて、日本ヘリコプタ協会の IHST 活動に対する取組みに関して，委員の意見交換を行い，日本ヘリコプタ協会として IHST 活動を行うことを再確認し、具体的な活動内容について協議した。

以上

Advanced Technologies for Helicopter Development（Dr. Yung H. Yu）

Advanced Technologies for Helicopter Development

Prof. Yung H. Yu

Director, Institute of Intelligent Vehicle System and Technology
Department of Aerospace Information Engineering
Konkuk University
Seoul, Korea

July 1, 2008
Japanese Helicopter Society Meeting

Introduction

- Changing Aerospace Requirements
  - affordability, cost, safety
  - environmental effects (pollution, noise), energy (hydrogen)
  - all-weather operation, vertical lift capability
  - real time information
- Advanced Technologies, Innovation
  - information, synthetic environments, miniaturization
  - man-machine interface / partnership, artificial intelligence, cognitive technology
  - multi-disciplinary (fusion) technology
- International Cooperation / Globalization
  - sharing of research, development, and manufacturing technology
    - -- flat world, out-sourcing
  - sustain its technological edge
    - -- transfer of new technology into systems, relevant technology
    - -- highly educated brains
    - -- flexible minds, out-of-box thinking

Rotorcraft

- **Immense social and economic benefits to society**
  - shrink the distance between countries and cities
  - expand human mobility
  - push high technologies (advanced knowledge)

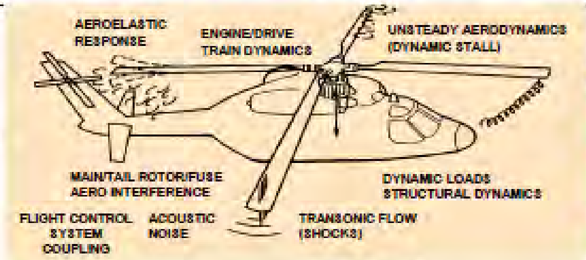
- **Rotorcraft is dynamic global business**
  - beyond the reach of one company or one country
    - development cost, aircraft unit cost, advanced technologies
  - collaboration / partnership
    - develop innovative technologies in unique areas
    - better culture understanding

Advanced Technology Development

Platform	speed, range, payload, weight, endurance flight controls, handling qualities, noise, vibration, composites
Engine	efficiency, weight, power-to-weight, noise
Mission equipments	all weather capability, mission capability, interoperability, communications, pilot workload survivability
Operations	failure prediction, on-condition maintenance, modularity, footprint, cargo handling
Subsystem	reliability, availability, maintainability, life cycle cost, survivability

Rotorcraft Analysis Technical Challenge
Barriers to Accurate Modeling & Simulation

- *Rotorcraft are unique in aerospace…*
  - Complex, highly interactive physical phenomena
  - Major scientific barriers - critical unsolved physical phenomena



Scientific Barriers
- Lack of fundamental knowledge of key rotorcraft phenomena
- Lack of first-principles, physics-based math models

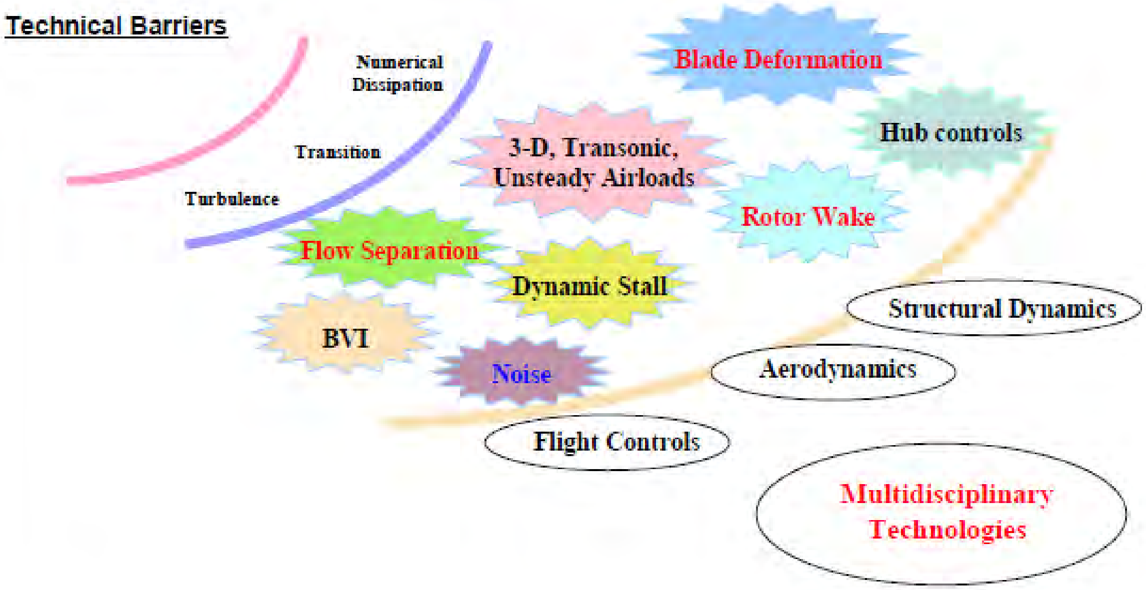
Multi-disciplinary System
- Rotor/airframe (fuselage, tail, multi-rotor)
- Propulsion (engine, drive train)
- Aircraft/Flight controls

Rotorcraft Complexity
- Hub, blade root, controls (bearingless, elastomers, dampers)
- Control (on-blade active, individual blade, swashplateless)

Technical
- Strong coupling, complex interactions
- Stringent accuracy requirements (key higher order effects)
- Accurate vehicle property data difficult to obtain
- User interfaces inadequate for complex vehicle

Computational
- Sheer size of problem - computer hardware limitations
- High productivity computation required

Technical Challenges
In
Aeromechanics



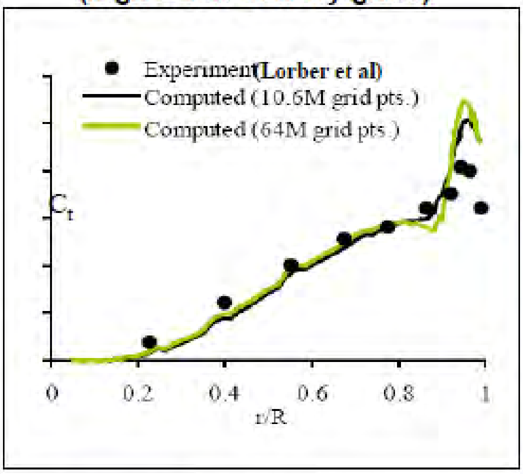
COMPUTING THE WAKE IS DIFFICULT BECAUSE OF SCALE DISPARITIES

- Maximum Scale is rotor diameter, D. Minimum scale is vortex core size, .01D.
- Assuming that resolution of the vortex requires 10 points across the core, required grid size is $(D / .001D)^3$ - - O(10^9) points !
- Two approaches: 1. Direct Numerical Solution (with adaptive grids or large machines)
  2. Wake modeling

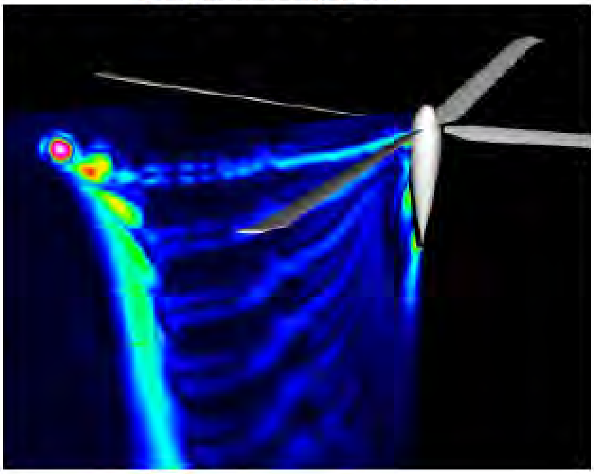
Computation of a Model Rotor in Hover (Strawn & Djomeri)

4th order finite difference model, overset periodic grid

Sectional thrust (high & low density grids)



Wake Cross Section (high-density grid)



- **Clear wake diffusion**
- **Tip-thrust overshoot due to vortex location error**

HOVER DATA IS EASILY CONTAMINATED BY WIND OR RECIRCULATION

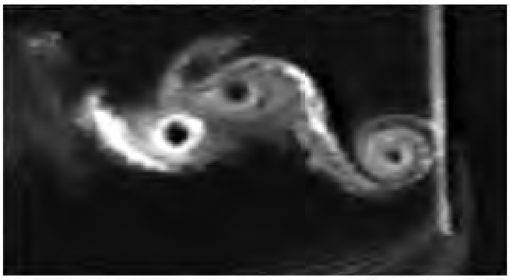
- -

CLIMB TESTING OF A ROTOR GIVES HOVER PERFORMANCE BY EXTRAPOLATION

- -

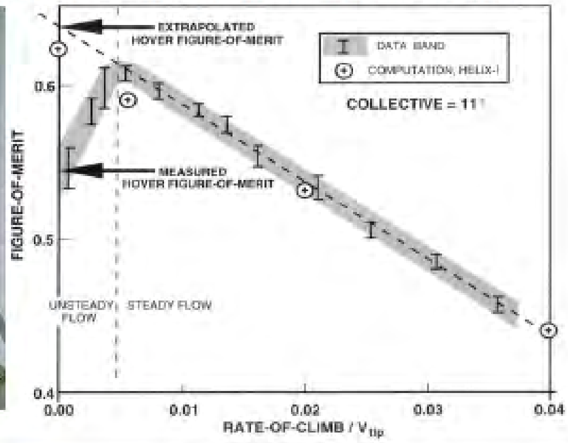
HOVER PERFORMANCE DATA THAT IS FREE OF FACILITY RECIRCULATION

STABLE WAKES FOUND IN STEADY CLIMB



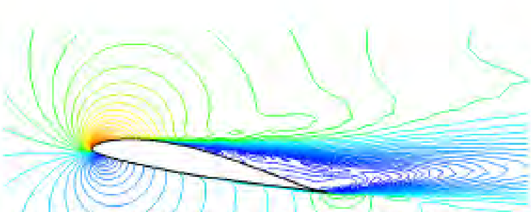
TESTING A ROTOR IN A CLIMB STATE

CLIMB PERFORMANCE TREND EXTRAPOLATES TO HOVER

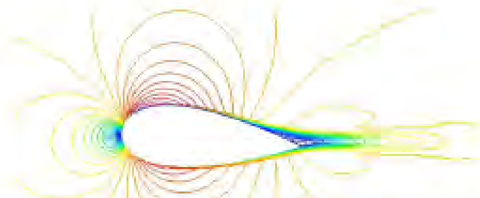


Flow Separation

- **Current ability to predict flow separation from "first-principles" is poor**
- **Develop advanced turbulence models for complex geometries such as DES (Detached Eddy Simulation), LES (Large Eddy Simulation)**
- **Implement advanced turbulence models such as 4-equation v^2f, SARC (Spalart-Allmaras model with rotation and curvature correction)**
- **Develop unsteady transition model for CFD prediction of small-scale rotor testing**



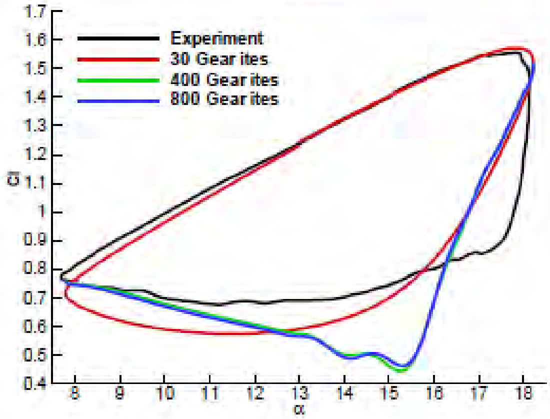
CFD VR07: excessive dissipation/turbulence



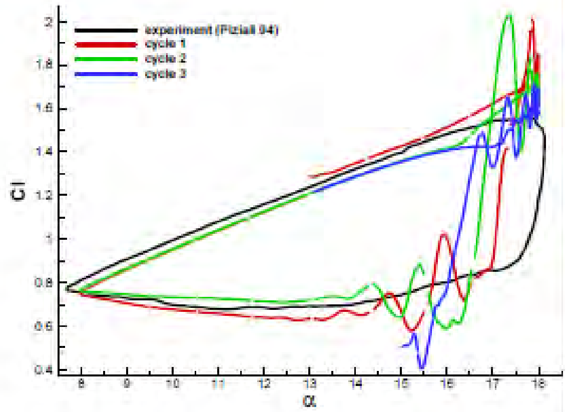
CFD NACA 0036: poor separation prediction

Dynamic stall configurations:

- RANS, DES computations
- good convergence of inner Newton sub-iterations mandatory for accuracy



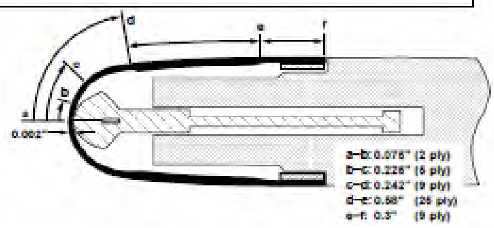
RANS

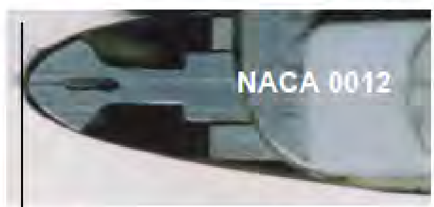


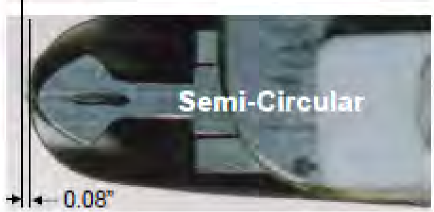
DES

COMPRESSIBLE DYNAMIC STALL CONTROL USING SHAPE ADAPTIVE AIRFOILS

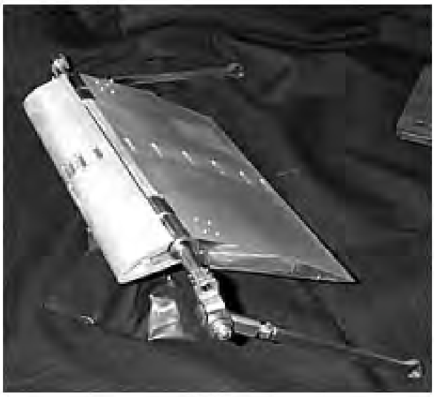
- Can Produce 320% Change in Leading Edge Radius
- Leading 20% Is Made from a Carbon-Fiber Composite
- Can Withstand Aerodynamic Loads at M = 0.45 and k = 0.05
- 0.002 in Thick Leading Edge Is Attached to a Mandrel by a Tang Set *Inside* the Airfoil
- Programmable Feed Back Control Drive System Enables Precise Airfoil Motion Control, Phase-Locked up to 20 Hz
- Fastest Shape Adaptation Can be Completed in 15 *millisec*



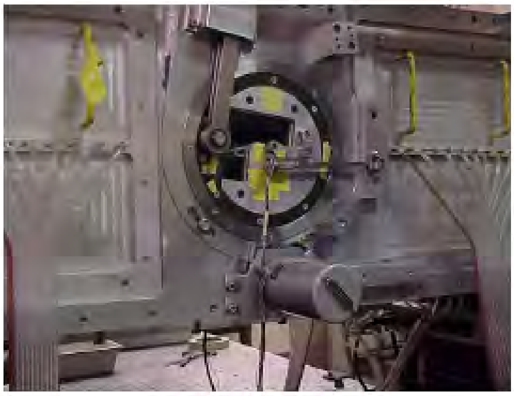




Airfoil with VDLE



Assembled VDLE airfoil



VDLE airfoil in CDSF, with drive linkage set for variable droop

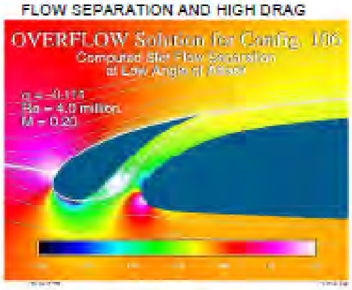
Multi-Element Airfoil Technology

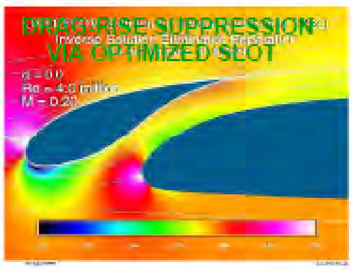
Advanced airfoils provide opportunity for major increase in performance

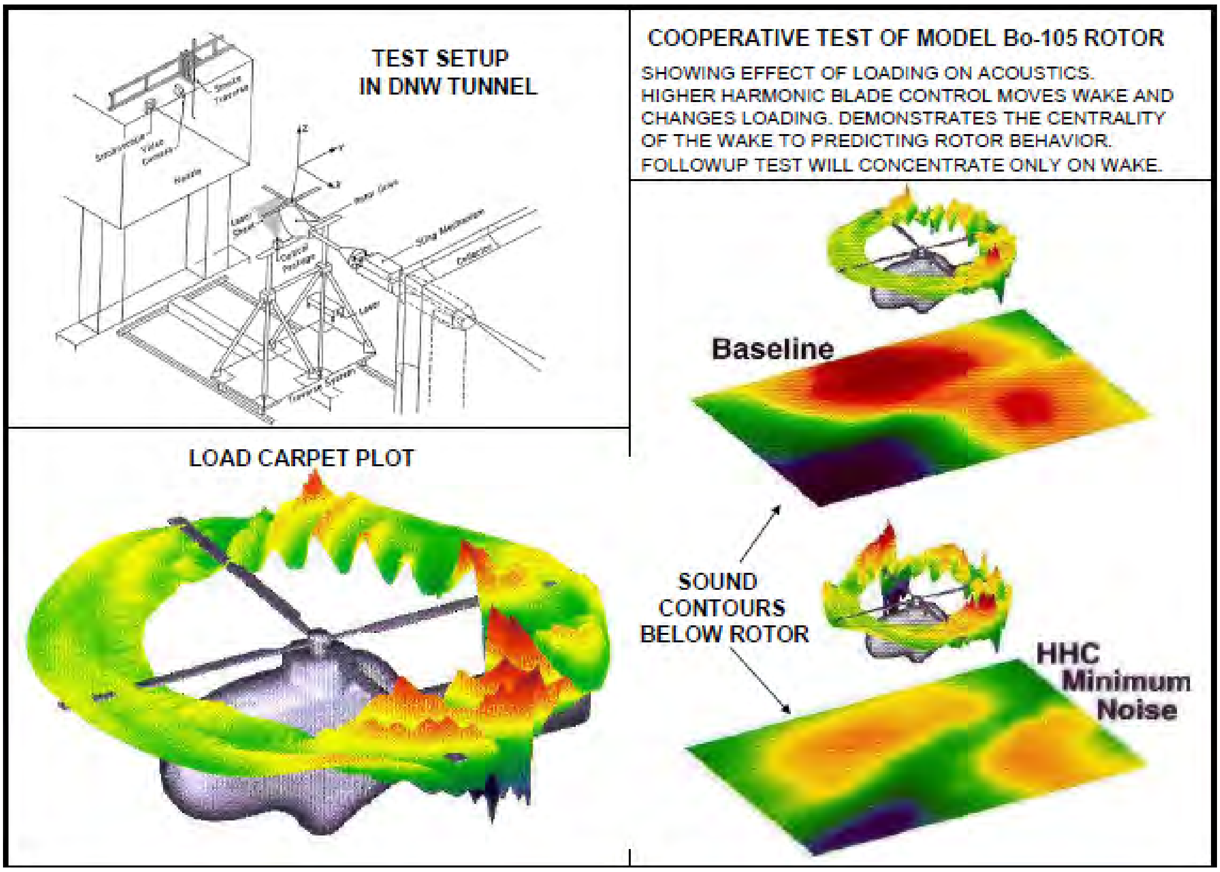
EXPERIMENTAL AND COMPUTATIONAL STUDIES SHOW FEASIBILITY OF EFFICIENT SLOT OPERATION AT ALL ROTOR CONDITIONS

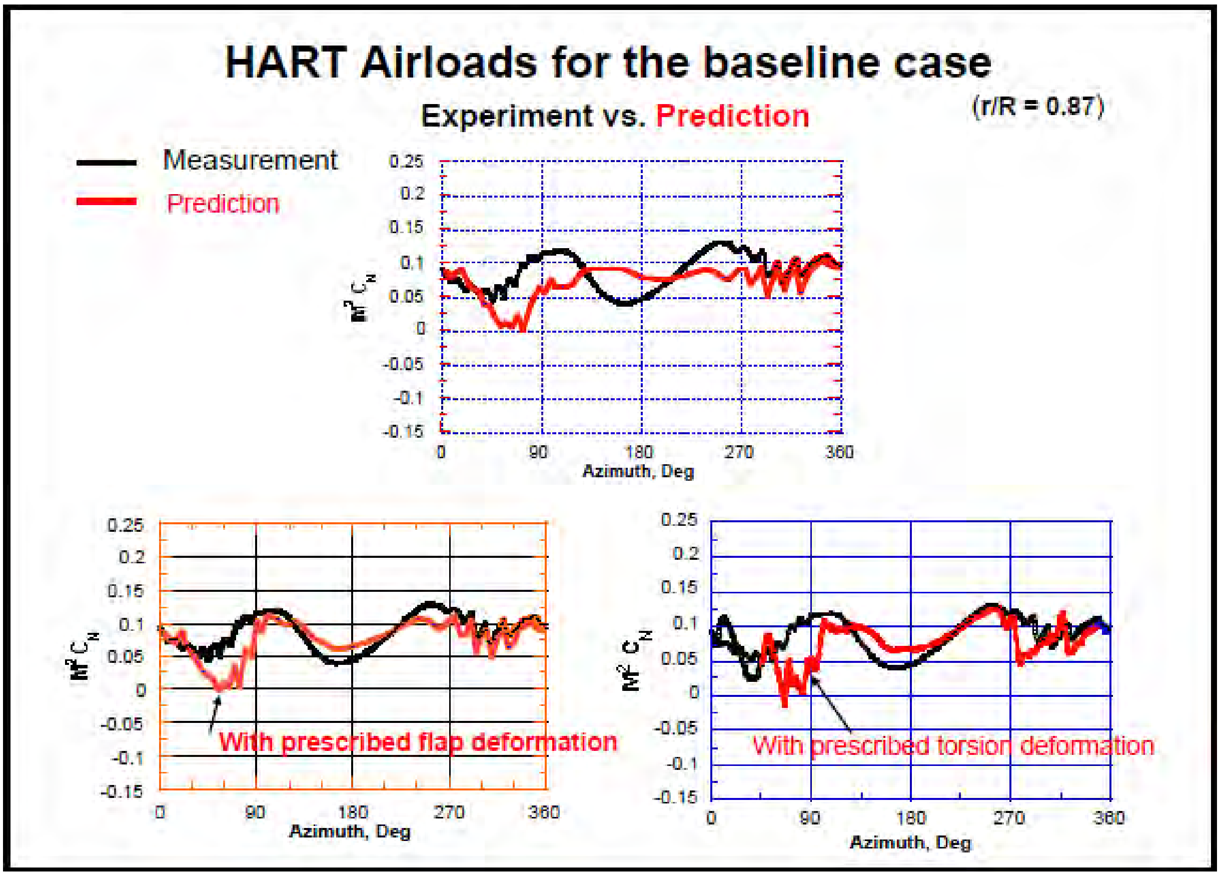
RETREATING BLADE
LOW SPEED, HIGH ANGLE-OF-ATTACK
UPPER SURFACE SUSEPTIBLE TO DYNAMIC STALL
AND DAMAGING CONTROL LOADS

ADVANCING BLADE
HIGH SPEED, LOW ANGLE-OF-ATTACK
SLOT IS SUSCEPTIBLE TO
FLOW SEPARATION AND HIGH DRAG



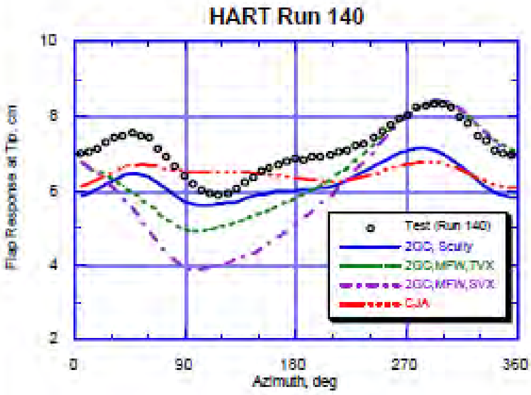



TEST SETUP
IN DNW TUNNEL
COOPERATIVE TEST OF MODEL Bo-105 ROTOR
SHOWING EFFECT OF LOADING ON ACOUSTICS.
HIGHER HARMONIC BLADE CONTROL MOVES WAKE AND
CHANGES LOADING. DEMONSTRATES THE CENTRALITY
OF THE WAKE TO PREDICTING ROTOR BEHAVIOR.
FOLLOWUP TEST WILL CONCENTRATE ONLY ON WAKE.
LOAD CARPET PLOT
Baseline
SOUND
CONTOURS
BELOW ROTOR
HHC
Minimum
Noise

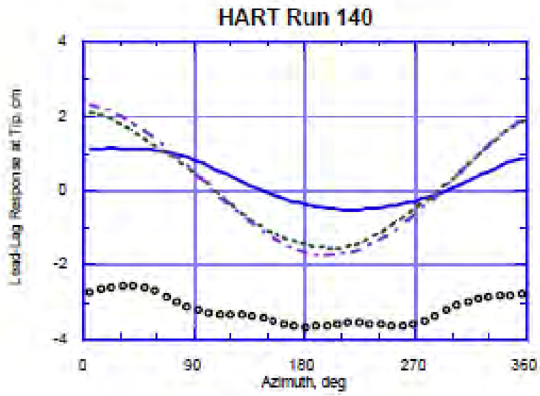

HART Airloads for the baseline case
Experiment vs. Prediction
(r/R = 0.87)
Measurement
Prediction
M² C_N
Azimuth, Deg
0
90
180
270
360
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
With prescribed flap deformation
With prescribed torsion deformation

Blade Flap and Lead-Lag Tip Deflections

Blade Flap Tip Deflection

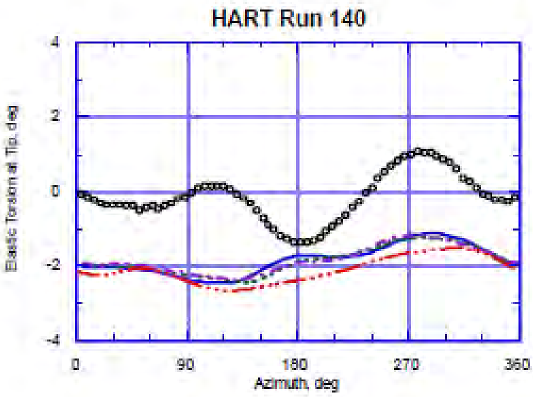


Blade Lead-Lag Tip Deflection

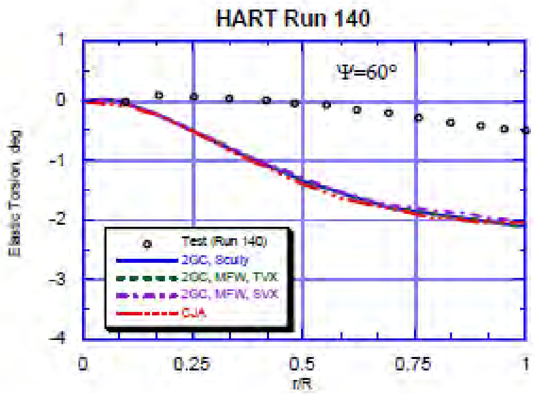


Blade Elastic Torsion

Blade Elastic Torsion at the Tip

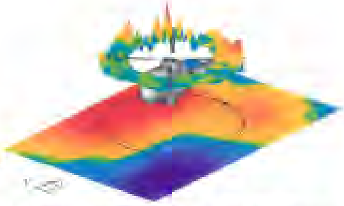


Blade Spanwise Elastic Torsion



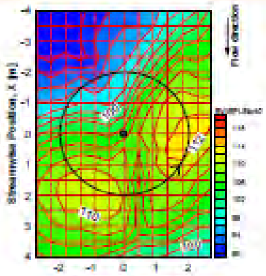
HELICOPTERS: BVI NOISE

- the prediction of Blade-Vortex Interaction (BVI) noise is essential, in view of its reduction
- efficient and validated tools to *simulate*, *understand* and find *strategies to reduce* BVI noise
- multidisciplinary field of research: dynamics, aerodynamics, acoustics

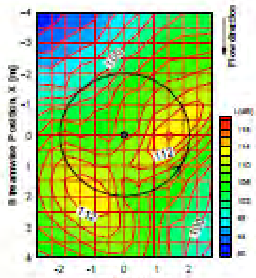


Bo105 rotor: pressure fluctuations and contour noise levels (DNW experiment)

Aerodynamics → acoustics (FW-H)

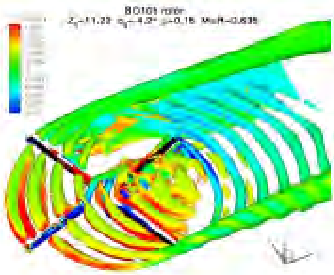


Experiment



prediction

aerodynamics (CFD) → acoustics (FW-H)



Noise Reduction Concepts:

• **High-Speed Impulsive Noise**

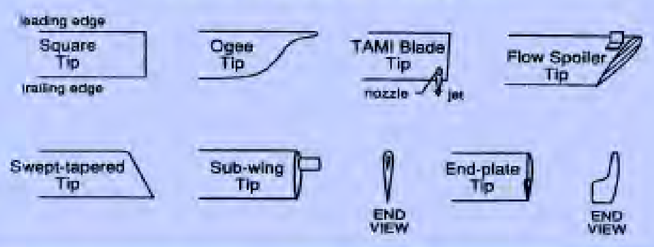
origin - shock waves on the advancing side
concepts - advanced airfoil and blade planform shapes
to reduce the effects of shock waves
sweep, taper, anhedral, thin airfoil, number of blades

• **Blade-Vortex Interaction Noise**

origin - unsteady pressure fluctuations during interactions
miss distance, tip vortex strength
concepts - blade planform shapes, active control concepts
to increase the miss distance or
to dissipate vortex strength
anhedral tip, number of blades
higher harmonic pitch control, individual blade control
porous leading edge, variable flap (variable camber)
smart structures for on-blade control

Rotor Noise Control Concepts

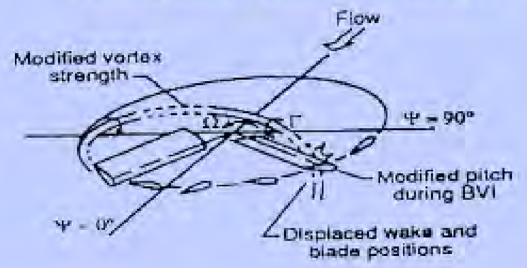
• Passive Design Concepts



• wake structures and geometry

• blade aeroelastic deformations

• Active Blade Control Concepts



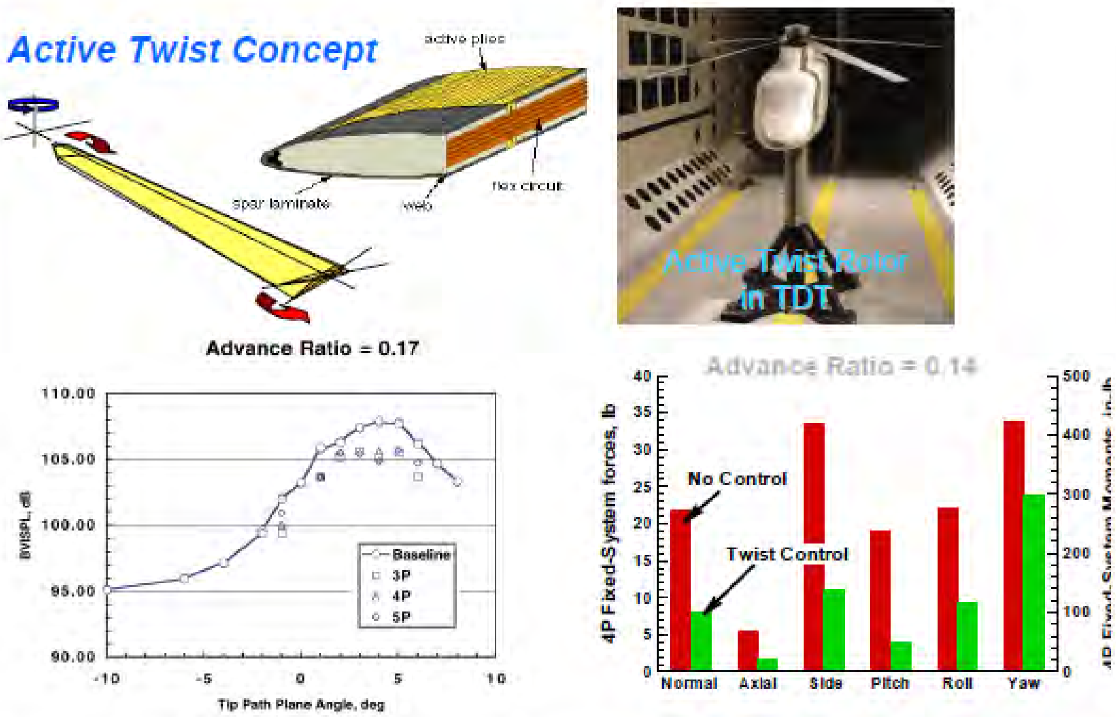
Active Blade Control Concepts

- wake modification
- increased induced velocity
- leading edge unsteady pressure modification

• higher harmonic pitch control, individual blade control

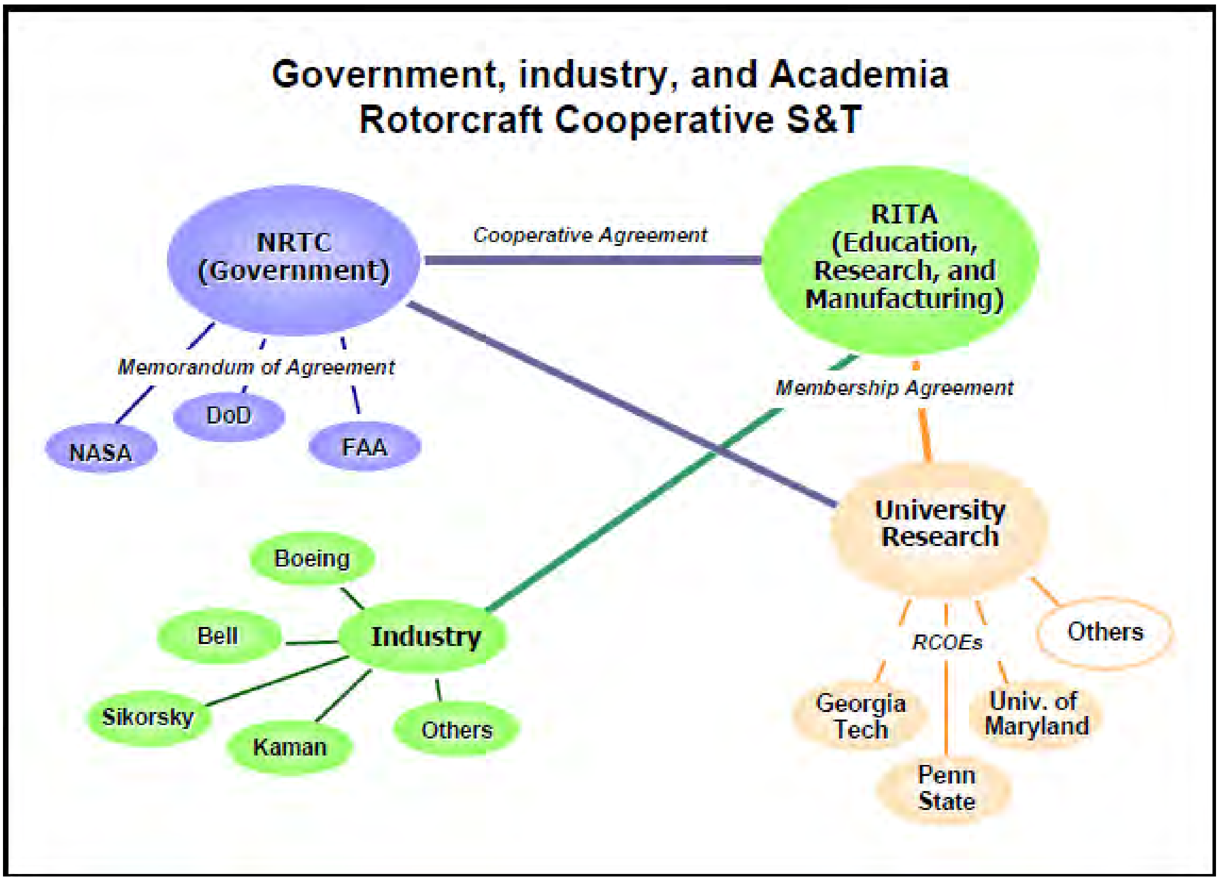
• active blade controls with smart structures
  trailing edge flaps, deformable leading edge,
  active blade twist, camber

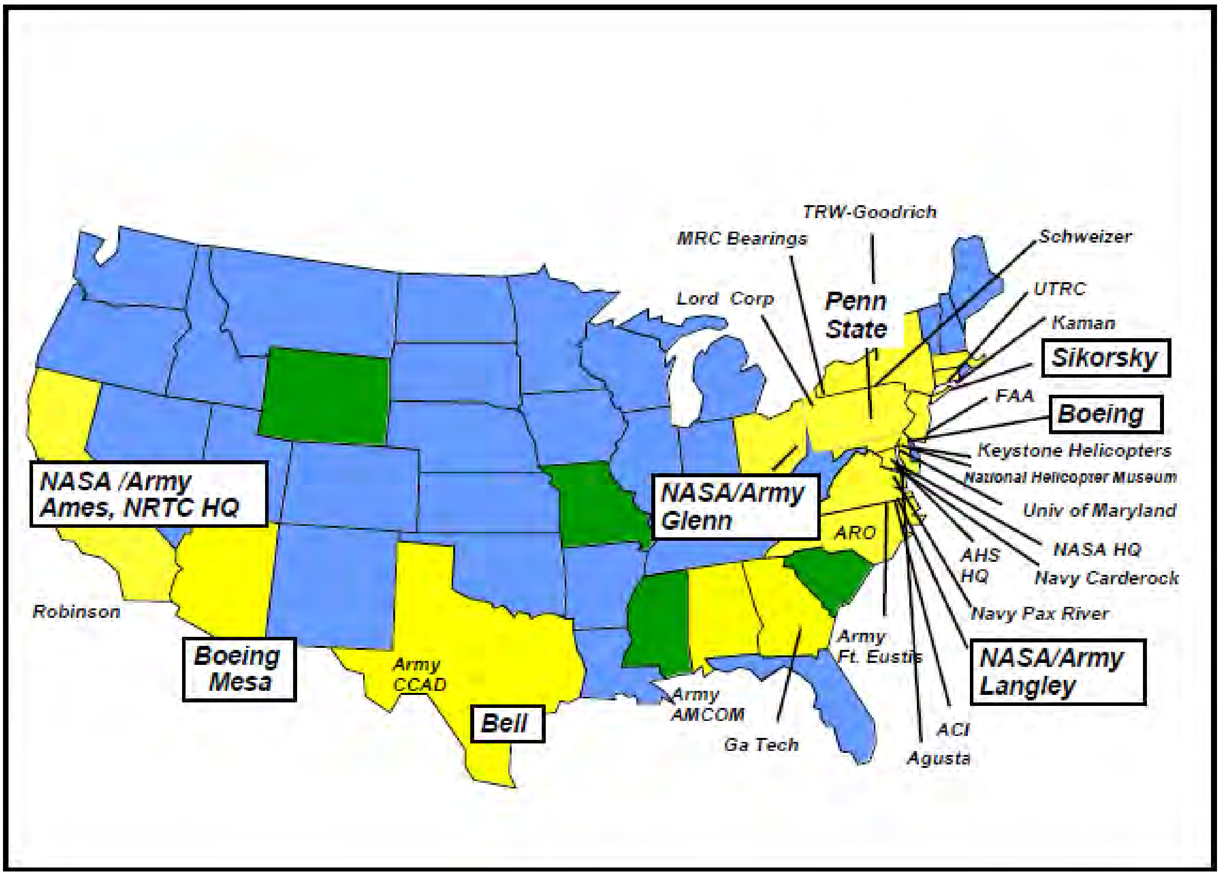
• adaptive airfoil/planform shape, Gurney flap



Government, industry, and academia cooperation

- Promote national security, emergency response, and economic development
- Revitalize government and industrial investment in required technologies, products and infrastructure
- Reconfigure rotorcraft activity to create renewed focus and optimize investment efficiency and critical mass/synergy


Government, industry, and Academia
Rotorcraft Cooperative S&T
NRTC
(Government)
Cooperative Agreement
RITA
(Education,
Research, and
Manufacturing)
Memorandum of Agreement
Membership Agreement
NASA
DoD
FAA
University
Research
Boeing
Industry
Bell
Sikorsky
Kaman
Others
RCOEs
Others
Georgia
Tech
Univ. of
Maryland
Penn
State


TRW-Goodrich
MRC Bearings
Schweizer
UTRC
Lord Corp
Penn
State
Kaman
Sikorsky
FAA
Boeing
Keystone Helicopters
National Helicopter Museum
Univ of Maryland
NASA /Army
Ames, NRTC HQ
NASA/Army
Glenn
ARO
AHS
HQ
NASA HQ
Navy Carderock
Navy Pax River
Robinson
Boeing
Mesa
Army
CCAD
Bell
Army
AMCOM
Ga Tech
Army
Ft. Eustis
NASA/Army
Langley
ACI
Agusta

International Cooperation (HART-III)

Goal: Understand active blade concepts for rotor noise/vibration

- developing comprehensive analysis capabilities (aerodynamics, dynamics, acoustics)
- validation test at DNW

Potential partners: US, France, Germany, the Netherlands, Japan, and Korea

Justification:

- Excellent opportunity to work with leading researchers in various countries
- Enhance comprehensive prediction analysis capability
- Develop noise/vibration reduction methodology with an active blade twist concept

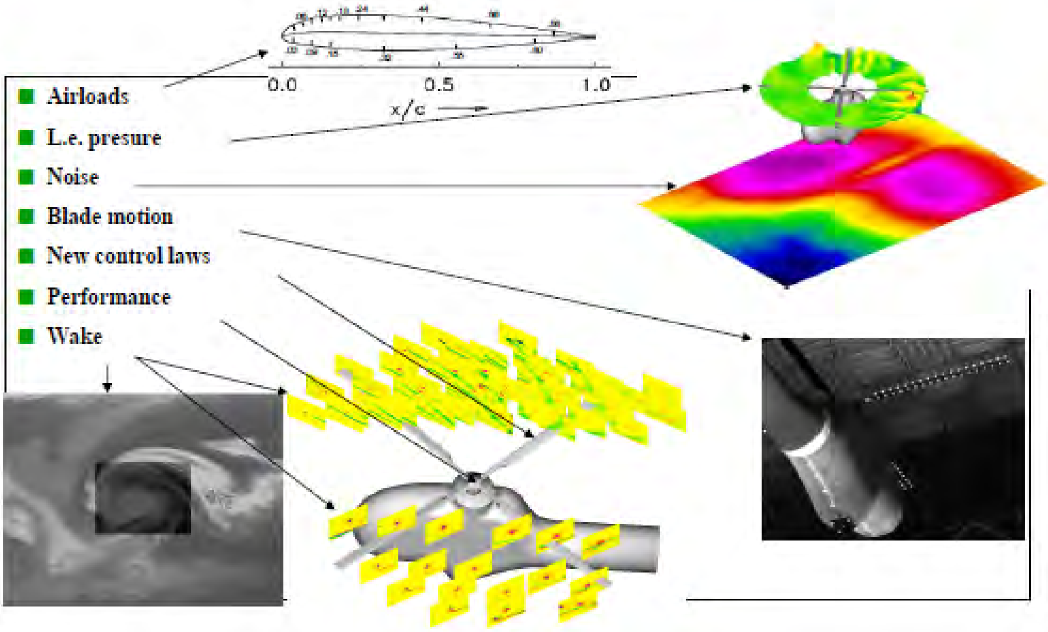
Plan :

- Regular workshops twice a year (at AHS forum and ERF)
- Partners will share equally in terms of financial and technical areas
  - DLR/ONERA – hardware and test responsibility
  - US, Japan, Korea – wind tunnel time responsibility
  - England
- Rotor test with an active blade twist is currently planned in 2011

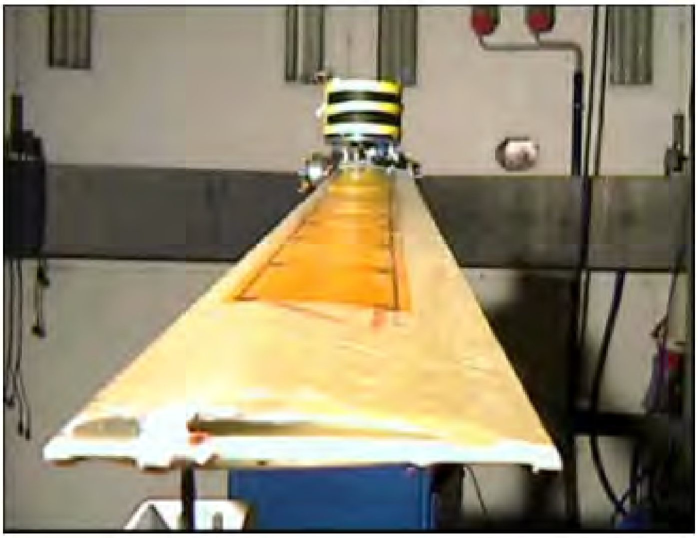
HART I test conducted in 1994
- acoustics, blade pressure measurements
- limited blade deformation measurements with projected grid method (PGM)
- limited vortex position measurements with laser light sheet (LLS) method

- HART II test conducted in 2001
  - acoustics, pressure measurements
  - extensive wake measurements with 3-component PIV (3C PIV)
  - stereo pattern recognition (SPR) for blade deformation measurements
  - blade tip deflection (BTD) for blade tip position and blade attitude measurements

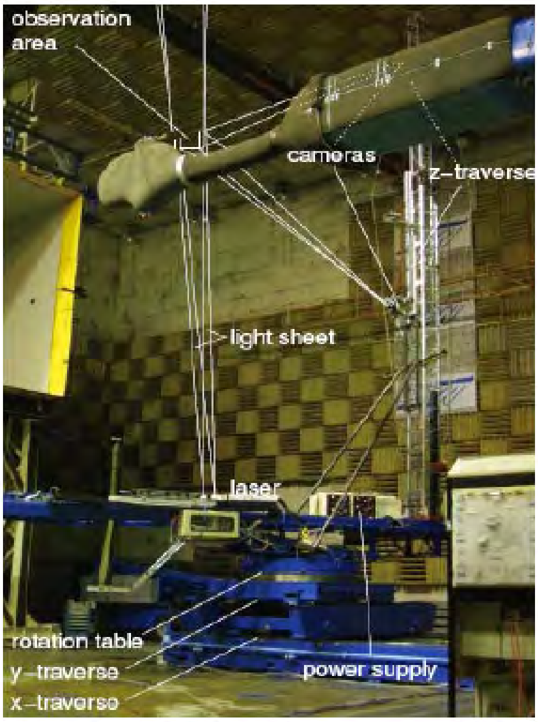
HART test

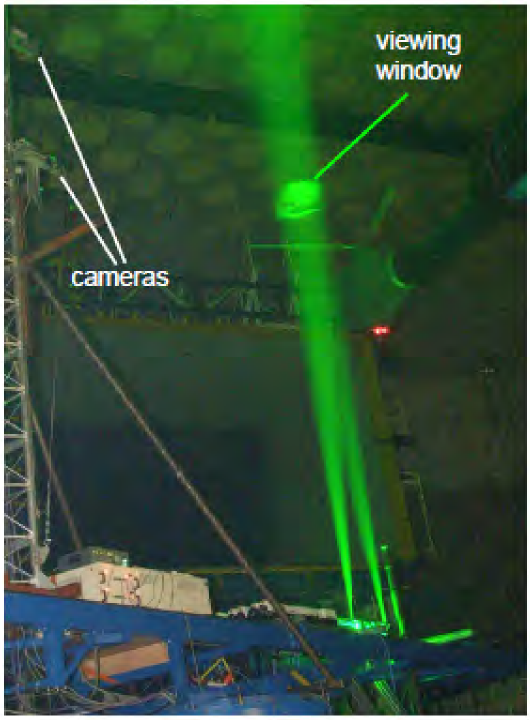


Active twist blade testing

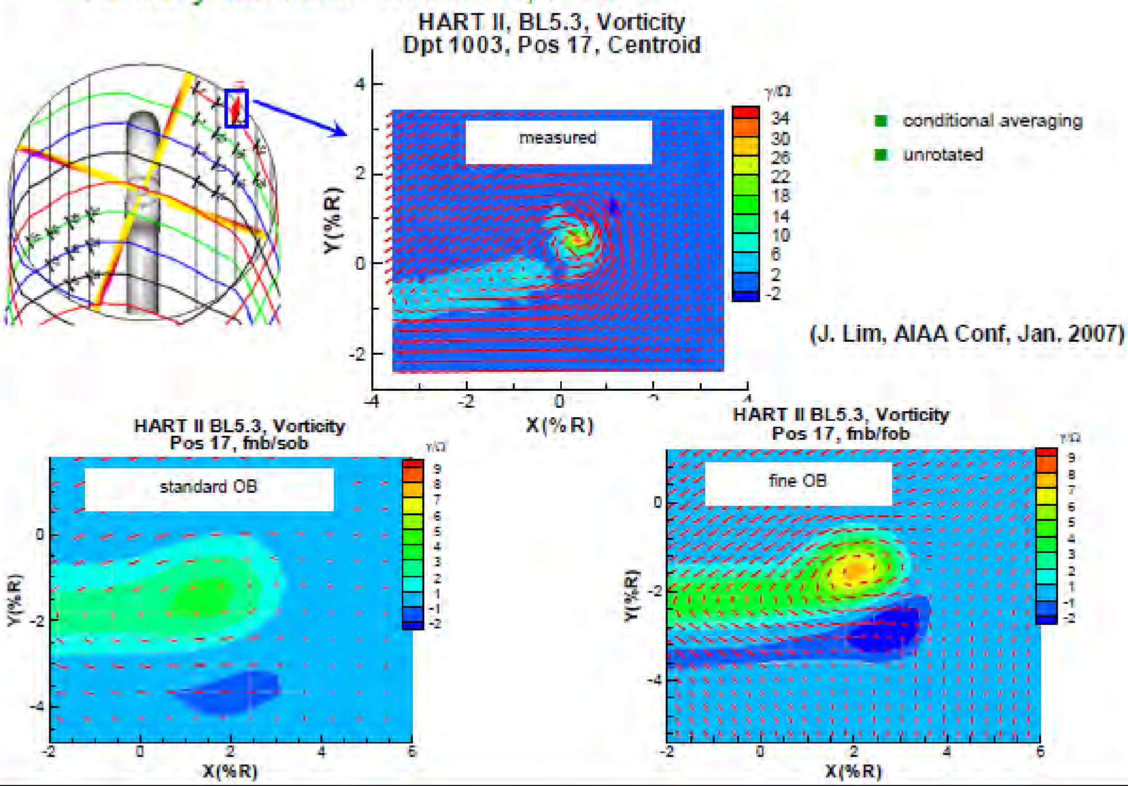


HART II PIV Measurement Setup





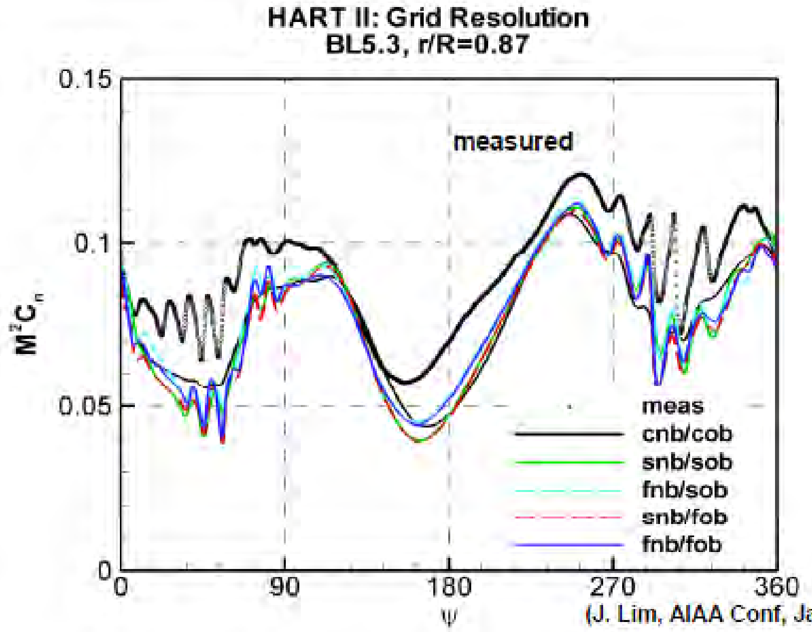
Vorticity Contour: Baseline, Pos 17



(J. Lim, AIAA Conf, Jan. 2007)

Nondimensional Lift (M^2c_n): Baseline

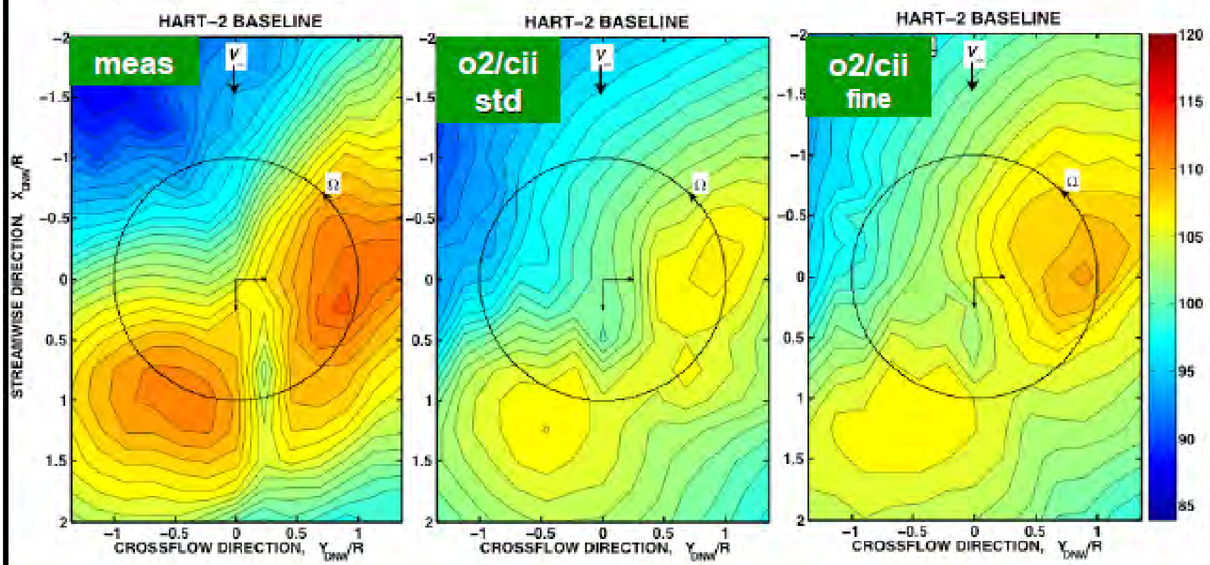
- Mean, 3-per-rev, and BVI loading

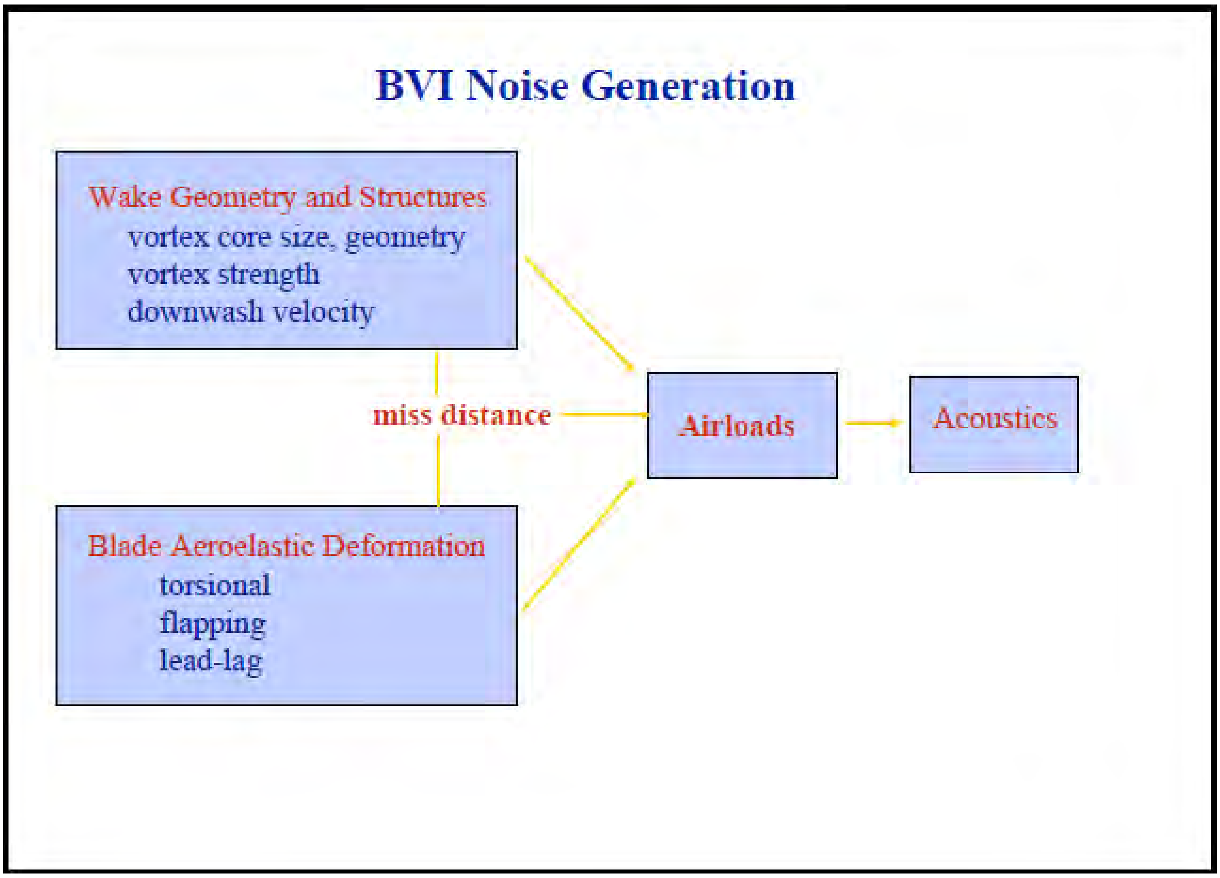


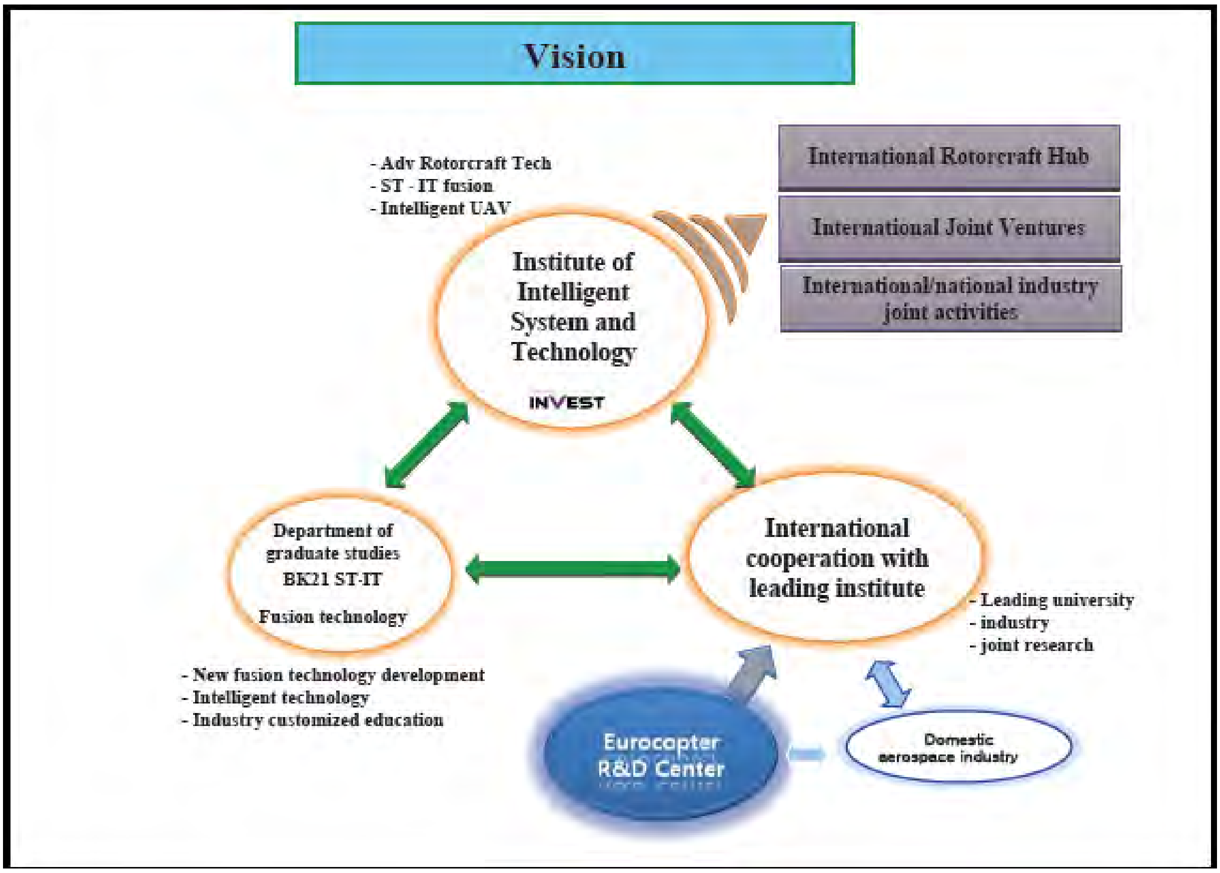
(J. Lim, AIAA Conf, Jan. 2007)

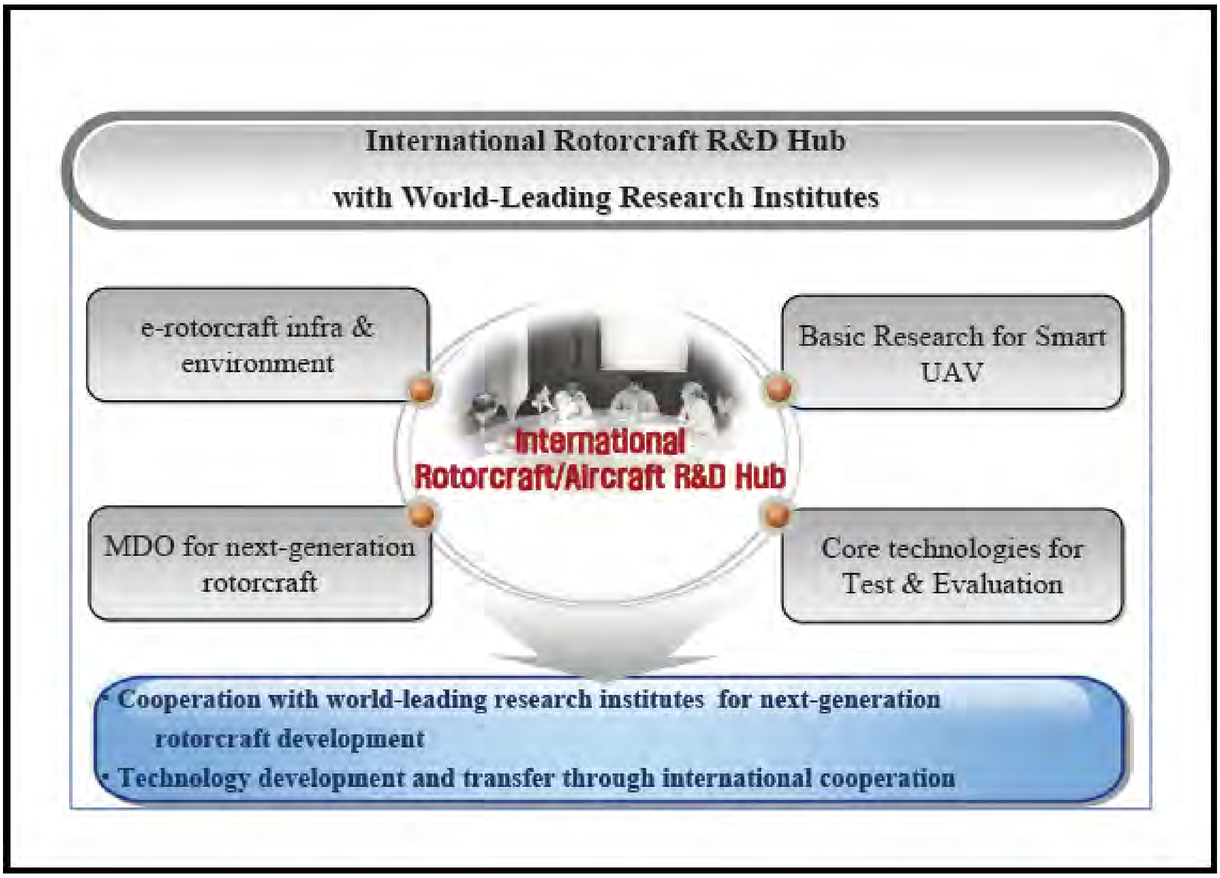
METRIC: BVISPL (6th to 40th BPF)

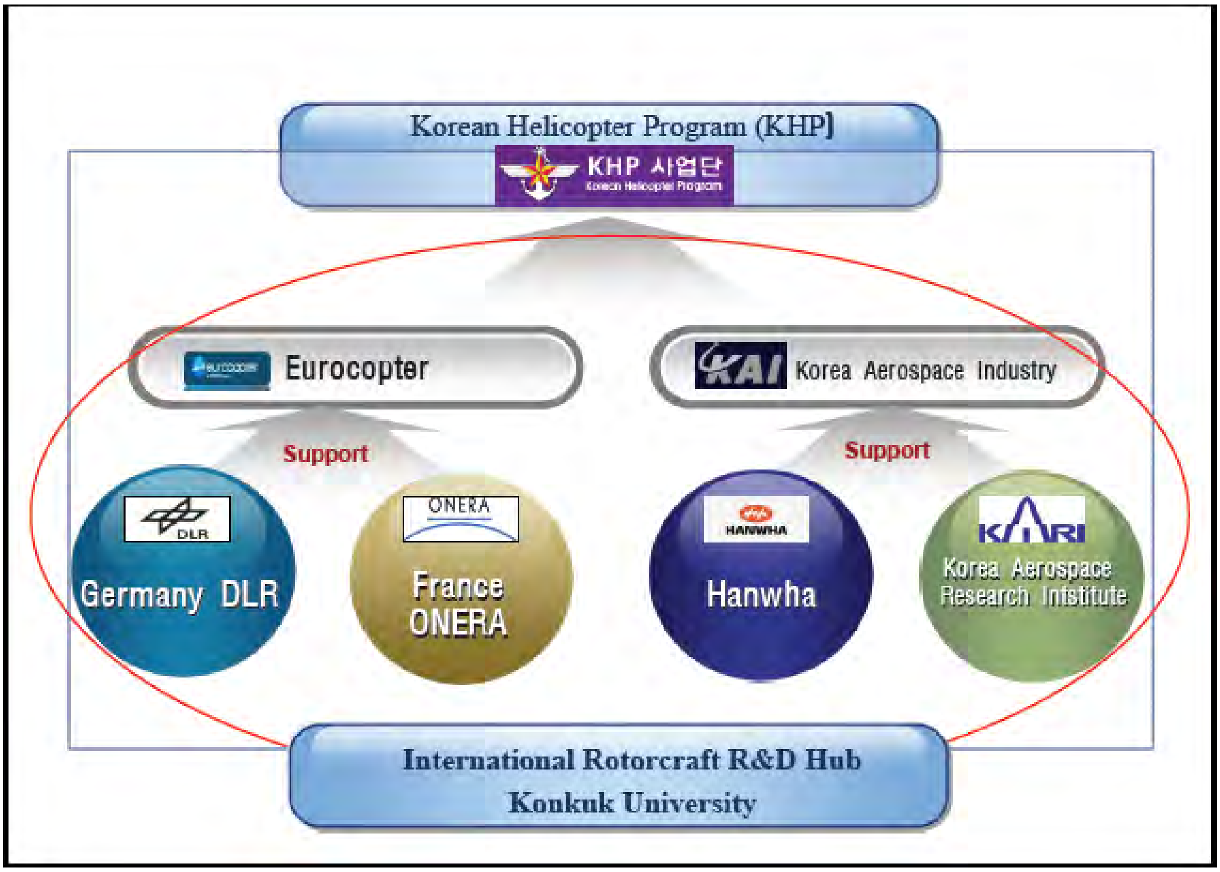
(B. Sim, AHS Forum, May 2006)




BVI Noise Generation
Wake Geometry and Structures
vortex core size, geometry
vortex strength
downwash velocity
miss distance
Airloads
Acoustics
Blade Aeroelastic Deformation
torsional
flapping
lead-lag


Vision
- Adv Rotorcraft Tech
- ST - IT fusion
- Intelligent UAV
Institute of Intelligent System and Technology
INVEST
International Rotorcraft Hub
International Joint Ventures
International/national industry joint activities
Department of graduate studies
BK21 ST-IT
Fusion technology
- New fusion technology development
- Intelligent technology
- Industry customized education
International cooperation with leading institute
- Leading university
- industry
- joint research
Eurocopter R&D Center
Domestic aerospace industry


International Rotorcraft R&D Hub
with World-Leading Research Institutes
e-rotorcraft infra & environment
Basic Research for Smart UAV
International Rotorcraft/Aircraft R&D Hub
MDO for next-generation rotorcraft
Core technologies for Test & Evaluation
• Cooperation with world-leading research institutes for next-generation rotorcraft development
• Technology development and transfer through international cooperation


Korean Helicopter Program (KHP)
KHP 사업단
Eurocopter
KAI Korea Aerospace Industry
Support
Support
Germany DLR
France ONERA
Hanwha
Korea Aerospace Research Institute
International Rotorcraft R&D Hub
Konkuk University

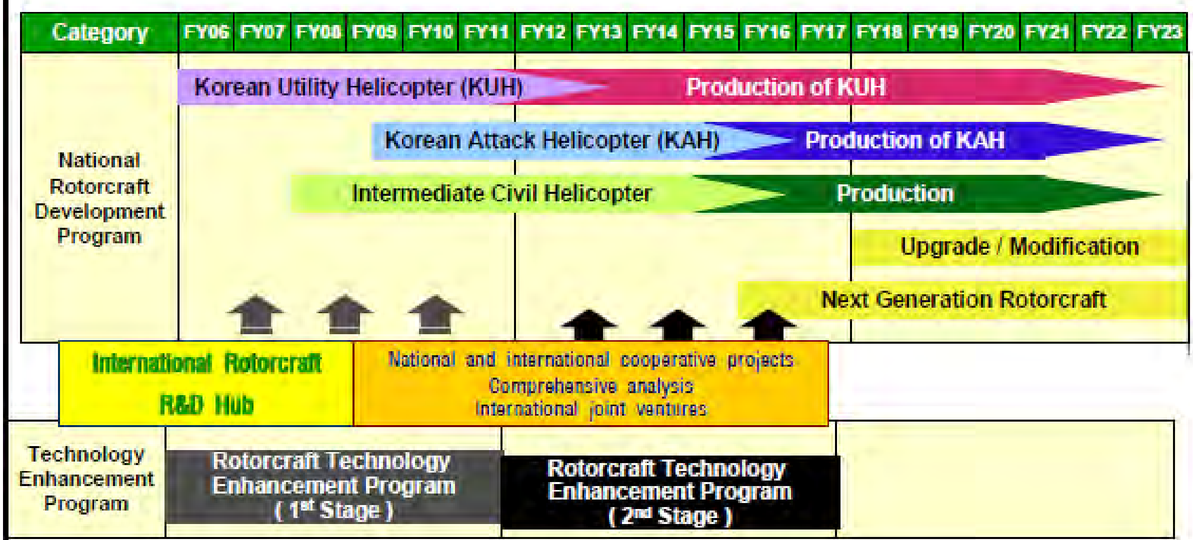
Korean Helicopter Program

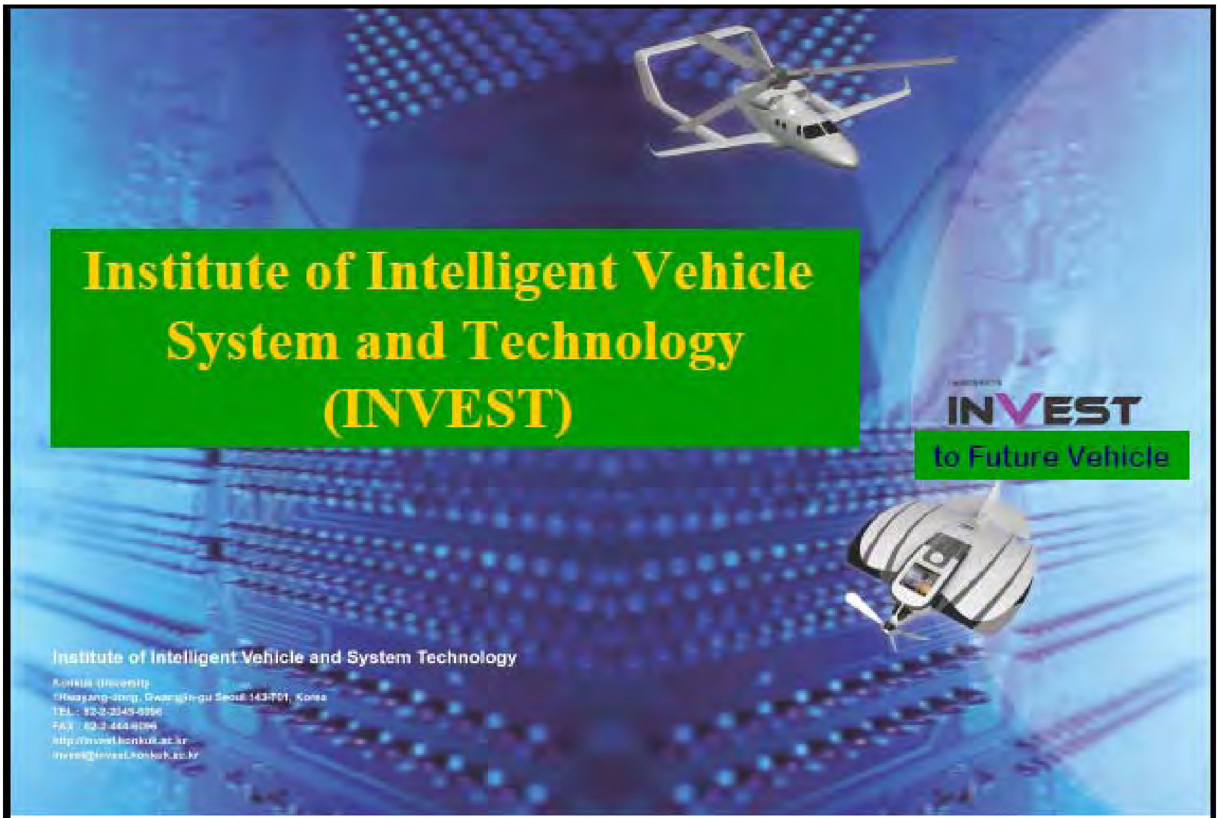
Replace 500MD & UH-1 helicopters

[500MD]

[UH-1H]

Rotorcraft Technology Map



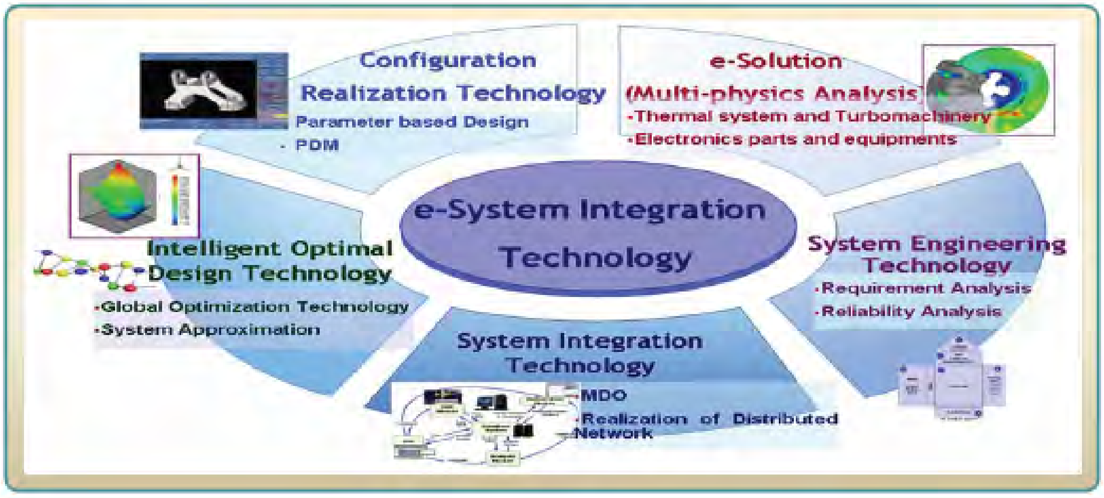


Arm Wrestling Service Robot
Future Tech Korea 2005

Micro Flying Robot (2005)
World's Smallest Surveillance Robot

Insect Mimetic Crawling Robot
with Artificial Muscle(2006)

Flying Saucer Robot
2005 Seoul Air Show

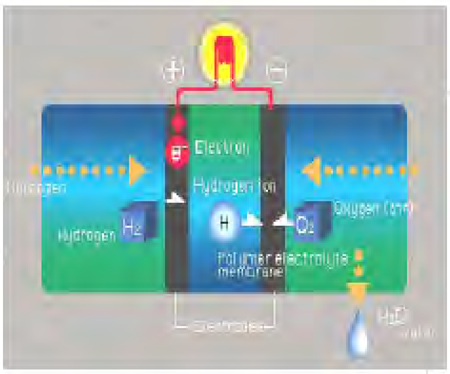


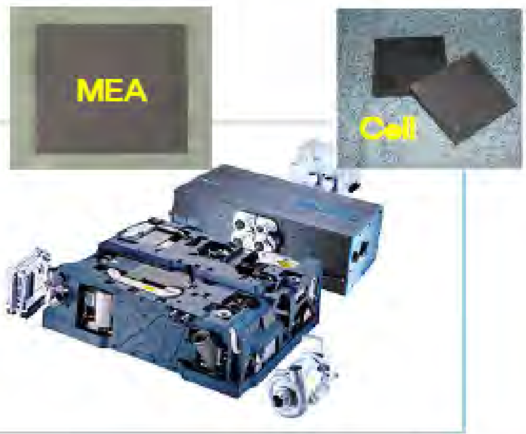
Center for Embedded Energy System (CEES)

-Center for the development of high efficiency ***micro fuel cells***

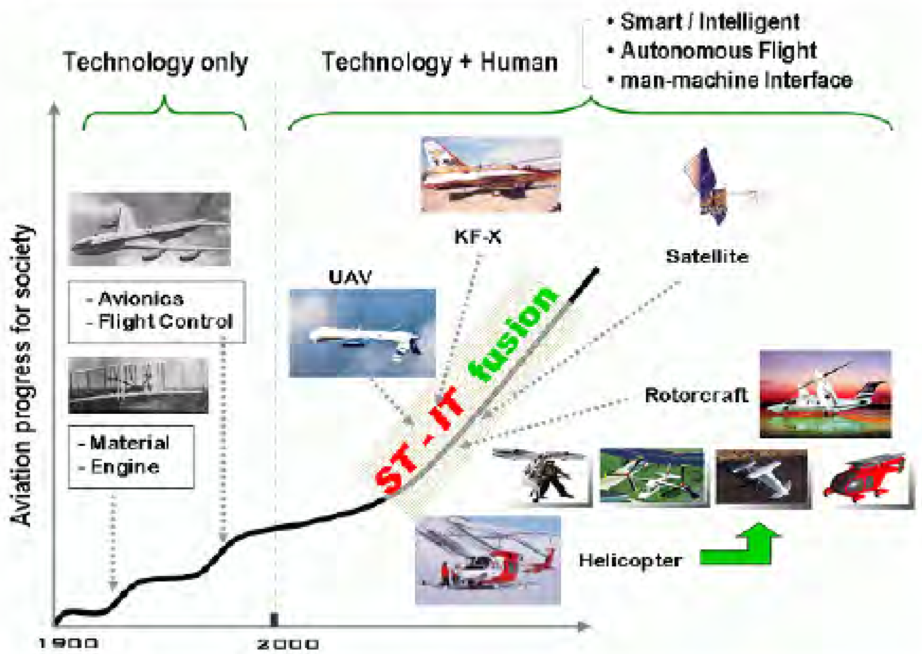
for the applications such as vehicle, bio-system and electronics

- *What's Fuel Cell ?*
  - *Pt catalyst layers on both sides of polyelectrolyte*
  - *Fueling H_2 → generating electrons*

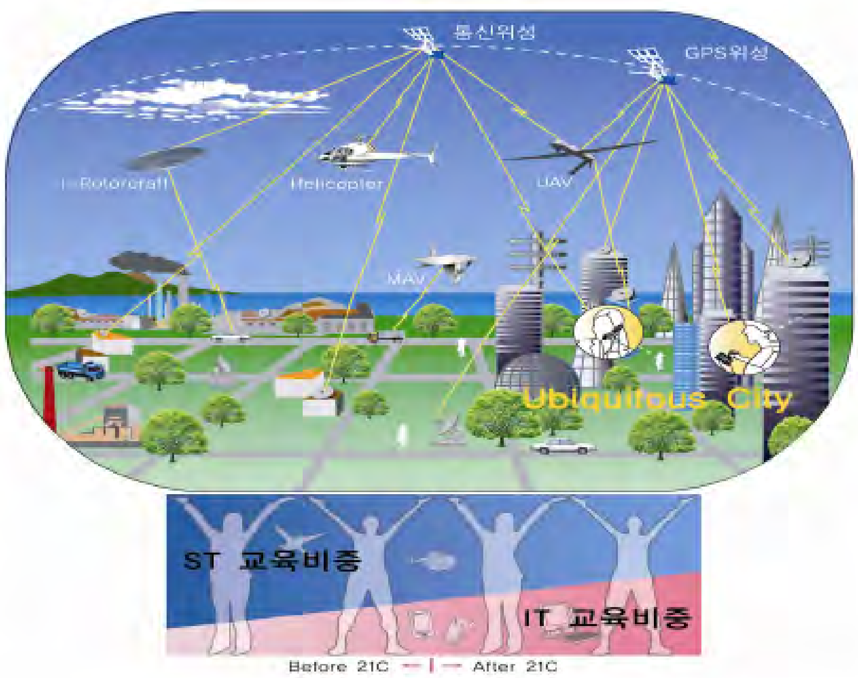




Vision of ST + IT Fusion Engineering



Vision of ST + IT Fusion Engineering



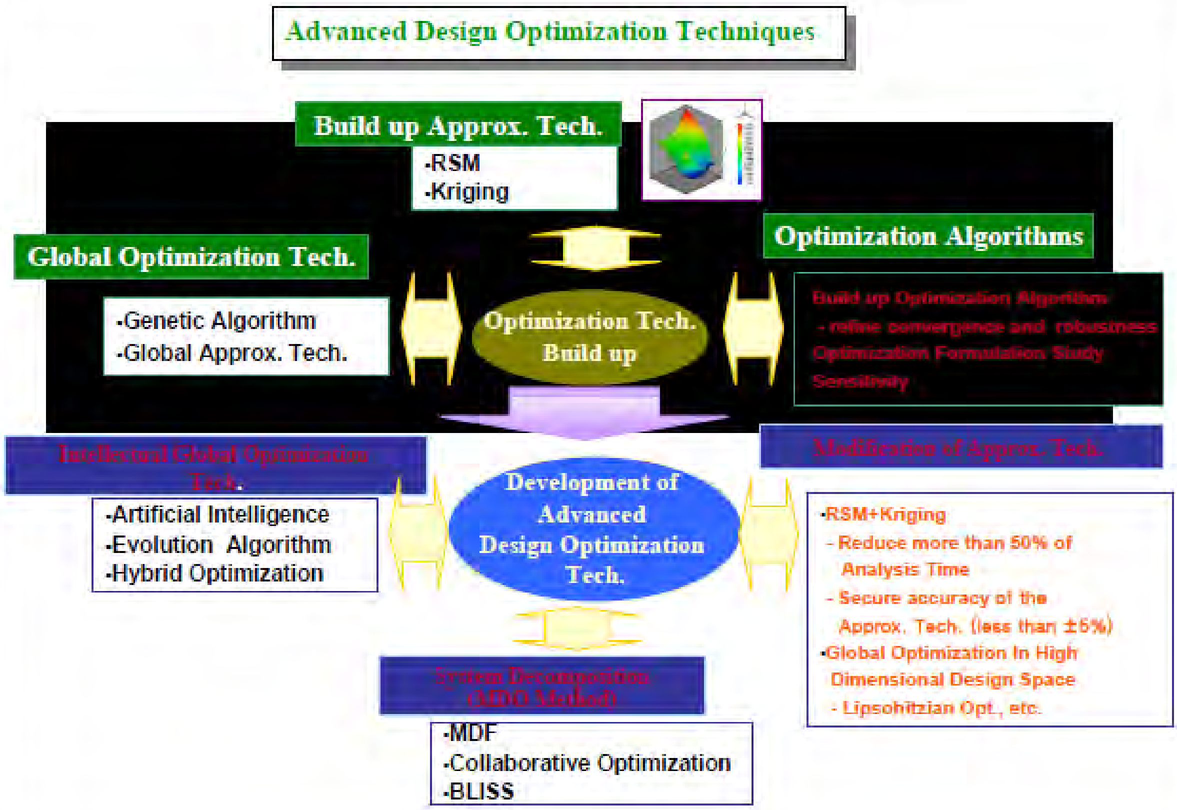
Department of Aerospace Information Engineering

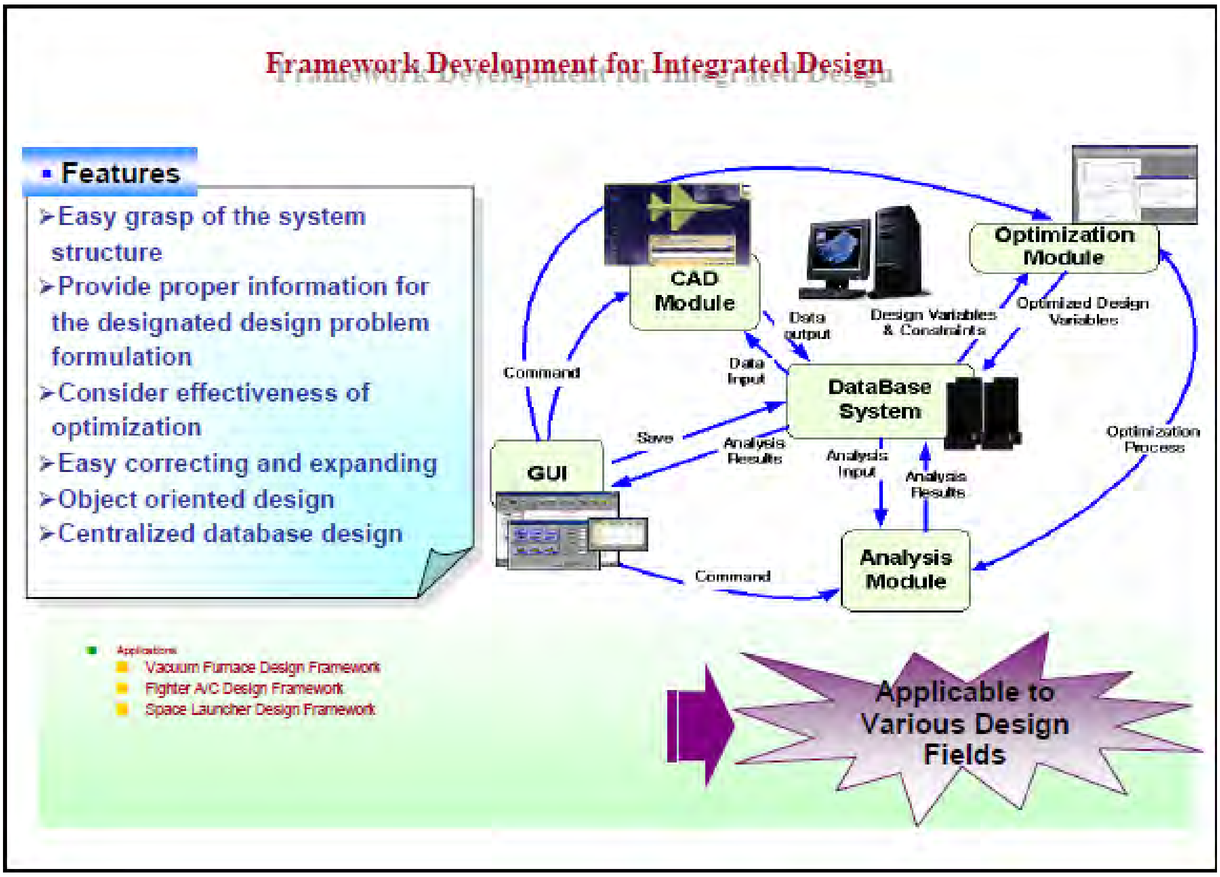
Undergraduate Program

- Department of Aerospace Information Engineering
  - Established on March 1990
  - Renamed as Aerospace Information Engineering in March 2007
  - Currently 160 undergraduates enrolled

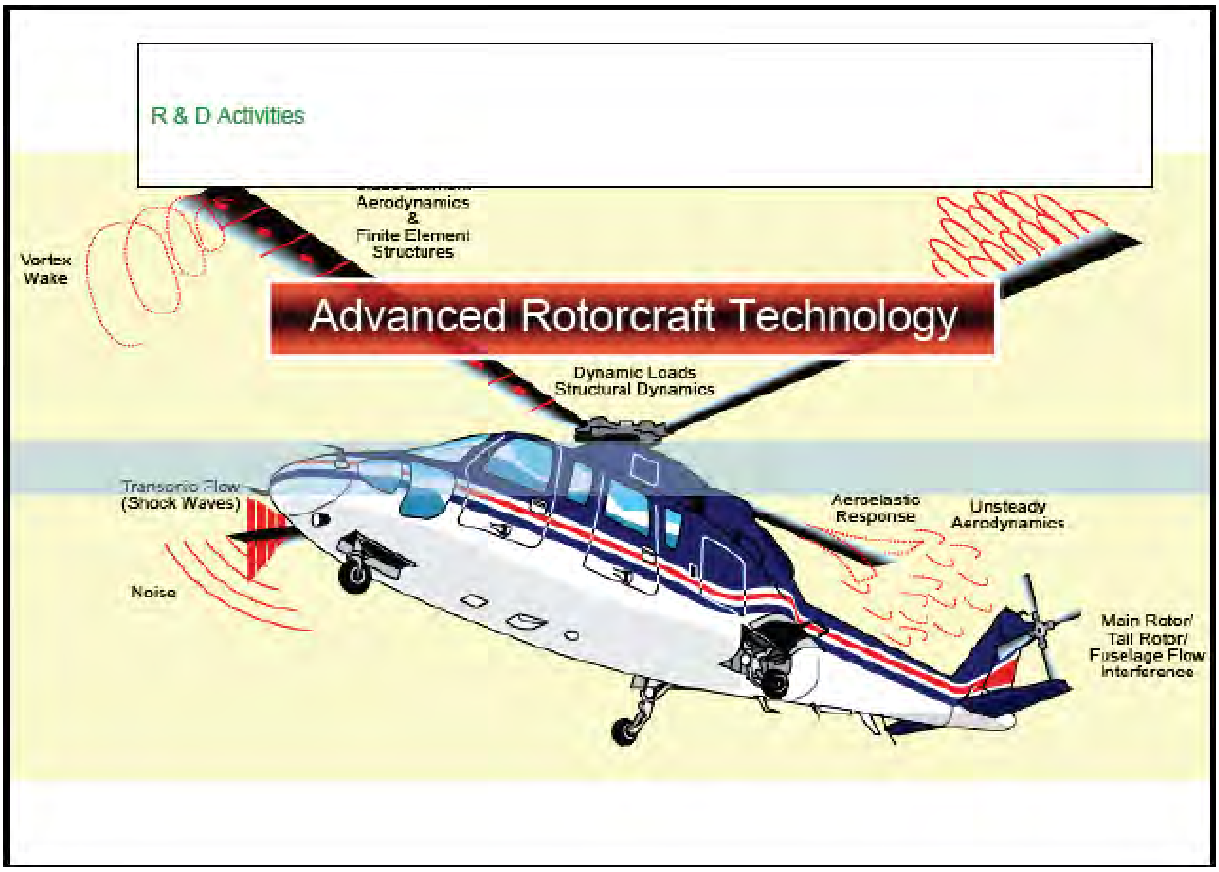
Graduate Program

- Selected as Korean government's "center of excellence" program in 2006 for 7 years
  BK21 ST-IT fusion program – only aerospace engineering department in Korea
  about $1M per year for the next 7 years
- M.S. and Ph.D. program with 18 professors and about 7 lecturers
  largest aerospace engineering department
- Renamed as Department of Aerospace Information Engineering in March 2007
- Currently about 70 graduate students and growing rapidly due to BK21 program
- New curriculum for technology fusion, international cooperation, industry cooperation
  only aerospace engineering department with multi-disciplinary emphasis in aerospace and information technology





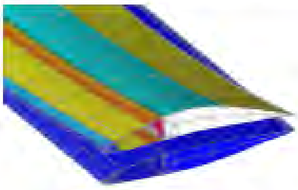
Framework Development for Integrated Design
Features
➢Easy grasp of the system structure
➢Provide proper information for the designated design problem formulation
➢Consider effectiveness of optimization
➢Easy correcting and expanding
➢Object oriented design
➢Centralized database design
Applications
Vacuum Furnace Design Framework
Fighter A/C Design Framework
Space Launcher Design Framework
CAD Module
Optimization Module
DataBase System
GUI
Analysis Module
Command
Data output
Data Input
Design Variables & Constraints
Optimized Design Variables
Save
Analysis Results
Analysis Input
Analysis Results
Optimization Process
Command
Applicable to Various Design Fields

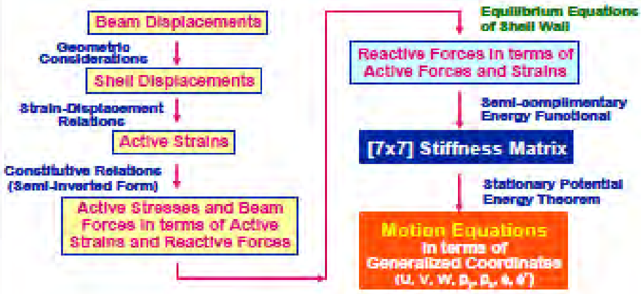


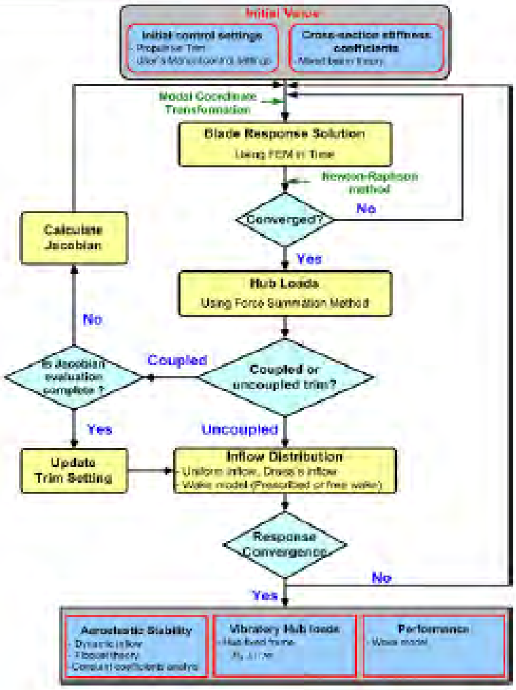
R & D Activities
Advanced Rotorcraft Technology
Vortex Wake
Aerodynamics
&
Finite Element
Structures
Dynamic Loads
Structural Dynamics
Transonic Flow
(Shock Waves)
Noise
Aeroelastic Response
Unsteady Aerodynamics
Main Rotor/
Tail Rotor/
Fuselage Flow
Interference

Helicopter Dynamics Analysis

- Blade Cross-section Analysis
- Aeroelastic Analysis System







Flight Dynamics & Control

FBW-VMS (Vehicle Management System)

Pilot Control

SAS/Autopilot

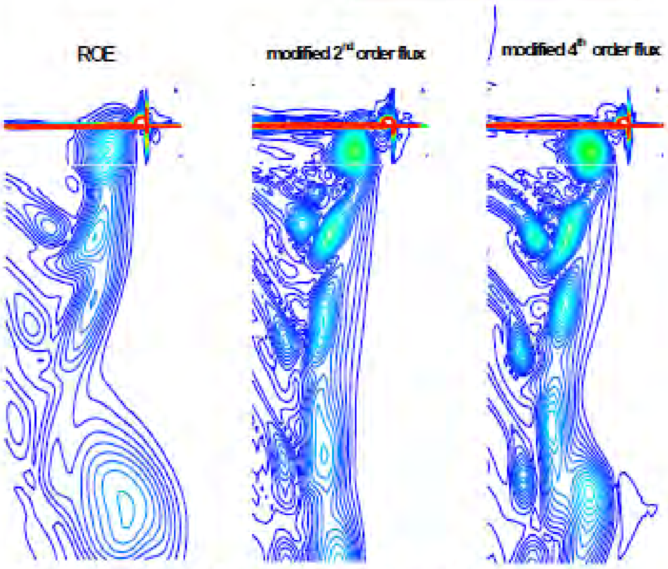
FBW FCS

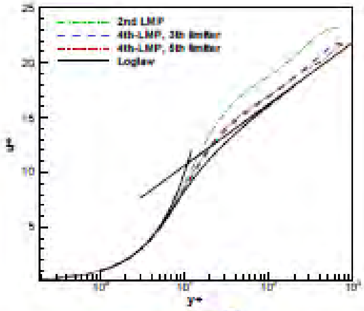
DFBW-VMS

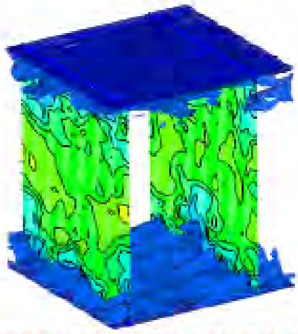
Unmanned Helicopter

Ground Simulation and Control Station

Rotor CFD Analysis



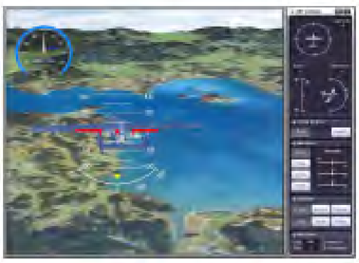




- From RANS turbulence modeling to Large Eddy Simulation
- High-order schemes for wake and vortex capturing
- Rotor blade-vortex interaction

U-Velocity Contours and iso-surfaces (U=0.2,U=0.5)
: Large Eddy Simulation of fully Turbulent Channel Flow (Re=23,000)

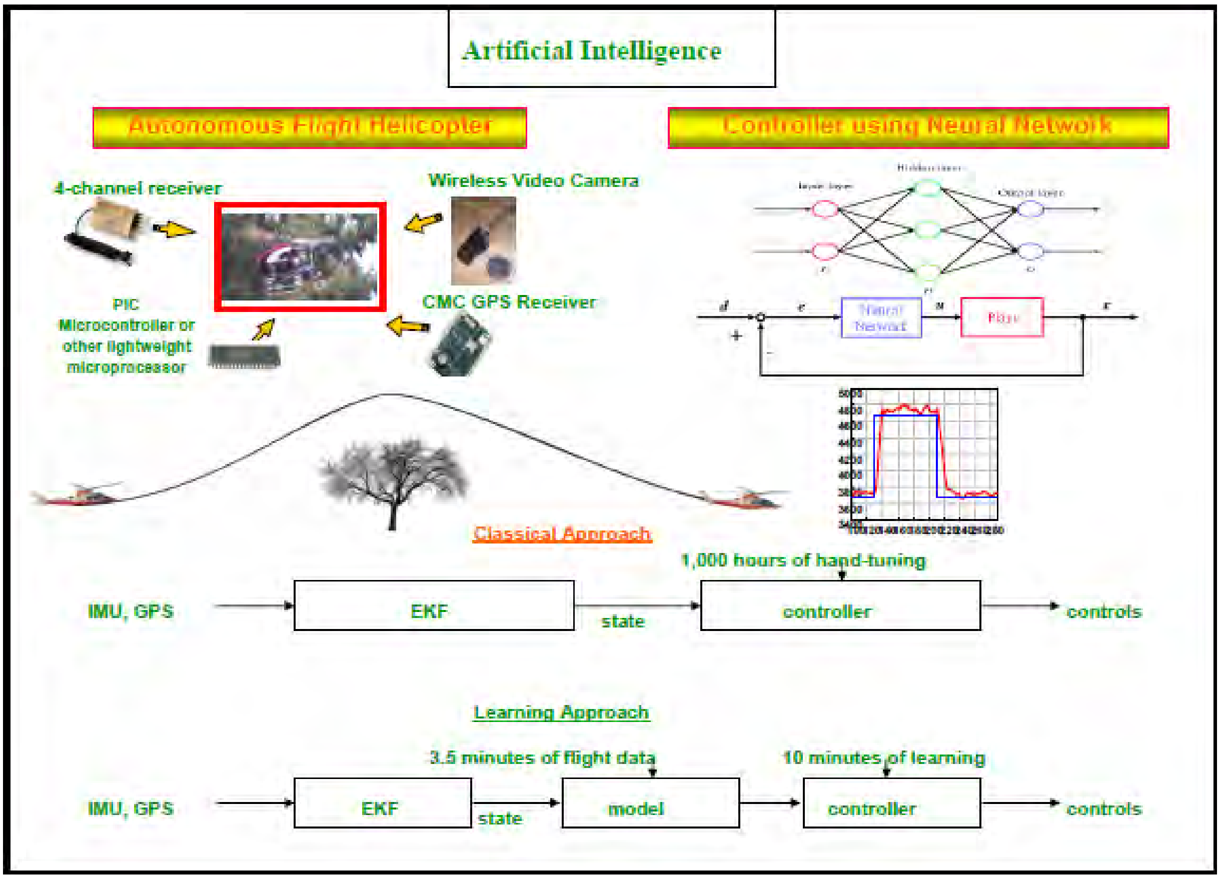
Ground Simulation and Control Station

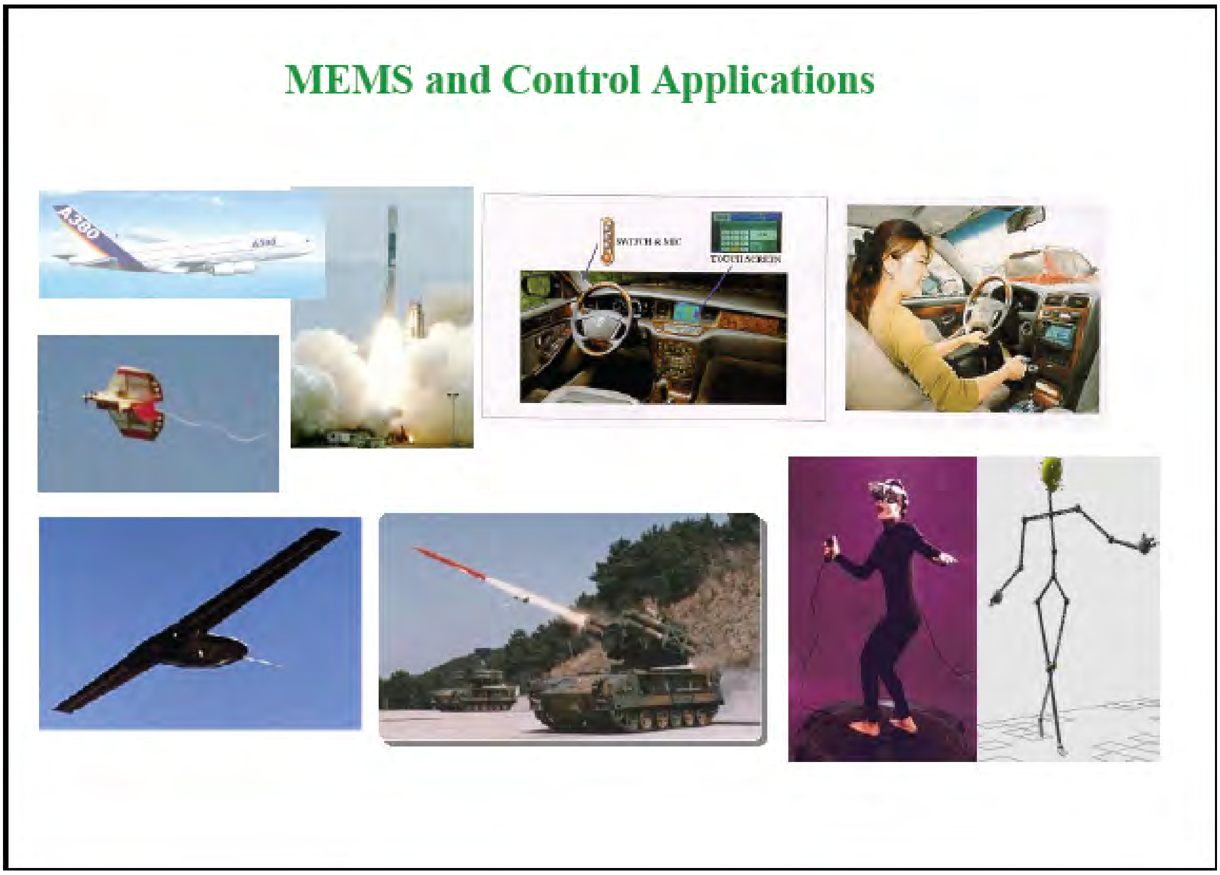


Major Functions

- Digital Map Generator
- Flight Planner
- Data Management
- Flight Controls and Display

High Fidelity Rotorcraft Simulation Environment


Artificial Intelligence
Autonomous Flight Helicopter
Controller using Neural Network
4-channel receiver
Wireless Video Camera
PIC Microcontroller or other lightweight microprocessor
CMC GPS Receiver
Classical Approach
1,000 hours of hand-tuning
IMU, GPS
EKF
state
controller
controls
Learning Approach
3.5 minutes of flight data
10 minutes of learning
IMU, GPS
EKF
state
model
controller
controls


MEMS and Control Applications
SWITCH & MIC
TOUCH SCREEN

UAV Precision Navigation

IMU + GPS

Altitude sensors

Velocity sensors

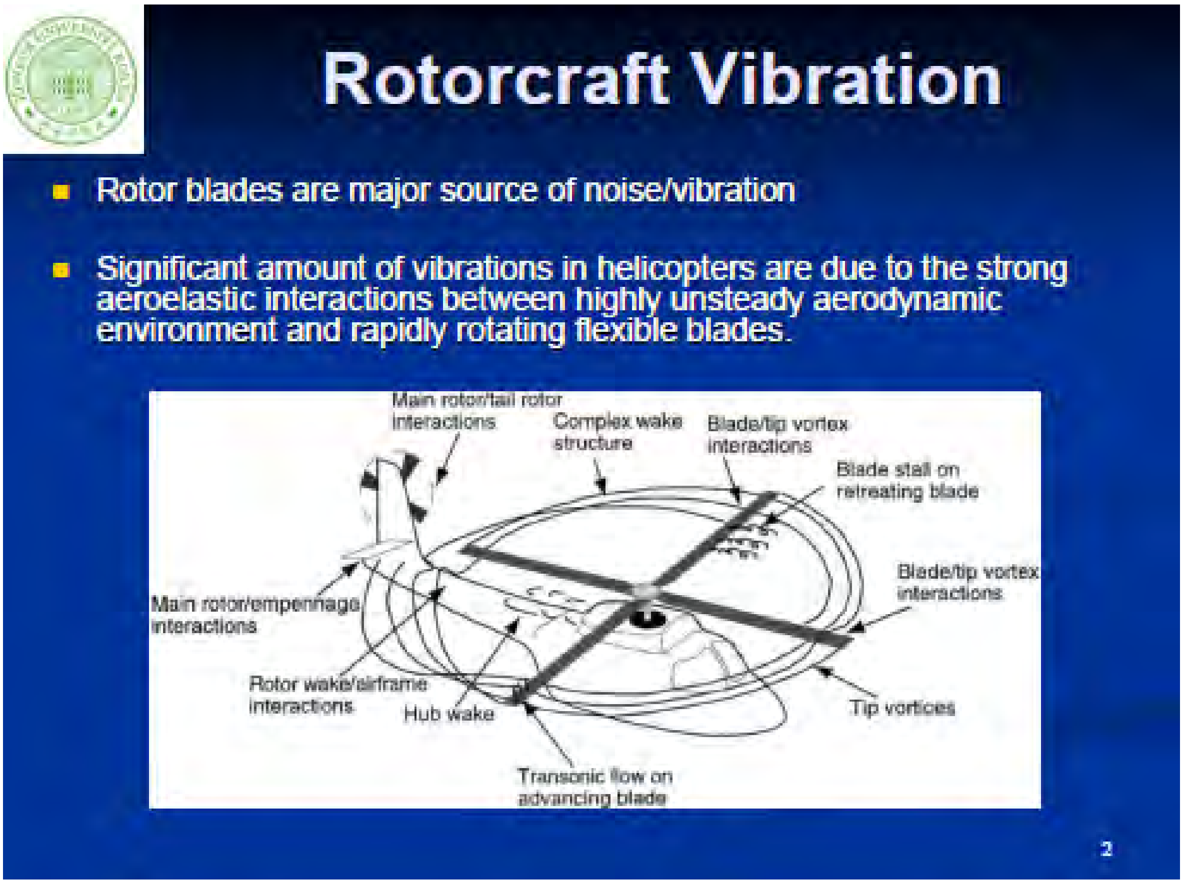
Summary

- Development of critical technologies
    - significant technology effort needed
        - reduction in cost per seat mile, all-weather operations, safety
        - intelligent technologies for rotorcraft
            - *applications of information technology, synthetic environment, simulation*
        - revolutionary rotorcraft
            - *innovative vertical lift configurations (speed + vertical lift), personal rotorcraft*

- International Cooperation, Globalization
    - higher education, flexible minds
    - flat world, international cooperation/competition
    - no boundary of a country
    - understanding of different cultures and values

- Multi-disciplinary Technology, Team work
    - aerospace – integration of many technologies
    - understand and listen to others, consideration of others

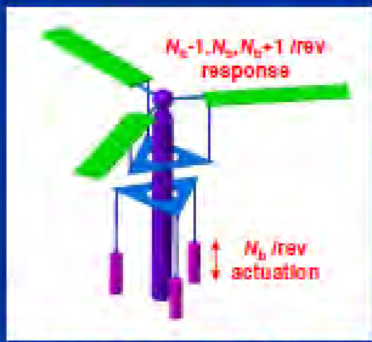
Active Vibration Reduction Study for Composite Helicopter Blades
with Dissimilar Characteristics（Dr. Sung N. Jung）



Vibration Reduction

- Helicopter vibration reduction can be achieved by passive structural changes and/or active blade control.
- Passive methods: modal shaping, design detuning and aeroelastic tailoring
- Active methods: Higher Harmonic Control (HHC), Individual Blade Control (IBC)

Pendulum absorber
(frequency tuning)

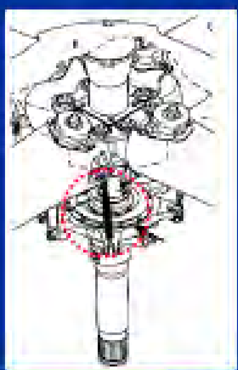


Higher Harmonic Control

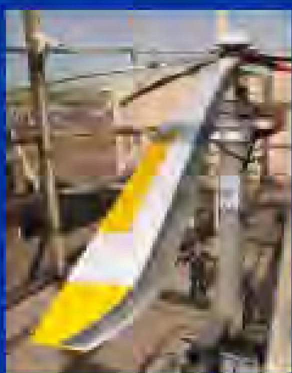
3

Individual Blade Control

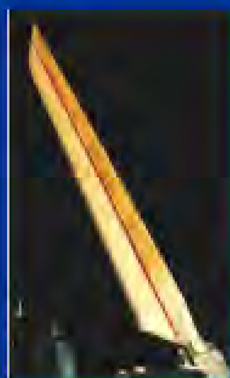
- IBC allows each blade to be controlled separately and thus requires less power compared to HHC. There are various ways to achieve IBC
  - Hydraulic pitch-link actuator: designed and tested in the early stage
  - Trailing-edge flap: used a small flap located in the outboard region of the blade to produce the desired unsteady aerodynamic loads
  - Active twist rotor: actively twisted the entire blade



IBC (BO-105)
Electro-hydraulic pitch actuator



Trailing-edge flap
(MD-900)



ATR
(Boeing/MIT)

4

Trailing-edge Flap Control

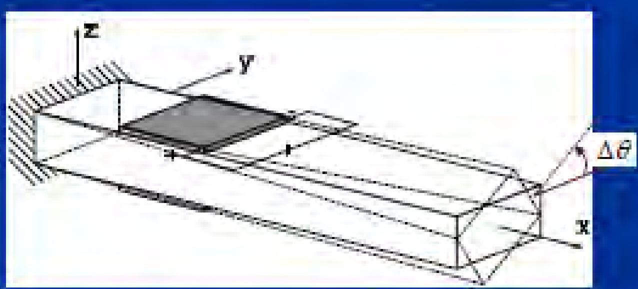
- The vibration control is achieved by exciting the flap at certain frequencies to generate new aerodynamic forces which, if correctly phased, cancel out unwanted vibrations
- This approach offers a high frequency bandwidth and is effective in terms of power consumption due to a smaller moving parts
- Shortcomings of this method include:
  - Need special apparatus or linkage mechanism to augment the flap angle
  - May deteriorate airfoil-vortex interaction leading to increase in vibrations
  - Can cause a profile drag penalty due to exposure to the airflow
  - Have greater chance of wear and tear

Schematic of trailing-edge flap

5

Active Twist Control

- The blade angle of attack variation with rotor azimuth is actively controlled to produce additional aerodynamic loads to suppress the unwanted vibration.
- Generally, ATR (Active Twist Rotor) concept requires high level of actuator power/authority by twisting the entire blades.
- This problem can be alleviated using a newly developed single crystal piezo materials which show high values of piezoelectric constants.

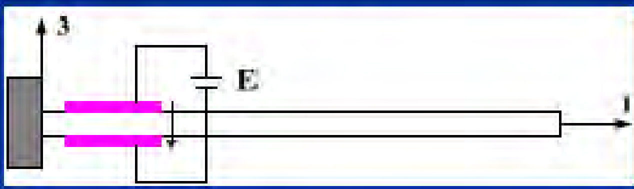


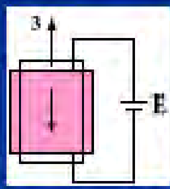
Schematic of ATR via induced shear actuation

6

Piezoelectric Actuation

- When an electric field is applied to the piezoelectric materials, a mechanical deformation is resulted





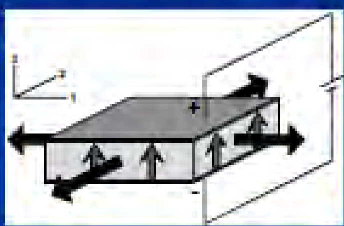
- Electro-mechanical constitutive relations

$$
\begin{Bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \\ \gamma_{23} \\ \gamma_{31} \\ \gamma_{12} \end{Bmatrix} =
\begin{bmatrix} S_{11} & S_{12} & S_{13} & 0 & 0 & 0 \\ S_{12} & S_{11} & S_{13} & 0 & 0 & 0 \\ S_{13} & S_{13} & S_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & S_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & S_{44} & 0 \\ 0 & 0 & 0 & 0 & 0 & S_{66} \end{bmatrix}
\begin{Bmatrix} \sigma_1 \\ \sigma_2 \\ \sigma_3 \\ \tau_{23} \\ \tau_{31} \\ \tau_{12} \end{Bmatrix} +
\begin{bmatrix} 0 & 0 & d_{31} \\ 0 & 0 & d_{31} \\ 0 & 0 & d_{33} \\ 0 & d_{15} & 0 \\ d_{15} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}
\begin{Bmatrix} E_1 \\ E_2 \\ E_3 \end{Bmatrix} +
\begin{Bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ 0 \\ 0 \\ 0 \end{Bmatrix} \Delta T
$$

7

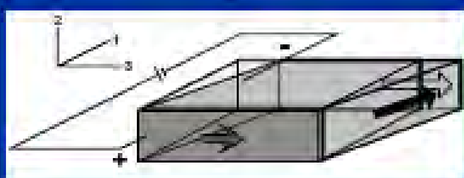
Piezoelectric Actuation

- Each of three different piezoelectric constants can be used for vibration reduction



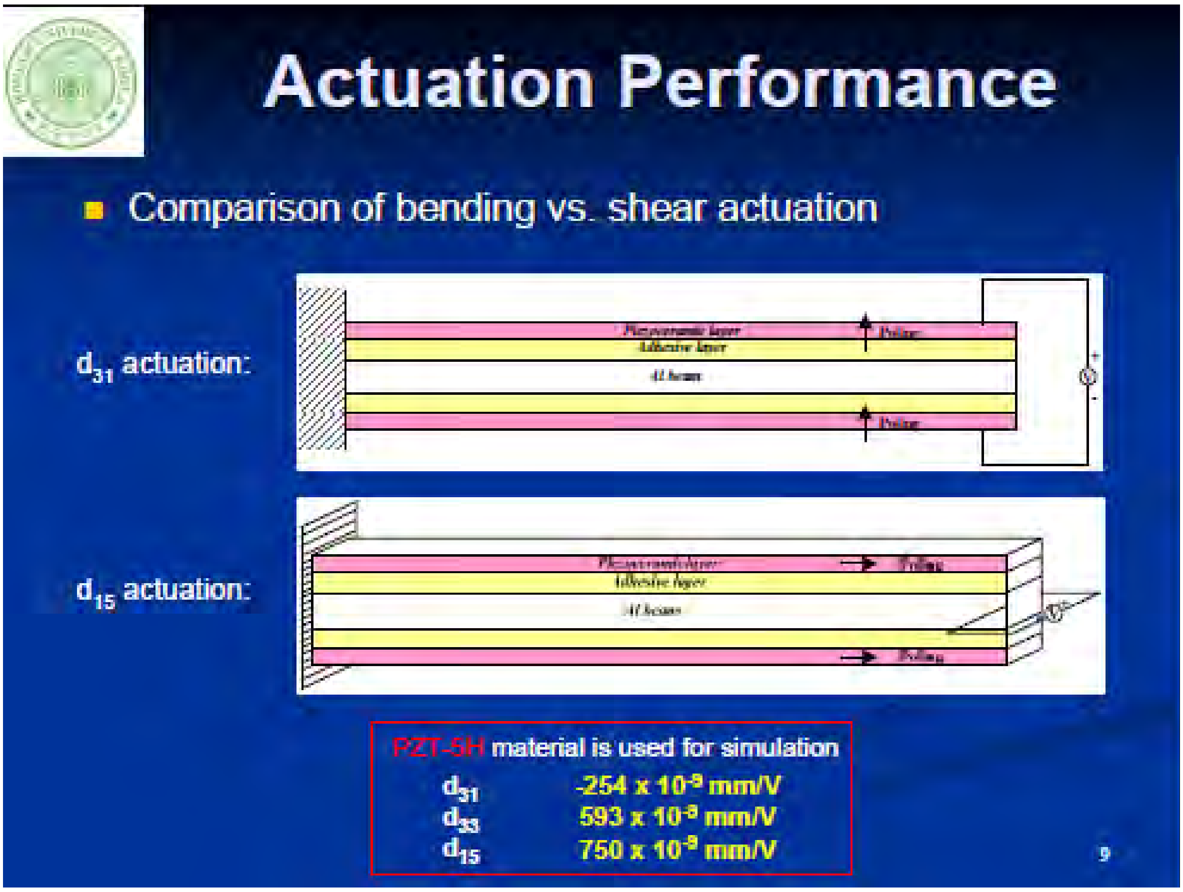
d_{31} actuation ← normal strains → d_{33} actuation

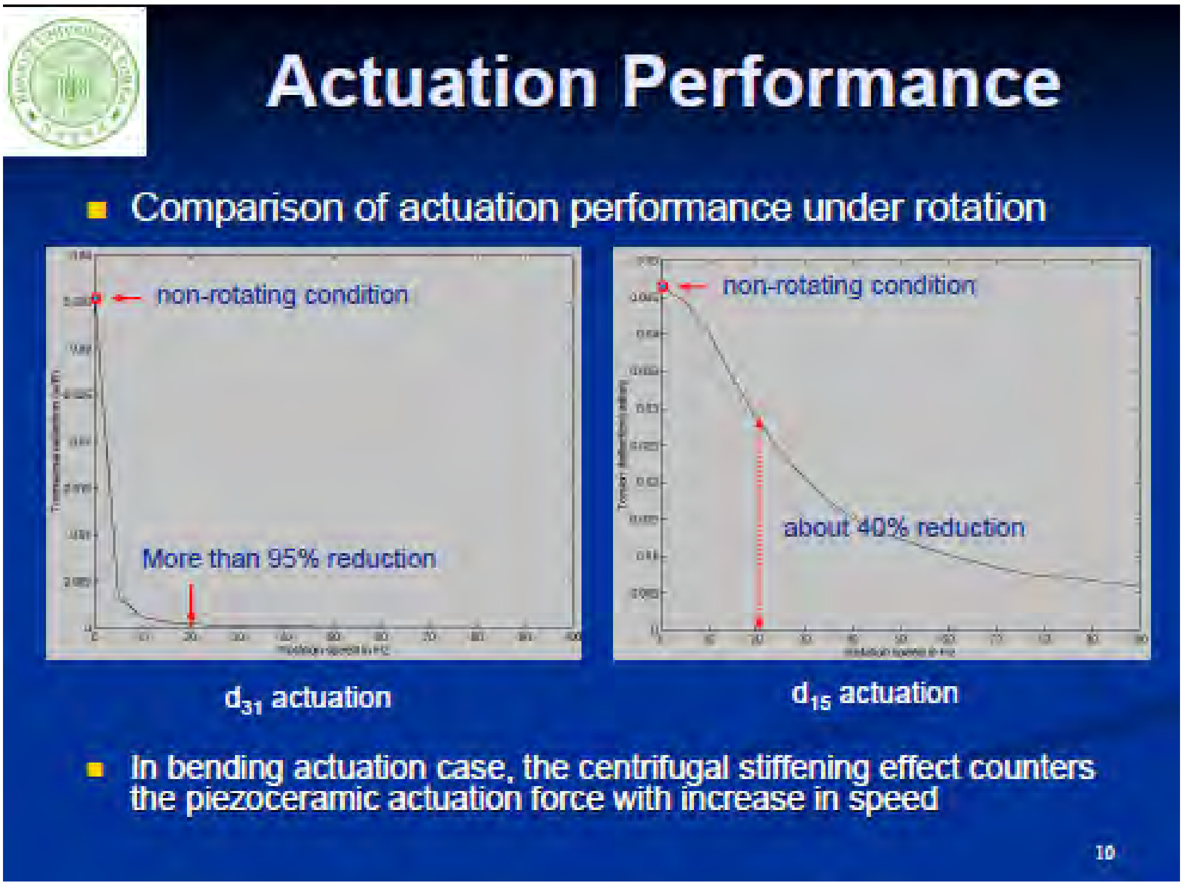
d_{15} actuation: shear strains



- d_{15} actuation is focused in the present study

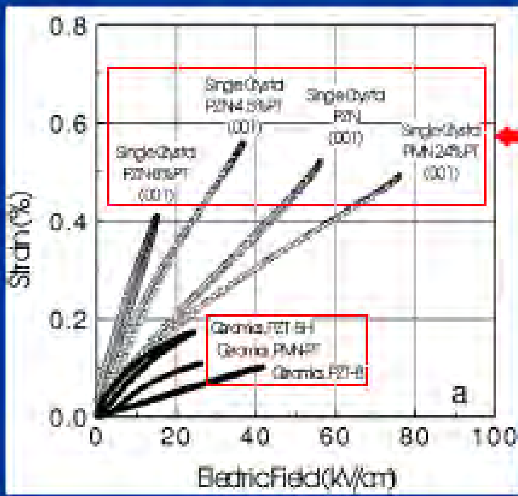
8


Actuation Performance
Comparison of bending vs. shear actuation
d31 actuation:
d15 actuation:
PZT-5H material is used for simulation
d31 -254 x 10-9 mm/V
d33 593 x 10-9 mm/V
d15 750 x 10-9 mm/V
9


Actuation Performance
Comparison of actuation performance under rotation
non-rotating condition
More than 95% reduction
non-rotating condition
about 40% reduction
d31 actuation
d15 actuation
In bending actuation case, the centrifugal stiffening effect counters the piezoceramic actuation force with increase in speed
10

Single Crystal Piezoceramics

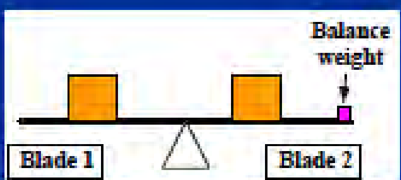
- The conventional PZT material has limited actuation authority to be used for vibration suppression
- Single crystal piezoceramics (e.g., PZN-PT) offers new opportunity to meet the large stroke requirement with less power usage



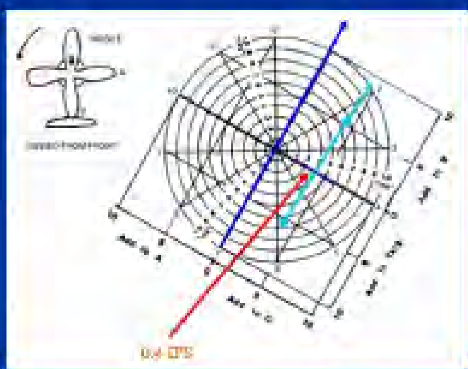
11

Rotor Imbalance

- Generally, active vibration control systems are designed based on identical bladed rotor system.
- Manufacturing defects, mass imbalance, stiffness degradation and environmental factors bring the rotor system dissimilarity



Static balancing



Dynamic balancing*

* Rotor & Wing Aviation Services

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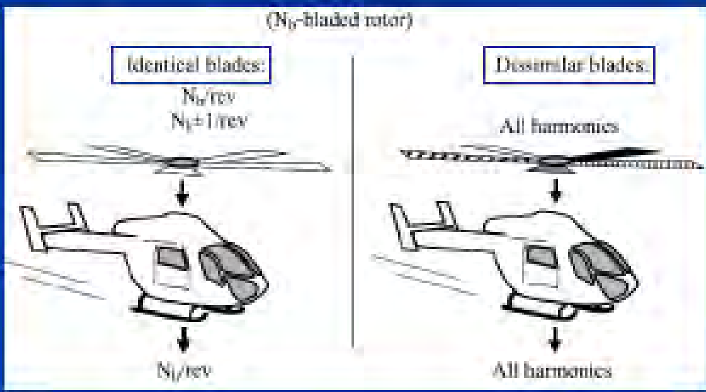
Hub Vibration

- Identical bladed rotor system filters out other than kN_b/rev harmonics. In this case, the rotor hub acts as a filter and only kN_b/rev harmonic loads are transmitted to the fuselage
- When a dissimilarity of blades exists, significant non-kN_b/rev loads are also transmitted to the fuselage



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Overview of Present Work

- Hub vibration reduction of hingeless composite blades is studied by using induced-shear piezoceramic actuation
- Single crystal PZN-8%PT material is used for shear actuation
- Individual blade control method is applied to suppress N_b/rev along with non-N_b/rev loads for a dissimilar rotor system
- The rotor blade is modeled as a one-dimensional thin-walled box beam representing stiff-inplane rotor blades
- It is assumed that blade-to-blade dissimilarity originates from stiffness degradation or loss of trim mass

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Blade Motion Equations

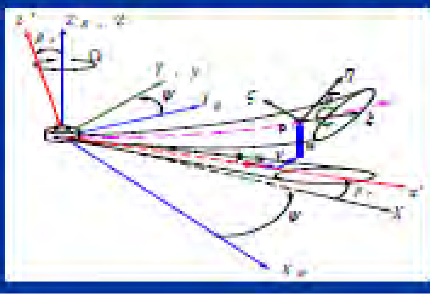
- The equations of motion for hingeless composite blades are obtained using Hamiliton's principle:

$$\delta\Pi = \int_{t_1}^{t_2} (\delta U - \delta T - \delta W)dt = 0$$

- The contribution of the strain energy can be divided into three parts:

$$\delta U = \delta U_{isotropic} + \delta U_{composite} + \delta U_{smart}$$

- The aerodynamic loads are obtained using the Leishman–Beddoes model and inflow distributions are obtained from the Bagai–Leishman free wake model



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Vibration Reduction

- The hub loads of the dissimilar rotor system contains various non-N_b/rev loads along with the N_b/rev loads. The control voltage function for i-th blade is based various voltage harmonics

$$V_i(\psi) = V_0 + \sum_{j=1}^{j=8}(V_j^c \cos(j\psi) + V_j^s \sin(j\psi)) \qquad |V_i(\psi)| \le V_a$$

- The problem is to find the optimum solution J expressed as a function of vibratory loads Z and voltage inputs U

$$J = Z^T W_z Z + U^T W_u U$$

where

$$Z = \left[z^{(1p)} \quad z^{(2p)} \quad z^{(3p)} \quad z^{(4p)} \quad z^{(5p)}\right]$$
$$U = [u_1 \quad u_2 \quad u_3 \quad u_4]$$

For 4-bladed case

$$z^{(k)} = \left[F_x^{(k)} \quad F_y^{(k)} \quad F_z^{(k)} \quad M_x^{(k)} \quad M_y^{(k)} \quad M_z^{(k)}\right]$$
$$u_i = \left[V_0 \quad V_1^c \quad V_1^s \quad V_2^c \quad V_2^s \quad \cdots \quad V_8^c \quad V_8^s\right]$$

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Optimal Control Algorithm

- A linear quasi-static model is used to relate the vibratory hub loads Z (output) to the voltage control harmonics U (input):

$$Z = Z_0 + TU$$

Z_0: initial hub loads (uncontrolled)

- The transfer matrix T is obtained using weighted-least-squares method
- The optimum control input for each blade is obtained from the minimization of the performance function: $\dfrac{\partial J}{\partial U} = 0$
- This leads to the optimal control input in the form:

$$U_{opt} = CZ_0 - CTU_0$$

where

$$C = -DT^T W_z$$
$$D = \left[T^T W_z T + W_u\right]^{-1}$$

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On Actuator Placement

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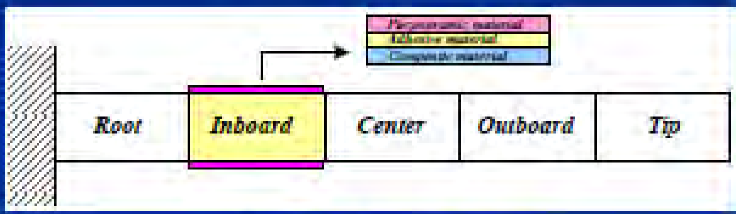
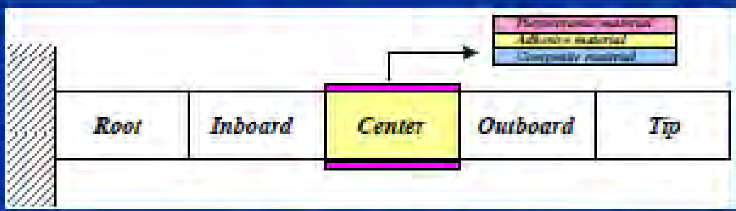
Actuator Placement

- Two actuator locations are studied



(a) actuator at inboard



(b) actuator at center

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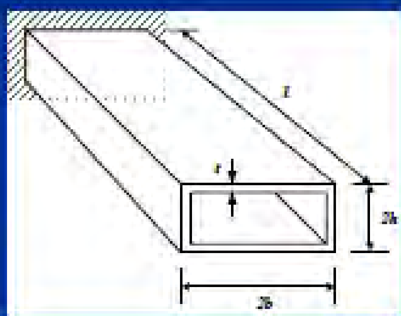
Elastically Coupled Layups

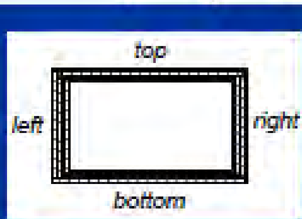
- Cases with different elastic couplings

Lay-up of composite spar laminate

Cases	Top	Bottom	Right	Left
Baseline	L1	L1	L1	L1
Negative Pitch-Flap	L2	L2	L1	L1
Positive Pitch-Flap	L3	L3	L1	L1
Negative Pitch-Lag	L1	L1	L2	L2
Positive Pitch-Lag	L1	L1	L3	L3
Negative Extension-Torsion	L3	L2	L2	L3
Positive Extension-Torsion	L2	L3	L3	L2

L1=$[0_4/(15/-15)_3/(30/-30)_2]_s$, L2=$[0_4/(-15)_6/(30/-30)_2]_s$, L3=$[0_4/(15)_6/(30/-30)_2]_s$





- The blade is represented as a single-cell box beam

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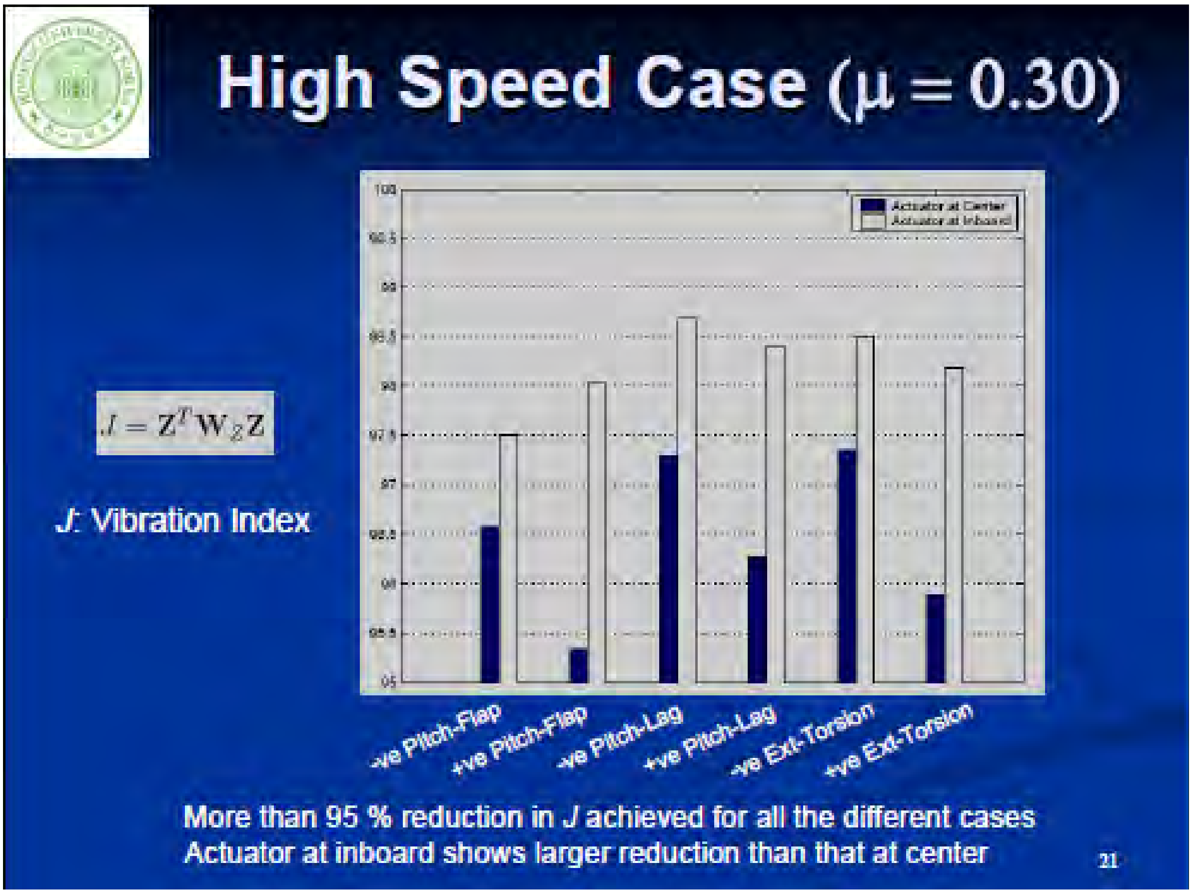
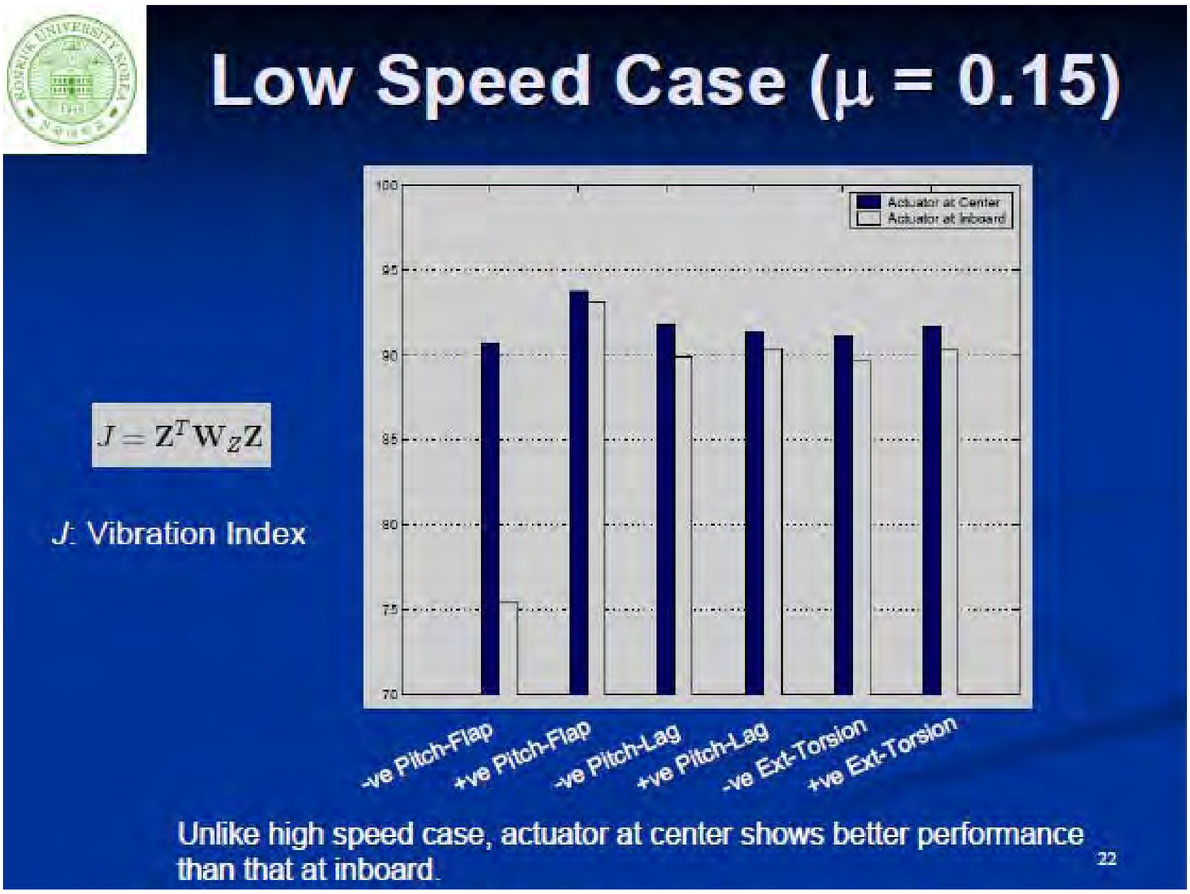

High Speed Case (μ = 0.30)
$J = \mathbf{Z}^T \mathbf{W}_Z \mathbf{Z}$
J: Vibration Index
Actuator at Center
Actuator at Inboard
-ve Pitch-Flap
+ve Pitch-Flap
-ve Pitch-Lag
+ve Pitch-Lag
-ve Ext-Torsion
+ve Ext-Torsion
More than 95 % reduction in J achieved for all the different cases
Actuator at inboard shows larger reduction than that at center
21


Low Speed Case (μ = 0.15)
$J = \mathbf{Z}^T \mathbf{W}_Z \mathbf{Z}$
J: Vibration Index
100
95
90
85
80
75
70
Actuator at Center
Actuator at Inboard
-ve Pitch-Flap
+ve Pitch-Flap
-ve Pitch-Lag
+ve Pitch-Lag
-ve Ext-Torsion
+ve Ext-Torsion
Unlike high speed case, actuator at center shows better performance than that at inboard.
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Numerical Simulation

Flight Condition

Advance ratio	0.3
Thrust, C_T/σ	0.07

Rotor properties

Lock number	6.34
$EI_y/m_0\Omega^2R^4$	0.007763
$EI_z/m_0\Omega^2R^4$	0.1236
$GJ/m_0\Omega^2R^4$	0.003693

MBB BO-105

Baseline vehicle properties

Number of Blades	4
Radius, ft.	16.2
Hover Tip Speed, ft/sec	650
Airfoil	NACA 0015
c_0, c_1	0.0, 5.73
d_0, d_1, d_2	0.0095, 0.0, 0.2
e/R	0.08
t/R	0.15
Solidity, σ	0.10
C_T/σ	0.07
Precone, β_p	0.0
Lock Number, γ	6.34
Mass per unit length, slug/ft.	0.135
Torsional Inertia, $\frac{mk_{m1}^2}{m_0R^2}$, $\frac{mk_{m2}^2}{m_0R^2}$	0.0001, 0.0004
Hub Length, x_{hub}/R	0.04
Aerodynamic root cutout, x_{root}/R	0.10
Long., Lat. CG offsets, x_{CG}/R, y_{CG}/R	0.0, 0.0
CG Below Hub, h/R	0.2
Flat Plate Area, $f/\Pi R^2$	0.01
Tail rotor radius, ft.	3.24
Tail rotor solidity, σ_{tr}	0.15
Tail rotor location, x_{tr}/R	1.2
Tail rotor above CG, h_{tr}/R	0.2
$(c_0)_{tr}$, $(c_1)_{tr}$	0.0, 6.0
Horizontal tail location, x_{ht}/R	0.95
Horizontal tail planform area, $S_{ht}/\Pi R^2$	0.011
$(c_0)_{ht}$, $(c_1)_{ht}$	0.0, 6.0

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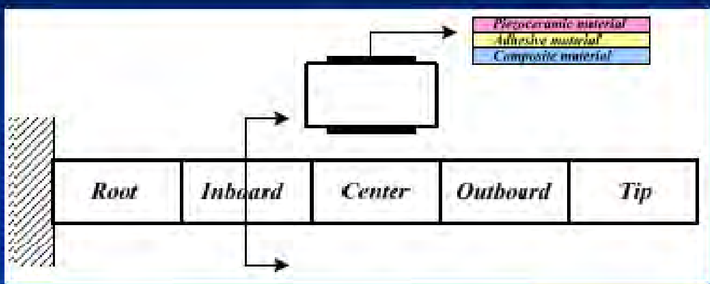
Numerical Simulation



Actuator properties

Material	PZN-8%PT
E	114.7 GPa
ν	0.3
d_{15}	18750x10^{-9} mm/V
V_a	200 V
Adhesive layer	0.4 mm

The piezoceramic layers are attached at the inboard locations

Blade properties

Blade radius R	4.94 m
Box width	203.2 mm
Box height	38.1 mm
Ply thickness	0.127 mm
E_L	144.1 GPa
E_T	9.79 GPa
G_{LT}	6 GPa
Poisson ratio	0.3

Lay-ups: $[0_4/(15/-15)_3/(30/-30)_2]_S$

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Stiffness Degradation

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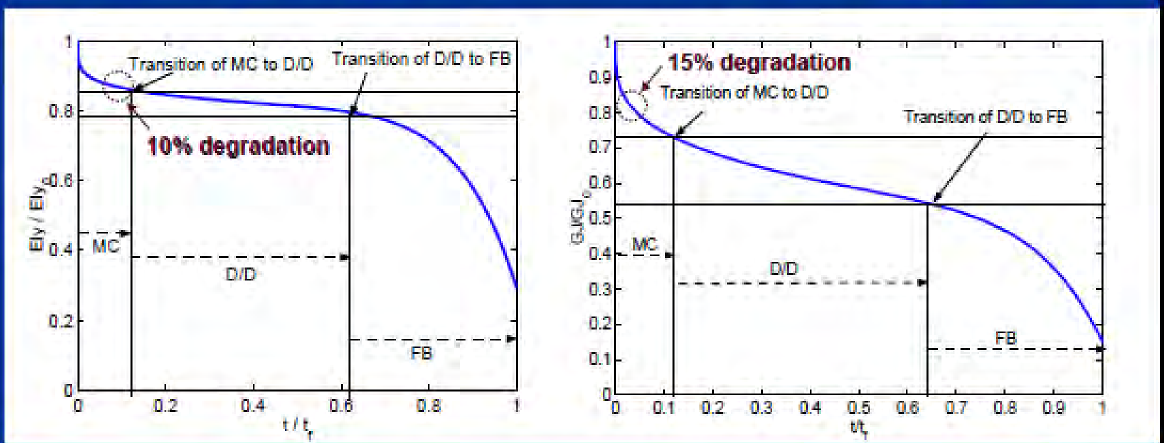
Stiffness Degradation

Bending stiffness, EI_y Torsion Stiffness, GJ



- Blade-to-blade dissimilarity is introduced by stiffness degradation

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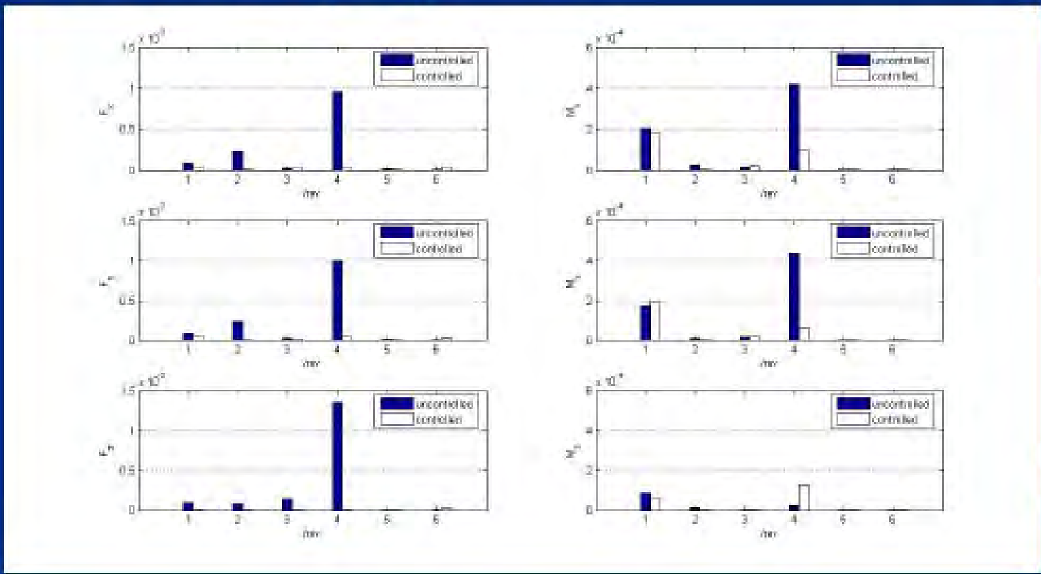
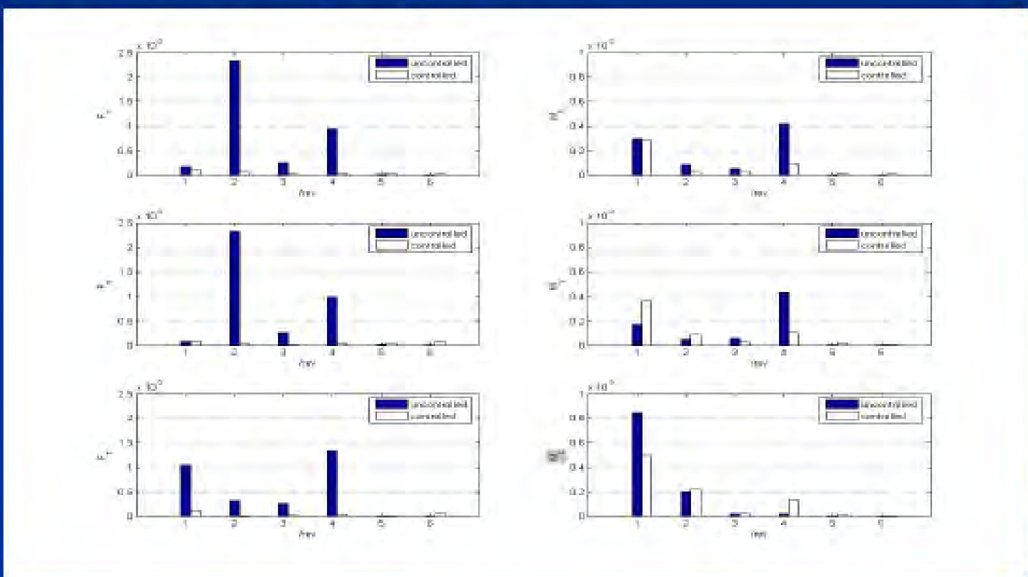
Controller Performance

- One Blade - EI_y Degradation



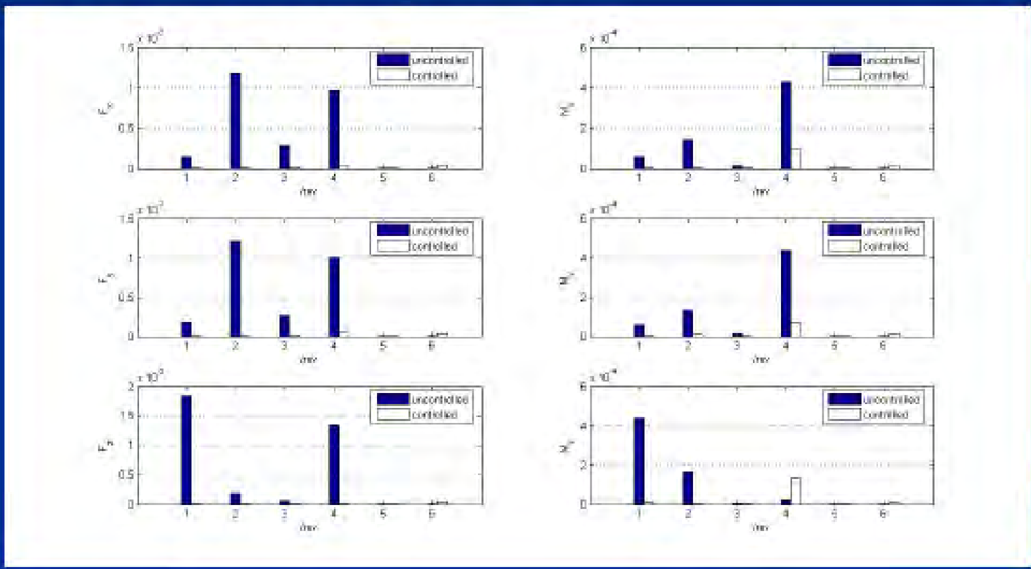
Controller Performance

- One Blade - EI_z Degradation



Controller Performance

- One Blade - ***GJ*** Degradation



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Summary

- Individual stiffness degradation shows that the non-N_b/rev harmonics are more sensitive to EI_z and GJ degradation as compared to EI_y degradation
- Degradation in EI_z show a large increase in 2/rev F_x and F_y and also 1/rev F_z and M_z
- IBC shows considerable reduction in all the non-N/rev and N/rev loads. The shear force reduction performance is quite good as compared to moments reduction performance

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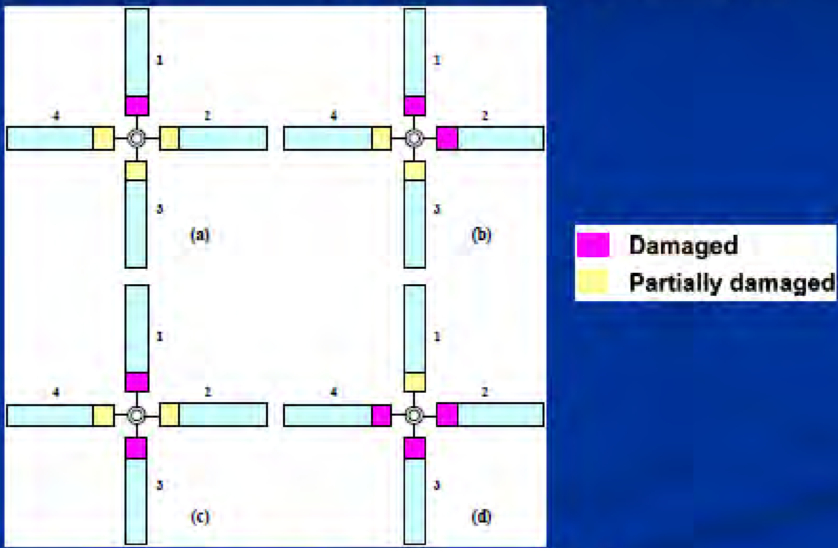
Blade-To-Blade Dissimilarity

- Four different dissimilarity cases are considered



(a) One blade damage (b) Two adjacent blades
(c) Two opposite blades (d) Three blades

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Damage Cases

- Percentage of damage for different cases

Cases	Damaged		Partially Damaged	
	Bending (%)	Torsion (%)	Bending (%)	Torsion (%)
Case 1-1 (One blade)	10	15	0	0
Case 1-2 (One blade)	10	15	5	7.5
Case 2 (Two adjacent blades)	10	15	5	7.5
Case 3 (Two opposite blades)	10	15	5	7.5
Case 4 (Three blades)	10	15	5	7.5

Root part of damage is assumed for each blade

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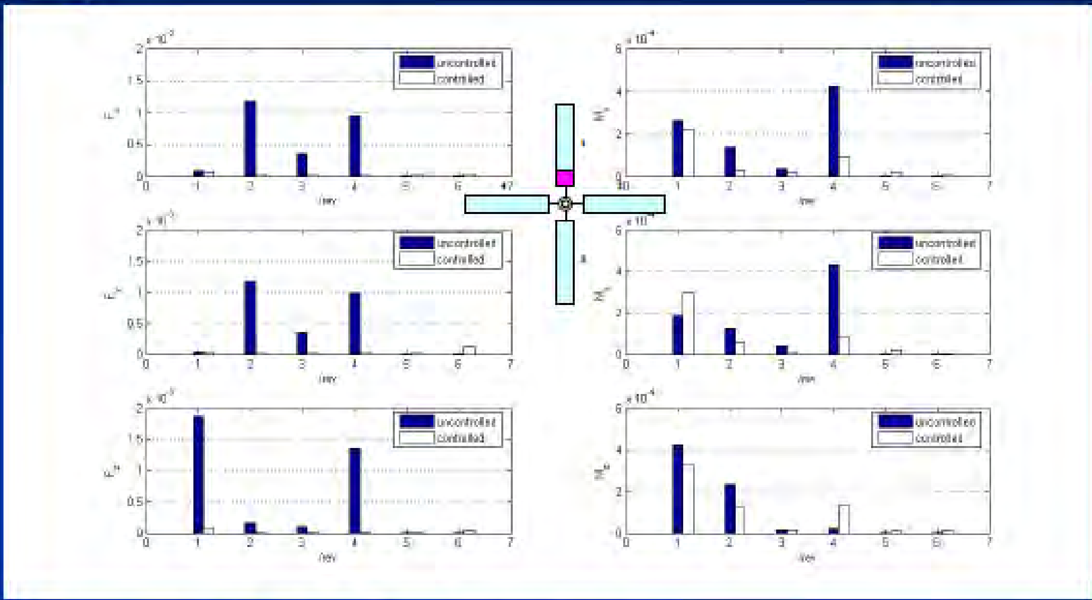
Case 1-1 : One Blade



- Around 95-99 % reduction in shear forces
- 1/rev F_x reduced by 16 % and others 55-80 %

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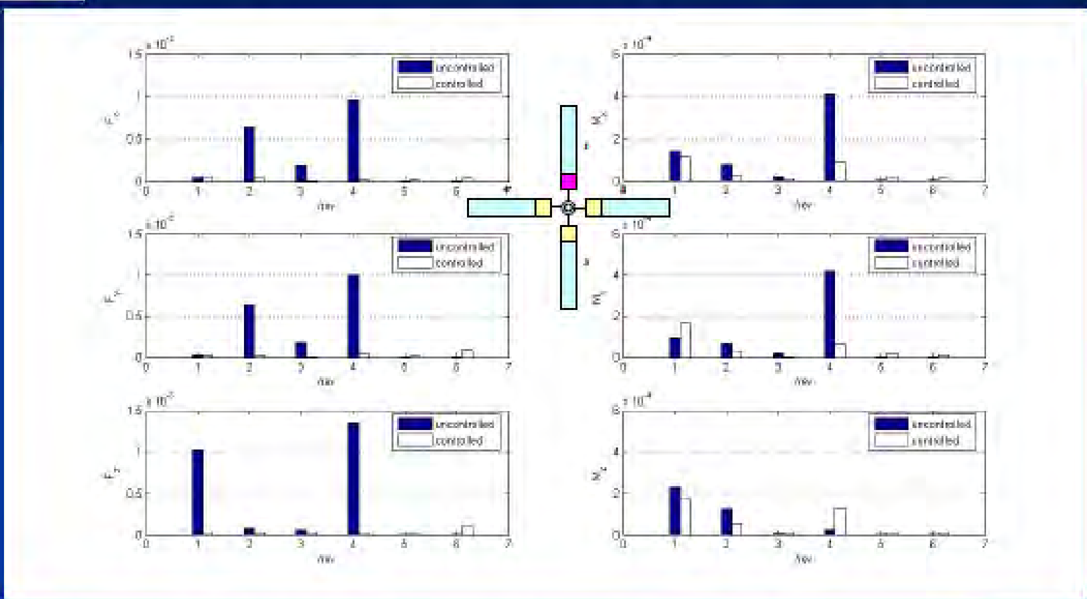
Case 1-2 : One Blade



- Assumption of partial damage shows less non-N_b/rev loads

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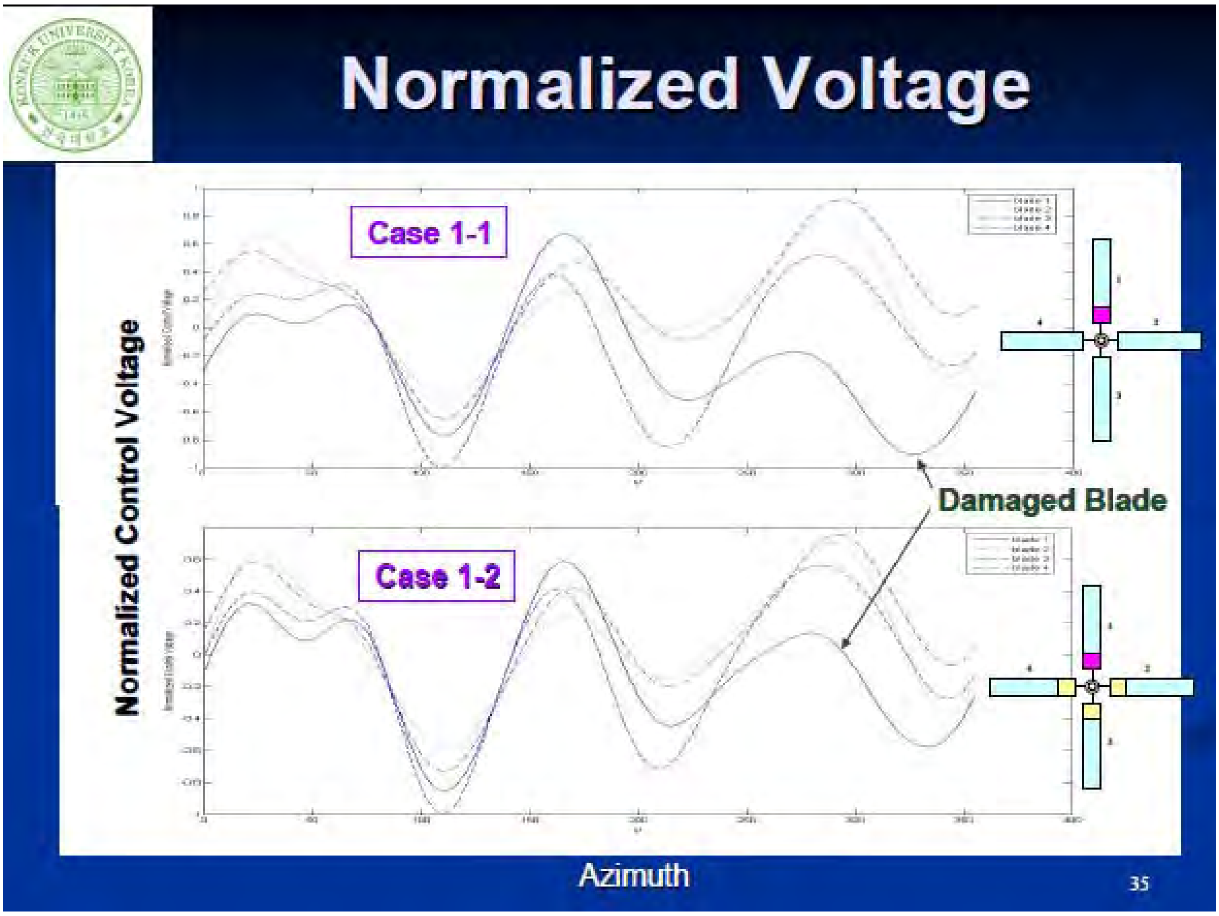
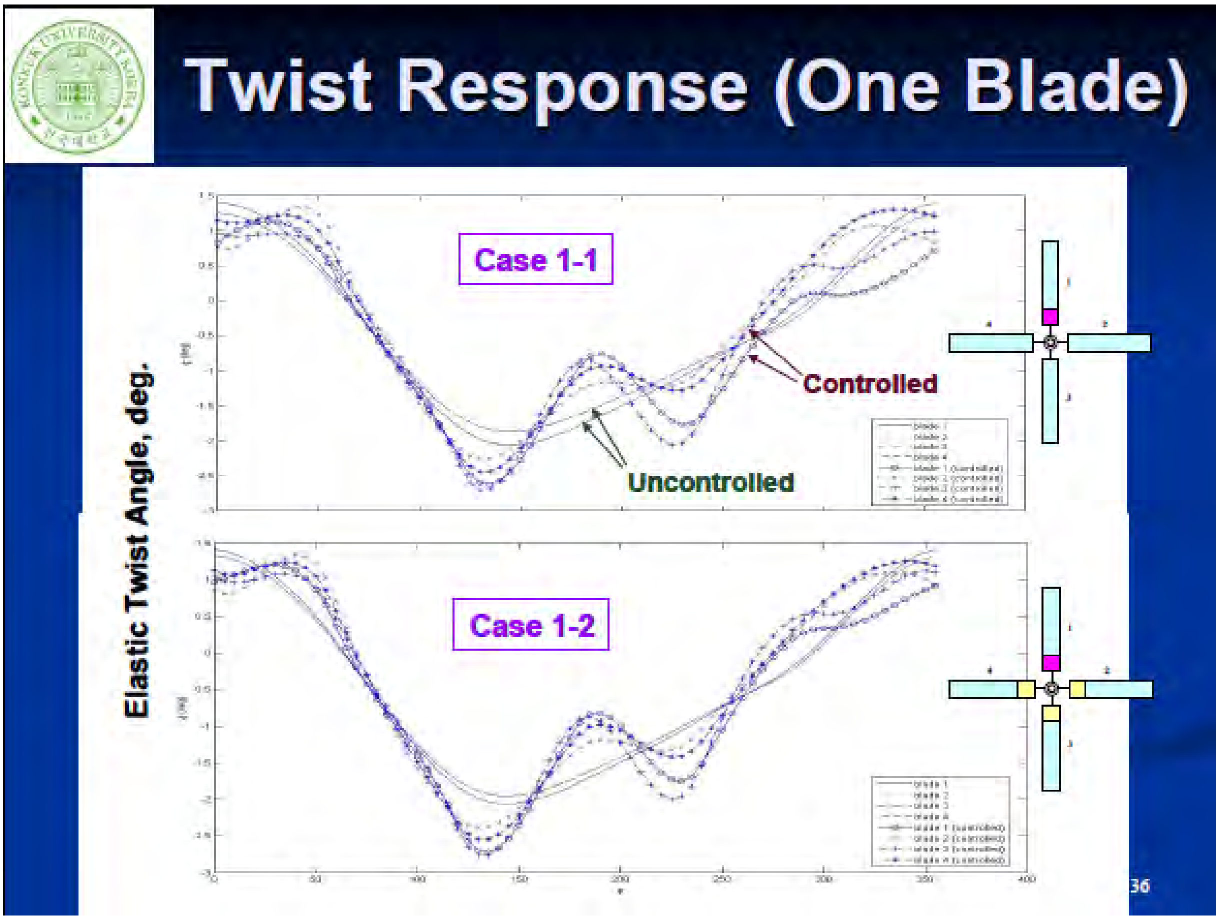
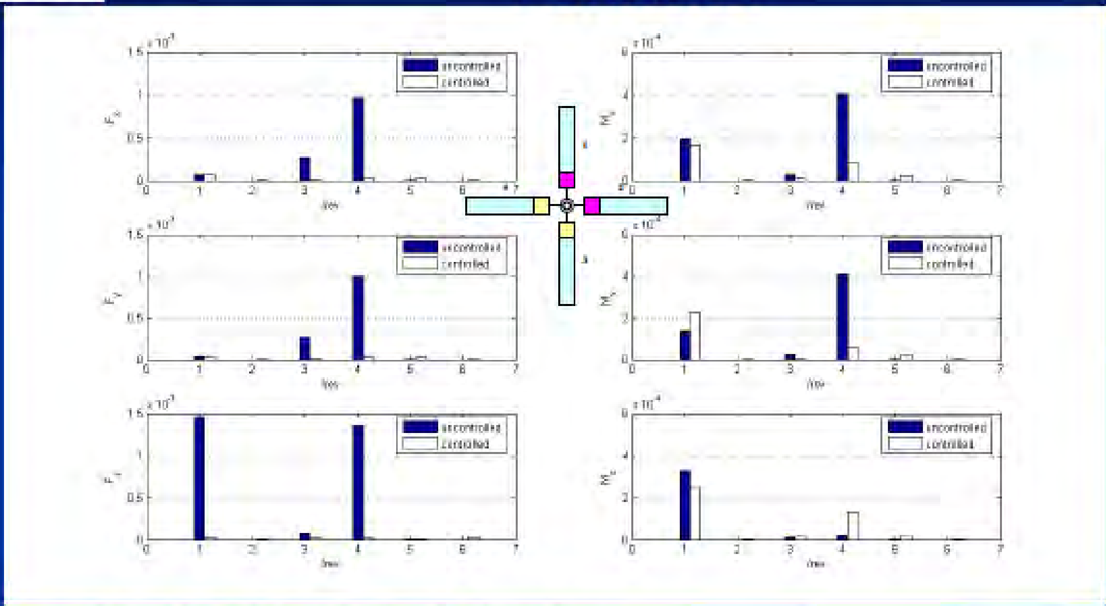

Normalized Voltage
Case 1-1
Case 1-2
Normalized Control Voltage
Damaged Blade
Azimuth
35


Twist Response (One Blade)
Case 1-1
Case 1-2
Elastic Twist Angle, deg.
Controlled
Uncontrolled
36

Case 2 : Two Adjacent Blades



- About 96-98 % reduction in shear force
- About 70-88 % reduction in moments. Whereas 1/rev M_x and M_z reduced by 15-25 %.

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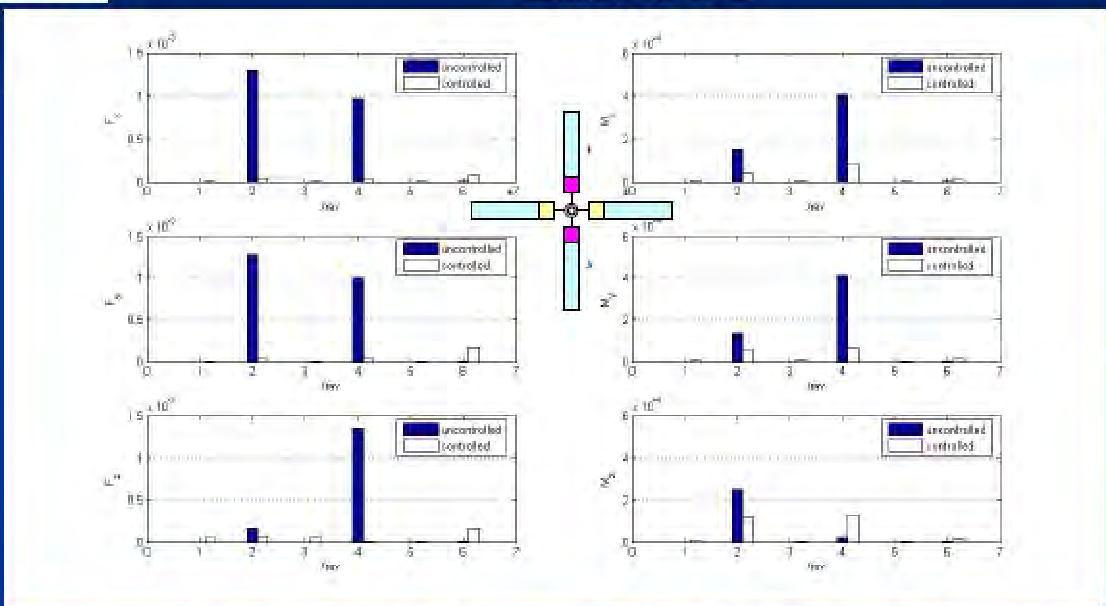
Case 3 : Two Opposite Blades



- 2/rev of F_x and F_y reduced by about 97% and 4/rev forces by 96-99%
- 2/rev moments reduced by about 55-75% and 4/rev moments by 80 %

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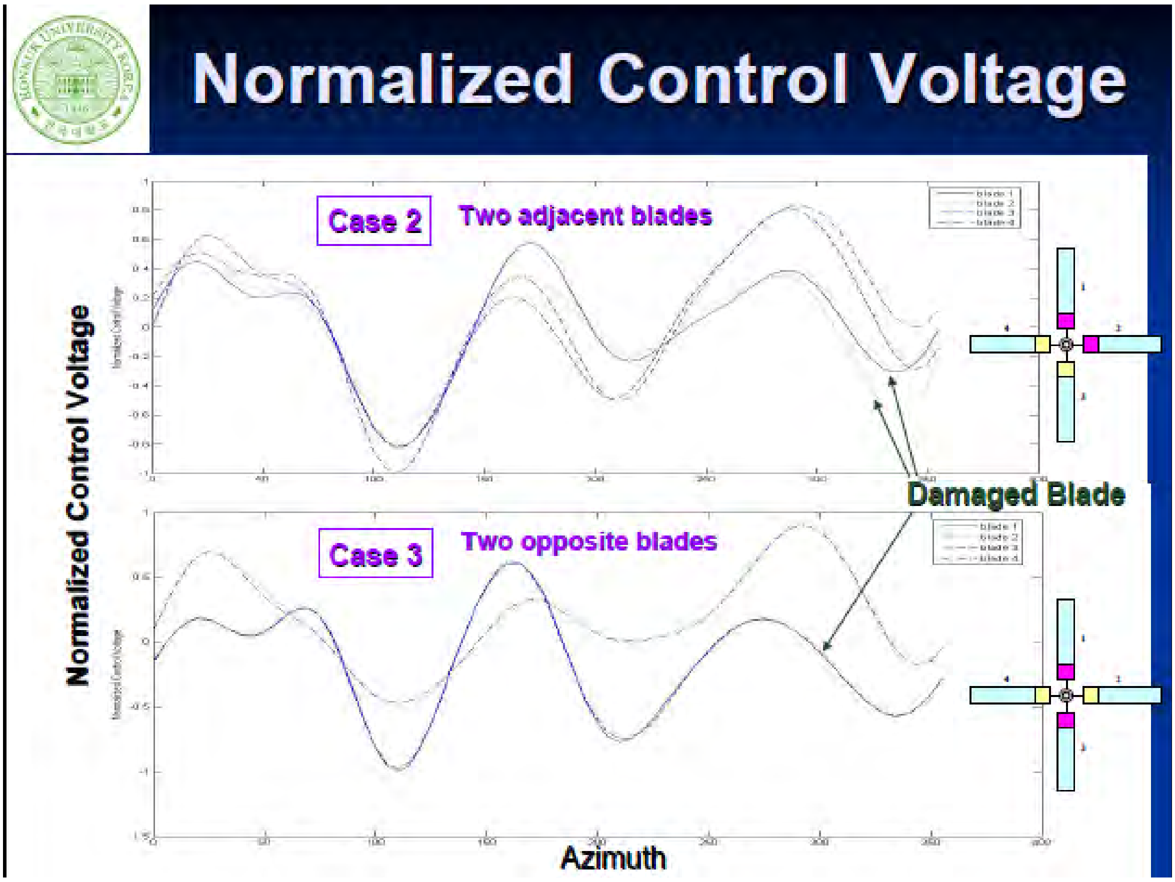
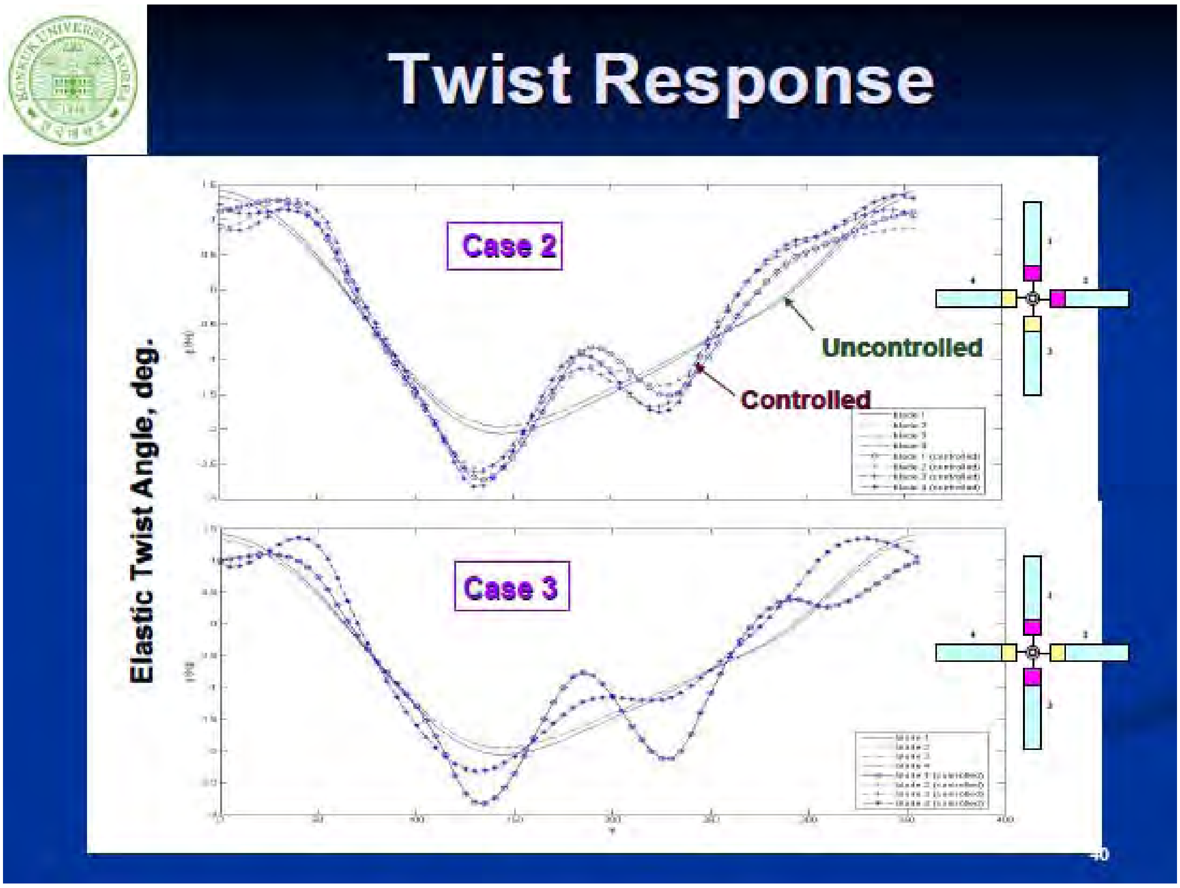
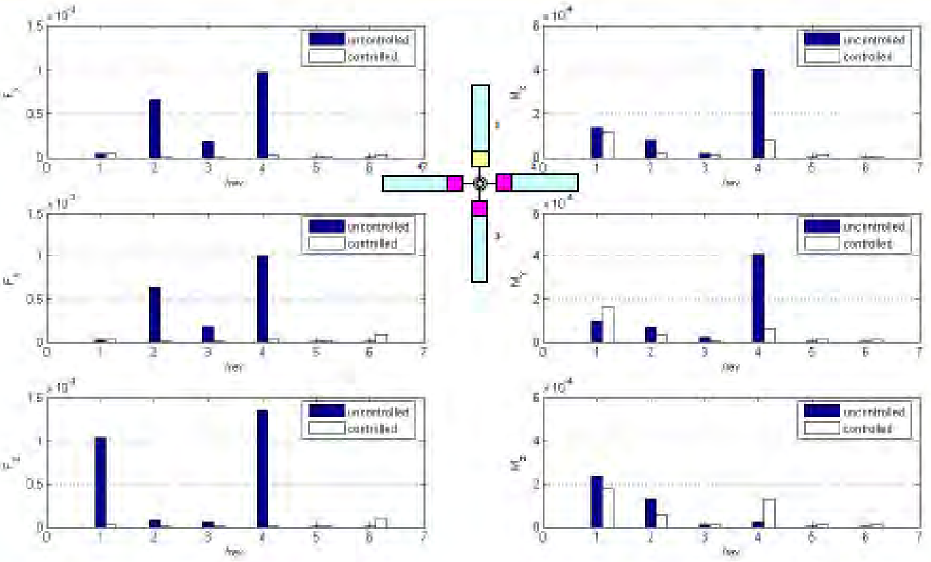

Normalized Control Voltage
Case 2
Two adjacent blades
Case 3
Two opposite blades
Damaged Blade
Normalized Control Voltage
Azimuth


Twist Response
Case 2
Uncontrolled
Controlled
Case 3
Elastic Twist Angle, deg.
40

Case 4 : Three Blades



- All shear forces are reduced by about 95-98 %
- 1/rev moments reduction is not much effective

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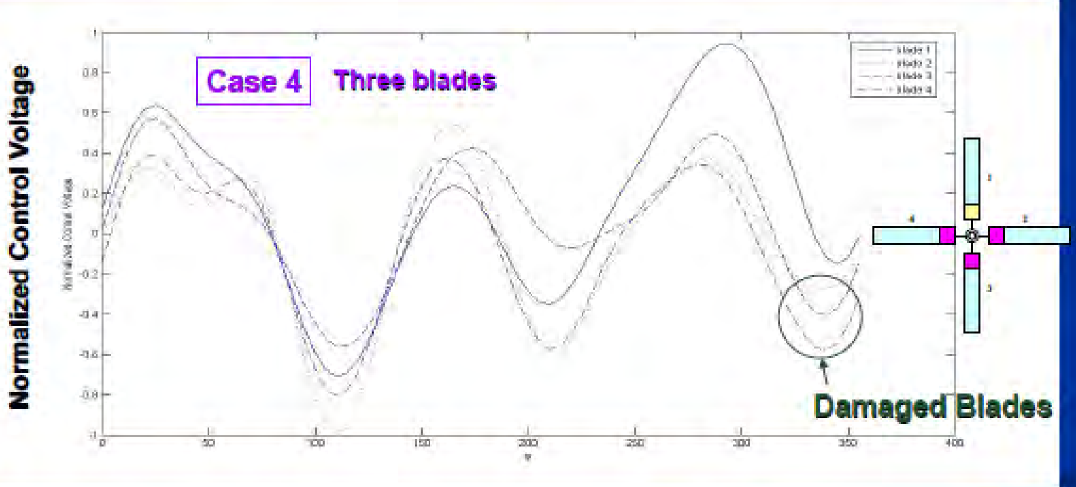
Normalized Control Voltage



- All the blades react to achieve new equilibrium positions

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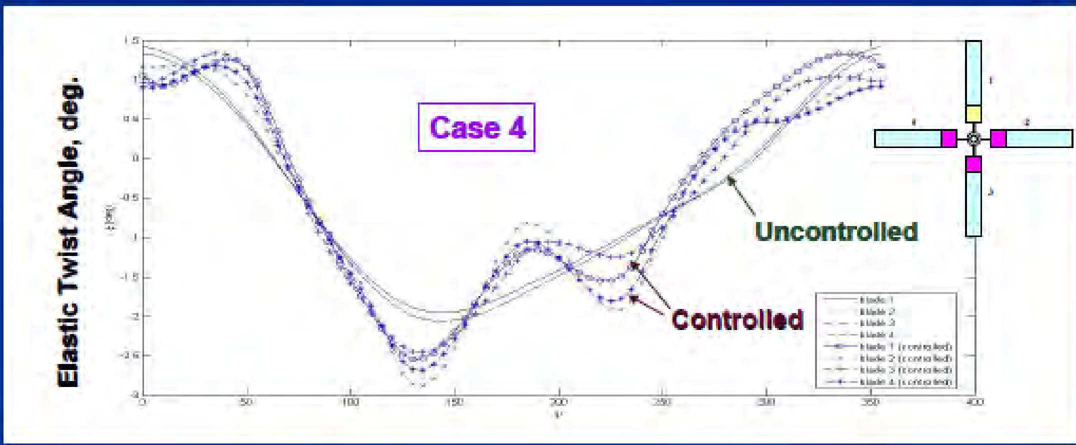
Twist Response



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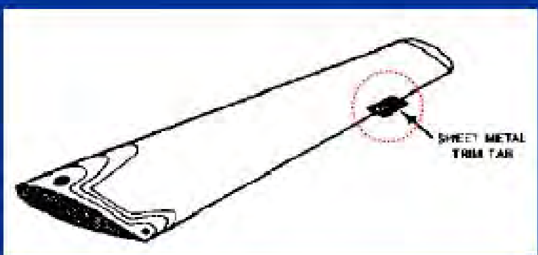
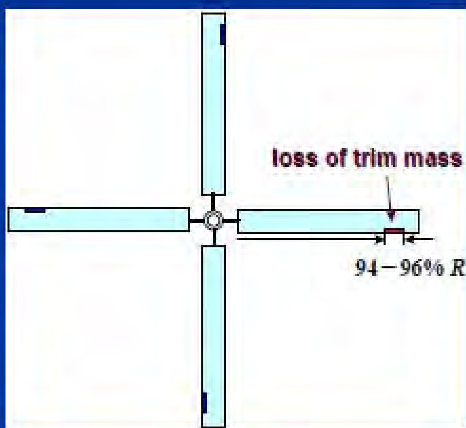
Mass Imbalance

- Case with 5% loss in trim mass in one blade





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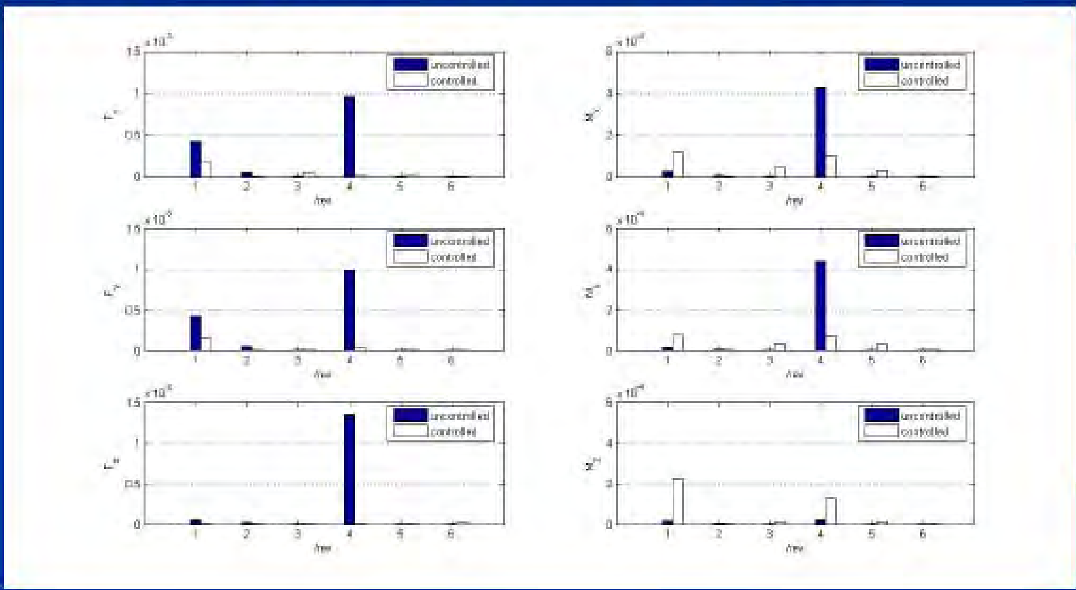
Mass Imbalance

- Case with 5% loss in trim mass in one blade



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Conclusions

- Considerable vibration reduction has been achieved by using the active twist control method
- Shear force reduction performance is quite excellent. All the shear force reduction is about 92-96% for all the cases
- 4/rev moments are reduced by about 77-85%. 2 /rev and 3/rev moments are reduced by about 50-80 %. However, 1/rev moment reduction is poor.
- This vibration reduction methodology will reduce the efforts required for manual tracking and balancing and can be used for in-flight tracking system.

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Blank

平成20年7月1日
日本ヘリコプター協会

AHS Forum64
IHST Safety Session　報告

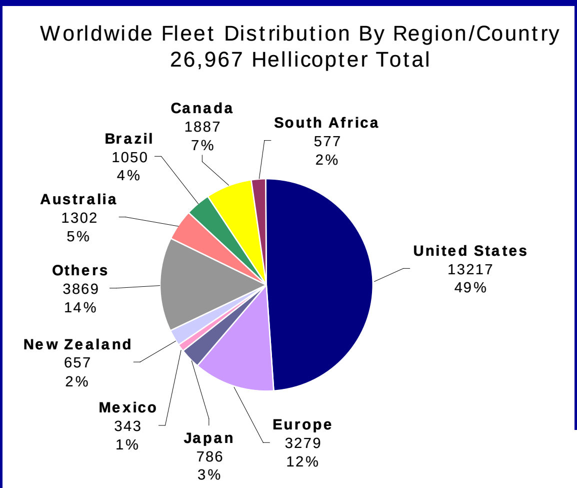
セントラルヘリコプターサービス（株）
古　澤　正　人

1、AHS　Forum64　IHST Safety Session 紹介
- Overview Briefing
  IHST Excom　Dave Downey, FAA
- DoD Helicopter Mishaps FY85-05: Findings and Recommendations
  USAF　Colonel Pete Mapes

2、Regional Development
- European Helicopter Safety Team Conference
- 2nd IHST South Pacific Regional Conference

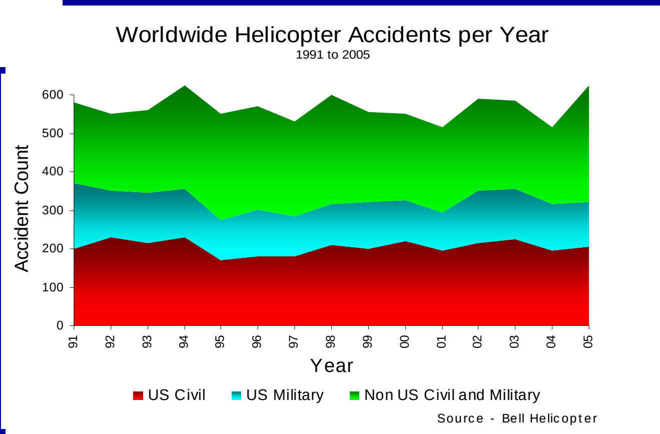
International Helicopter Safety Team Overview Briefing

Dave Downey,
IHST Executive Committee
FAA



The IHST's goals can only be reached through strong ties with the international community

We have a problem!



JHSAT Achievements

- **Jack Drake / Jim Grigg : Co-Chairs**
- **197 accident analyses completed - data from year 2000**
- **150 safety recommendations covering 16 missions presented at IHSS 2007 in Montreal 19-21 September 2007, addressing:**
  - **Training**
  - **Safety Management**
  - **Safety Equipment**
  - **Information**
  - **Infrastructure**
  - **Regulatory**
  - **Maintenance**

JHSAT の成果
・2000年の197事故のデータを分析
・150 のリコメンドを抽出
（IHSS 2007 で発表）

JHSIT Achievements

- **Greg Whyte / Hooper Harris : Co-Chairs**
- **Fred Brisbois SAC to replace Greg Whyte**
- **Team formed with good representation from helicopter operators.**
- **Processes developed for managing recommendations**
  - **Implementation**
  - **Tracking effectiveness**
- **Early focus on SMS toolkit presented at IHSS 2007 in Montreal 19-21 September**
- **Currently processing JHSAT Year 2000 report recommendations**

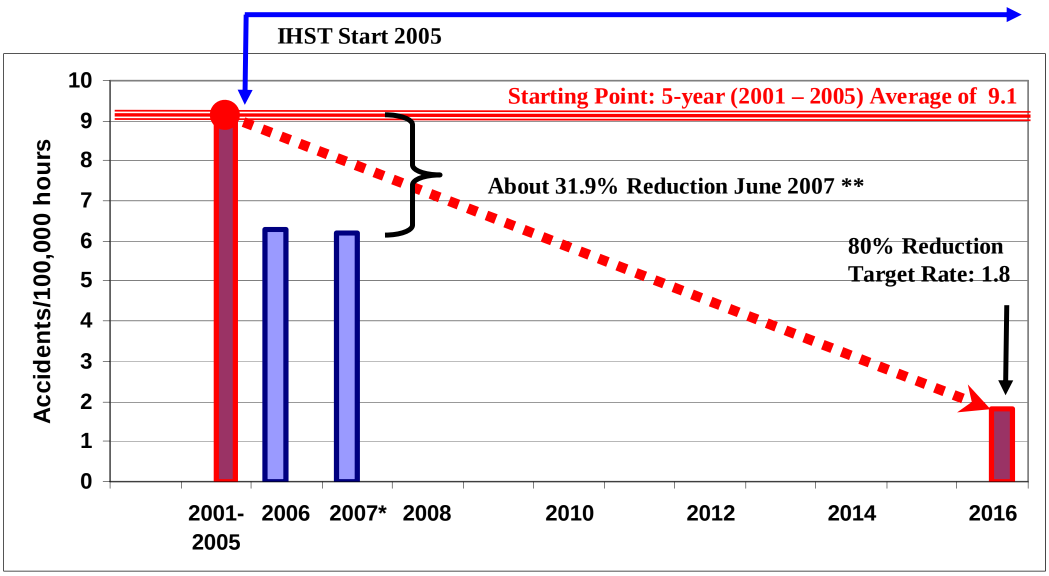
JHSIT の成果
・運航者代表を入れてチームを編成
・JHSATのリコメンドの処理手順を設定
・SMS toolkit（IHSS 2007で発表）
・JHSAT 2000年 リコメンドを検討中

IHST Regional Developments

- 1st Regional Conference held in New Delhi in June 2006 – JHSAT process workshop in New Delhi in March 2007
- 2nd Regional Conference held in Melbourne, Australia in March 2007
- Latin American Regional Conference held in Sao Paulo, Brazil in June 2007, with JHSAT process workshop – regional JHSAT/JHSIT starting up
- Canadian and EU JHSATs operational
- Future Conferences:
  - Middle East – Nov 2008
  - Far East
  - Russia – COSCAP June 2008
  - Europe – September 2008

IHST US Score Card

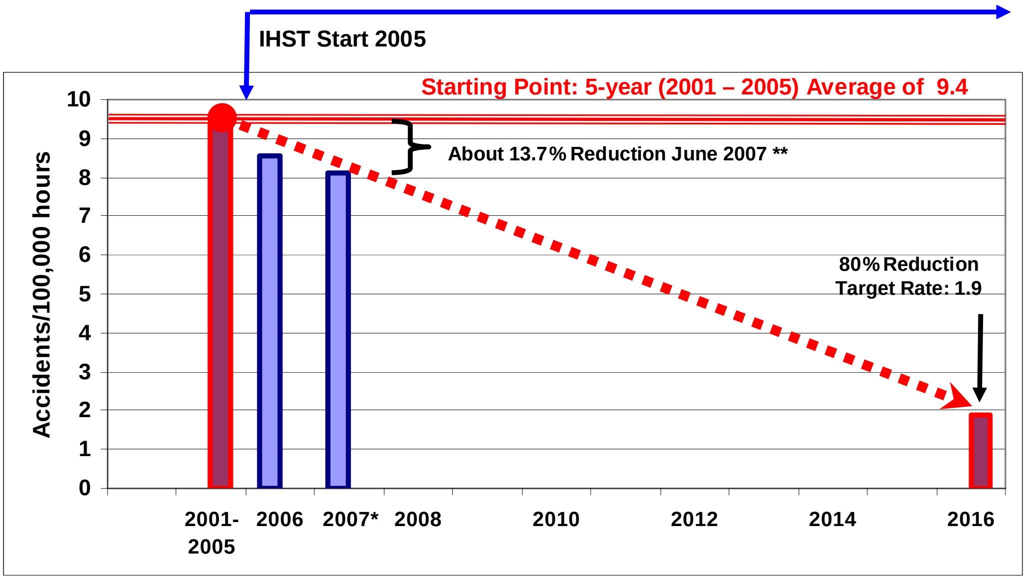
(Accident Rate of U.S. Civil Registered Helicopters)



* 2007 Estimate Twice 1st 6 months

IHST Score Card - Preliminary

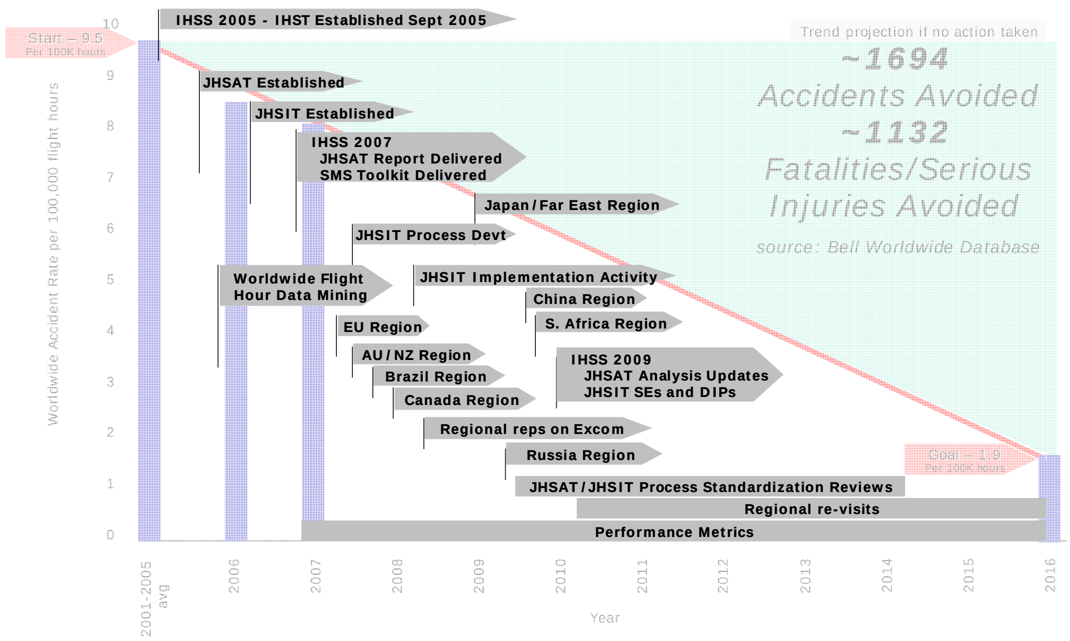
(Accident Rate of All Civil Registered Helicopters Worldwide)



* 2007 Estimate Twice 1st 6 months ** Preliminary Worldwide Flight Hours

Progressing Toward the 80% Goal

Significant IHST Program Events/Milestones



Regional Development の考え方
・共通のアプローチ
・Data Driven
・Regional Ownership
・JHSAT/JHSIT lead team

This is a worldwide effort

A structured approach will be used to manage the analytical and implementation work sponsored by the IHST.

Key attributes:

All recommendations will be data driven

Regional ownership - Data is owned and analyzed by those most familiar with it. Safety recommendations will be implemented by teams most familiar with local needs.

JHSAT and JHSIT lead teams will be responsible for training/coaching regional teams, measuring the results of the safety recommendations and implementation effectiveness.

Summary

- **IHST is making good progress**
  - **European representative added to Executive Committee**
  - **North American JHSAT report presented at IHSS 2007**
  - **JHSIT SMS toolkit presented at IHSS 2007**
  - **EHEST/EHSAT building on North American work**
  - **Groups in Australia, Brazil and India committed to support the IHST**

今後の活動

- Implementation Activity
- IHSS 2009　analysis update/Implementation SE and DIP
- Regional Development

  EHEST、Canada : in working

  Middle East、S.Africa、Russia : conference in 2008

  日本　？

DoD Helicopter Mishaps FY85-05: Findings and Recommendations

By

Colonel Pete Mapes, USAF, MC, CFS

LtCol Rob Kent, USAF, MC, SFS

LtCol Rawson Wood, USAF, MC, SFS

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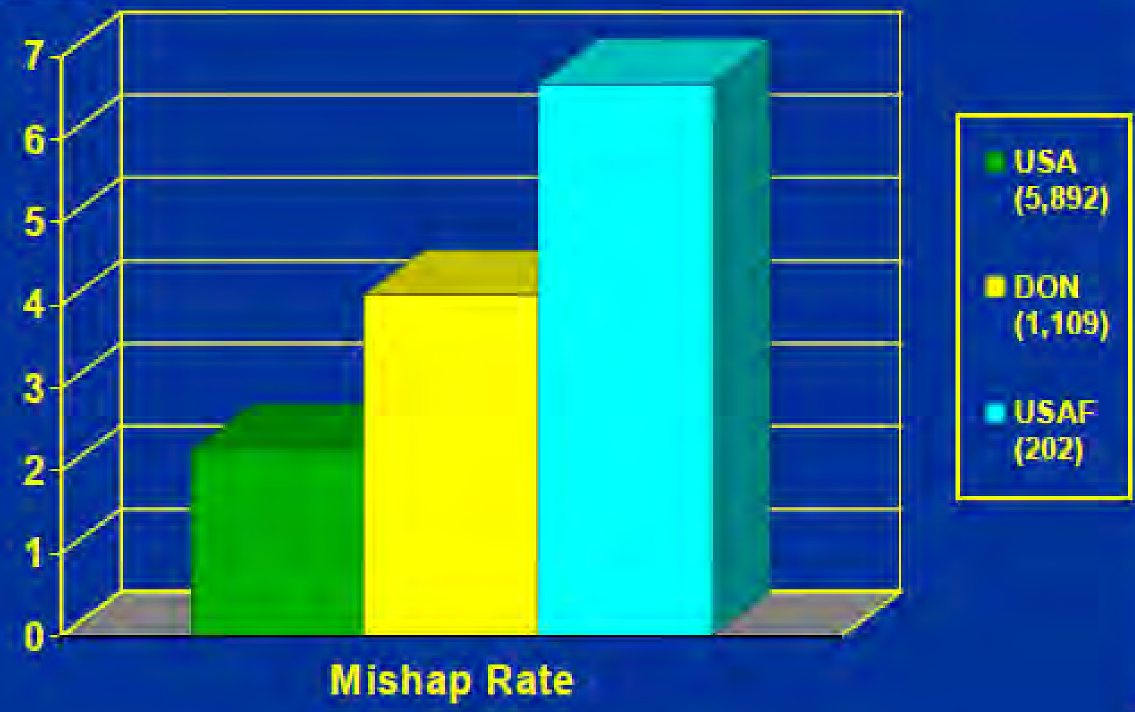
- 本報告は調査者の見解である（DoD等の機関の見解ではない）
- FY85-05 の DoD classA-B ヘリコプタ事故 945件を対象
  977機の損耗・大破、3800+の人が事故に遭遇
  Service Safety Center の事故ファイルに基づく
- データ・セット
  USAF：Safety Reports 88 Mishaps
  DON: 393 Mishaps
  USA Human Factor Mishaps：251件、278機
  USA Non-Human Factor Mishaps：207件、207機

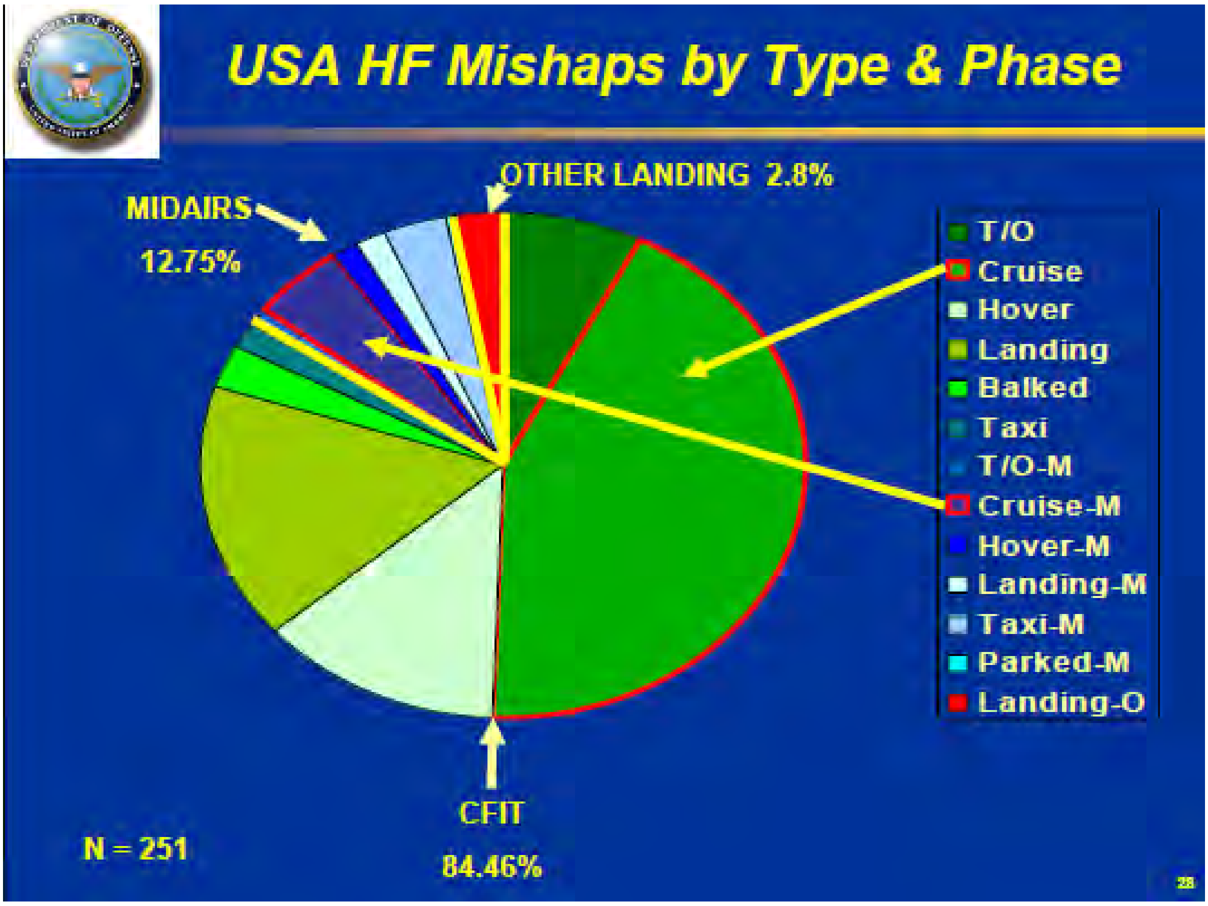
Outline

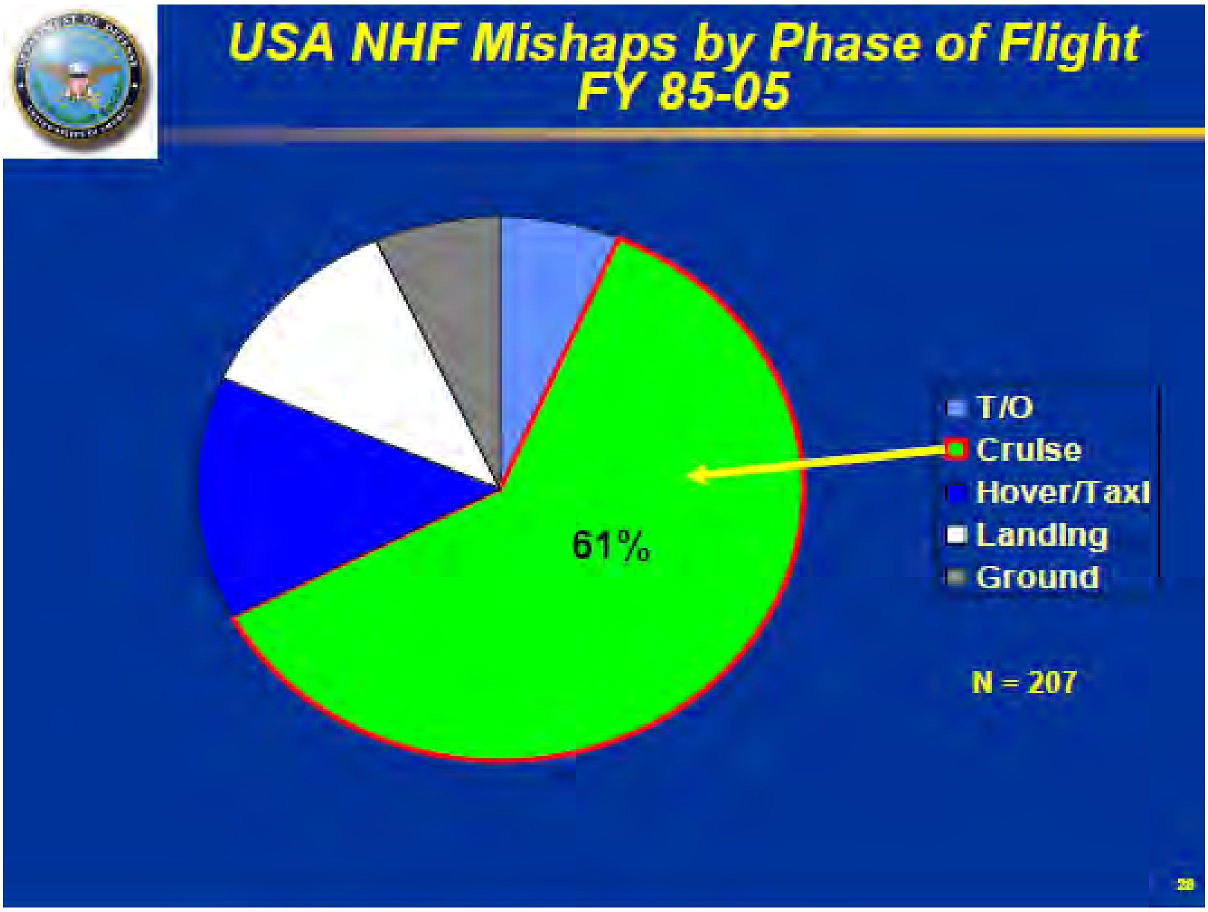
- Fleet Size, Service Mishap Rates & Utilization
- Mishaps by Service, Phase of Flight & Cause
- Fatality & Injury Patterns
  - DoN Water Fatalities
- Whiteout, Brownout, Night, IMC
- Experience, Recency, Training & Supervision (USAF Data)
- MDS Specific Data
- Mishaps & Injuries By Phase Of Flight
- Findings
- Recommendations

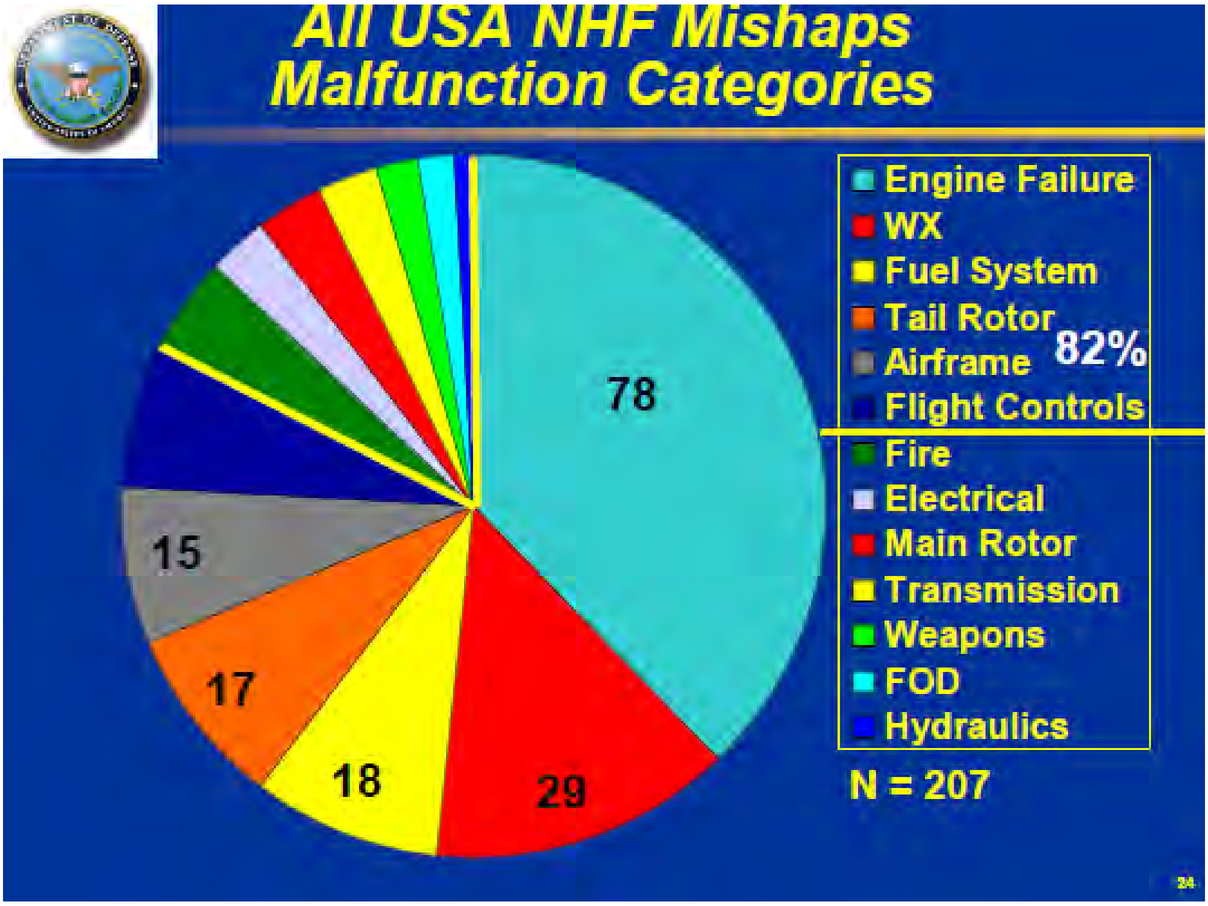
6

Class A & B Mishap Rate per 100Khrs by Service FY 85 – 05

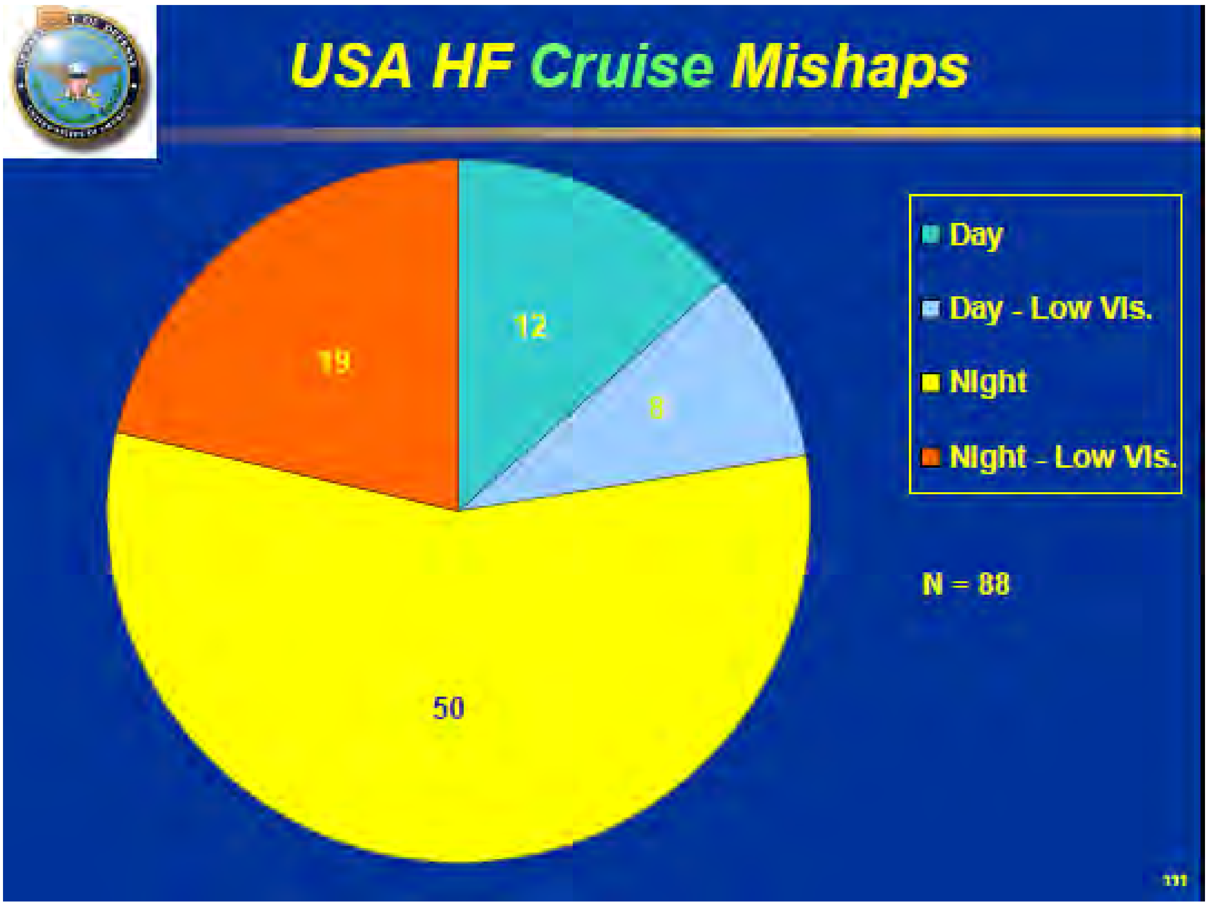



USA HF Mishaps by Type & Phase
OTHER LANDING 2.8%
MIDAIRS
12.75%
T/O
Cruise
Hover
Landing
Balked
Taxi
T/O-M
Cruise-M
Hover-M
Landing-M
Taxi-M
Parked-M
Landing-O
CFIT
84.46%
N = 251
28

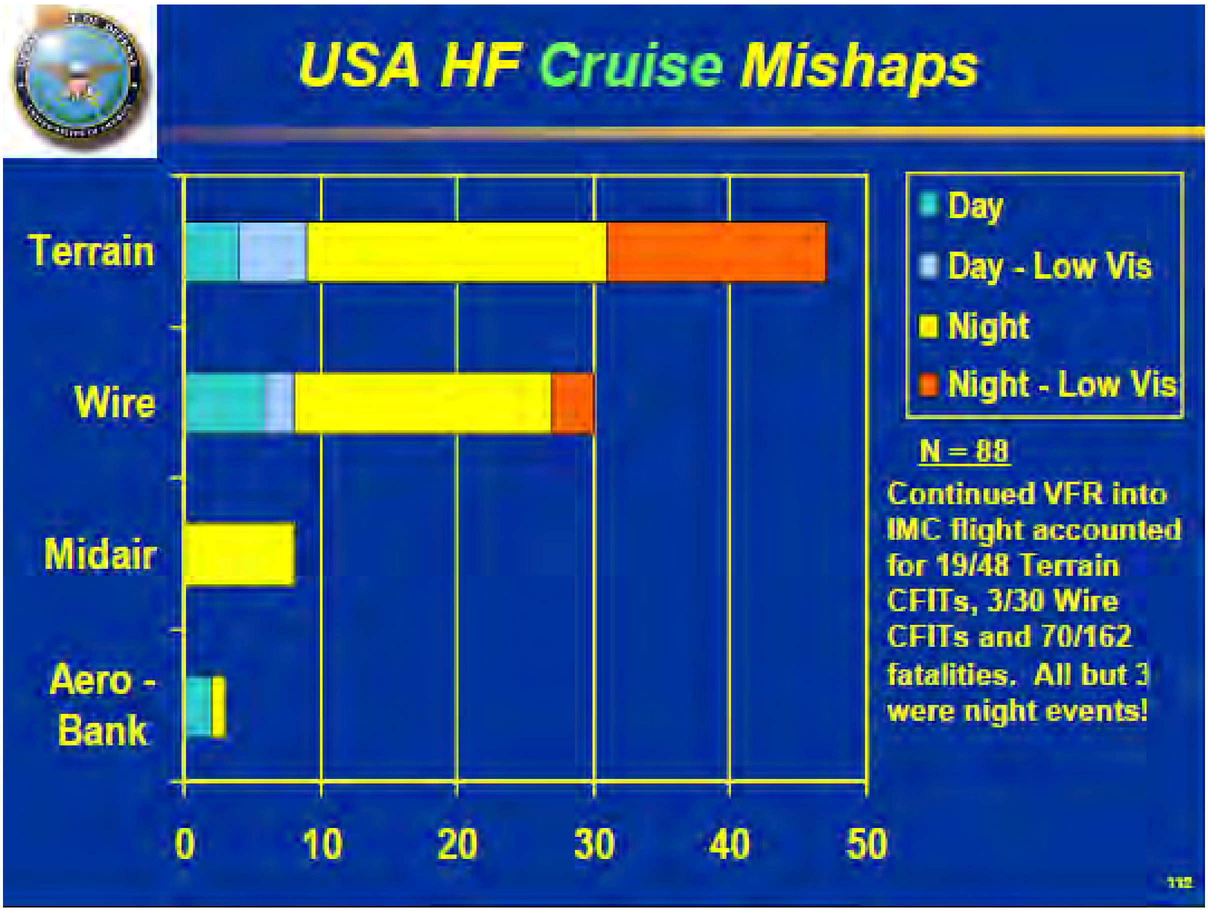

USA NHF Mishaps by Phase of Flight
FY 85-05
61%
T/O
Cruise
Hover/Taxi
Landing
Ground
N = 207
28

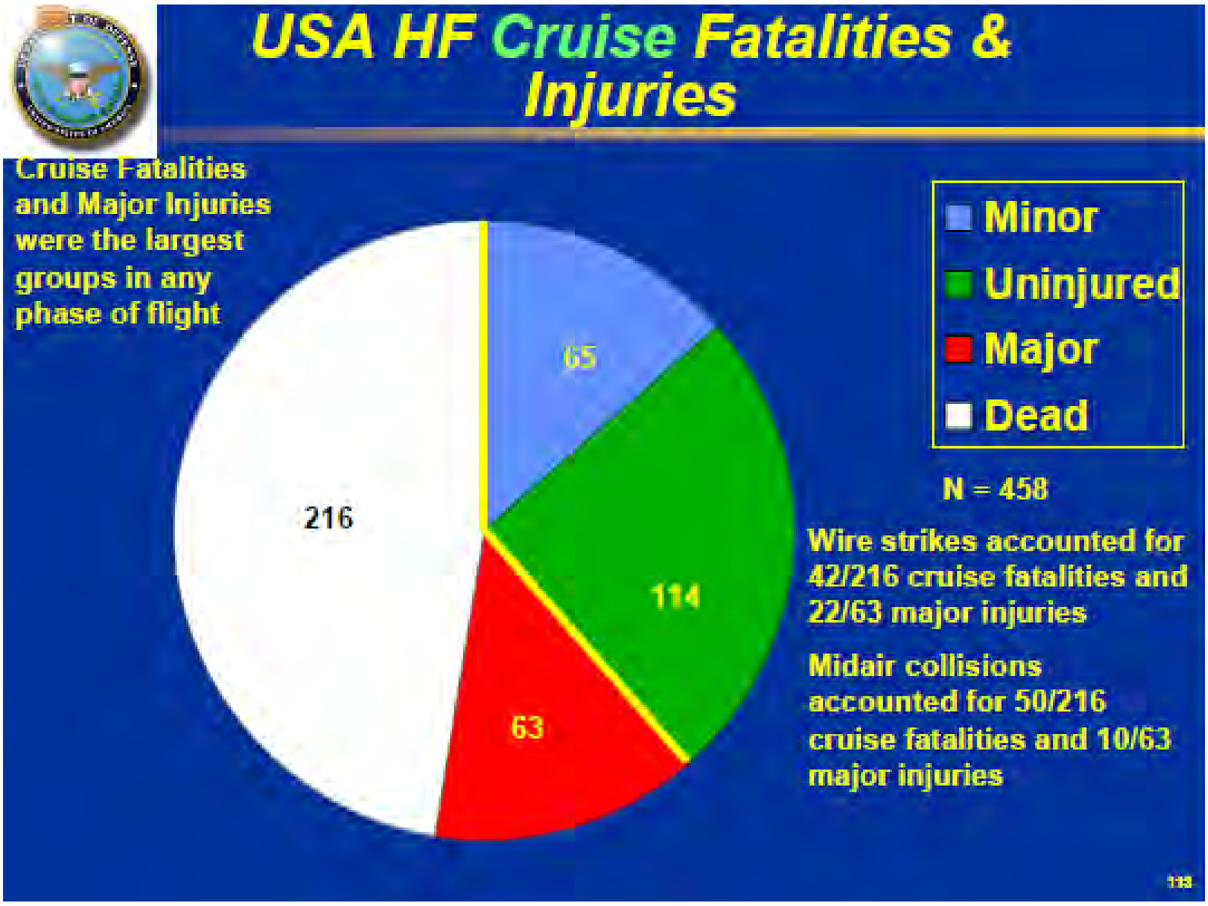


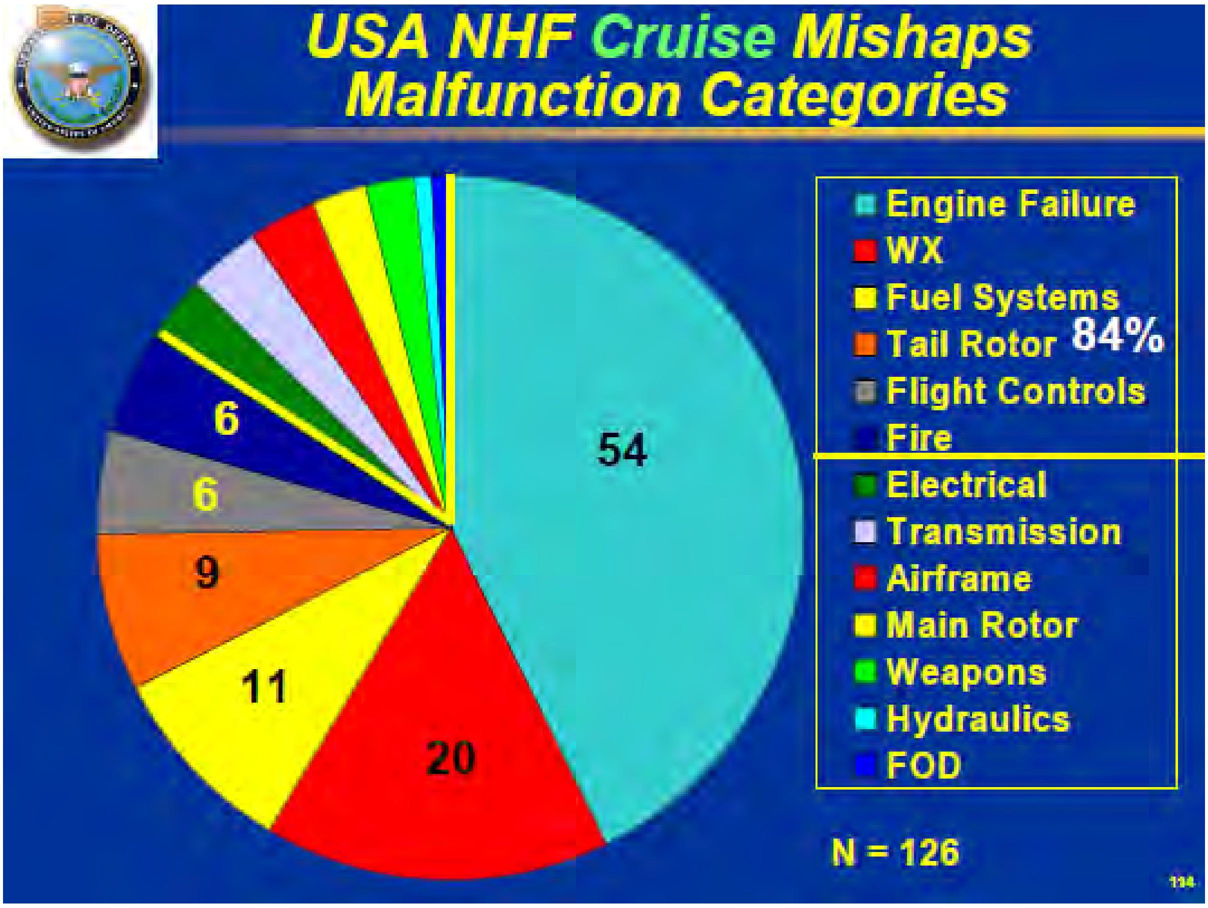
All USA NHF Mishaps
Malfunction Categories
78
29
18
17
15
Engine Failure
WX
Fuel System
Tail Rotor
Airframe
82%
Flight Controls
Fire
Electrical
Main Rotor
Transmission
Weapons
FOD
Hydraulics
N = 207
24

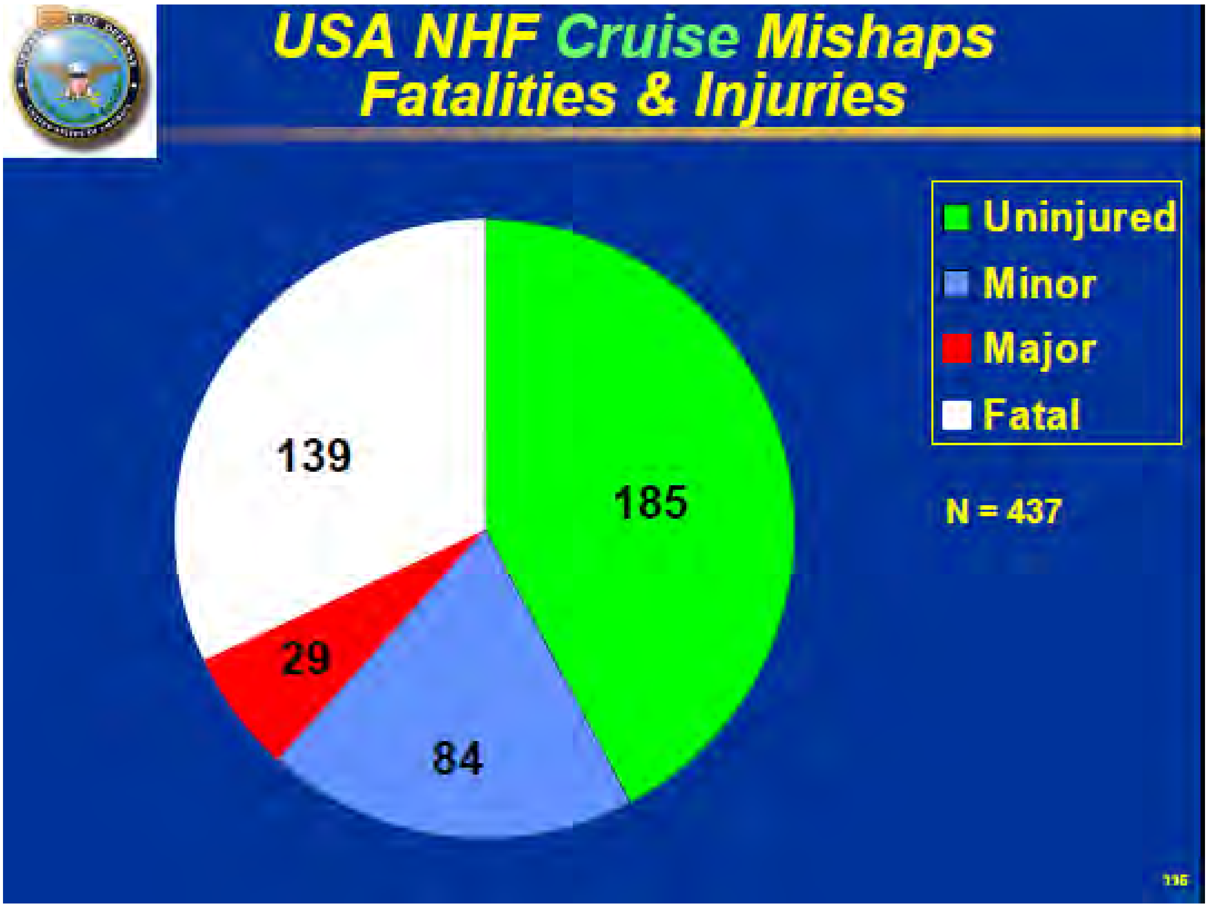


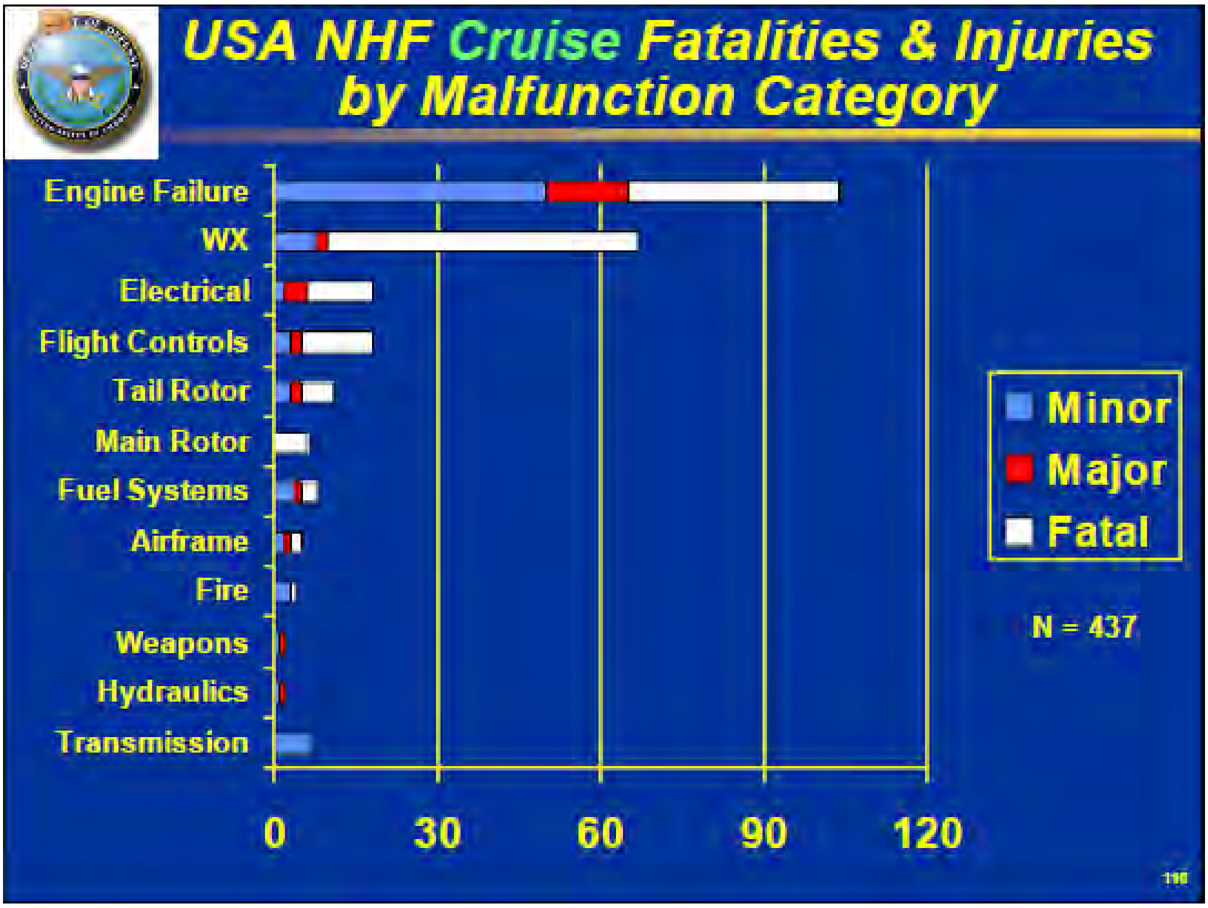
USA HF Cruise Mishaps
12
8
19
50
Day
Day - Low Vis.
Night
Night - Low Vis.
N = 88
111


USA HF Cruise Mishaps
Terrain
Wire
Midair
Aero -
Bank
0
10
20
30
40
50
Day
Day - Low Vis
Night
Night - Low Vis
N = 88
Continued VFR into IMC flight accounted for 19/48 Terrain CFITs, 3/30 Wire CFITs and 70/162 fatalities. All but 3 were night events!


USA HF Cruise Fatalities & Injuries
Cruise Fatalities and Major Injuries were the largest groups in any phase of flight
Minor
Uninjured
Major
Dead
65
114
63
216
N = 458
Wire strikes accounted for 42/216 cruise fatalities and 22/63 major injuries
Midair collisions accounted for 50/216 cruise fatalities and 10/63 major injuries


USA NHF Cruise Mishaps
Malfunction Categories
Engine Failure
WX
Fuel Systems
Tail Rotor
84%
Flight Controls
Fire
Electrical
Transmission
Airframe
Main Rotor
Weapons
Hydraulics
FOD
54
20
11
9
6
6
N = 126


USA NHF Cruise Mishaps
Fatalities & Injuries
Uninjured
Minor
Major
Fatal
185
139
84
29
N = 437



Findings

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Army Findings

- Cruise flight is the most lethal and injurious
- Twin rotor aircraft & attack helicopters appear to be the most survivable
- The training pilots receive to deal with NHF mishaps improves protection factor by roughly 20%
- Cargo compartment crew are more likely to receive major injuries and die than pilots
- IMC is associated with the highest risk of mishap fatality
- Unforecast adverse weather accounts for 1/6 of NHF mishaps, engine failure is the leading NHF mishap cause
- Whiteout/brownout was the most common risk factor in mishaps below ETL
- Tail rotor strikes were common in AH & OH helicopters

120

Recommendations

121

Recommendations

- Technology Recommendations 6
  (Life Saving – Requirements)
- Technology Recommendations 8
  (Life Saving – Crashworthiness)
- Technology Requirements 2
  (Aircraft Saving)
- Policy Recommendations 4
- Initiatives 2
- Needed 5

(27)

Technology Recommendations (Life Saving - Requirements)

- USA & USAF Helicopters would benefit from a system similar to TAWS
  - Militarize a COTS item to provide this for legacy aircraft
  - Use Navy TAWS when computer present
- Bring datalink weather data into all helicopter cockpits
- Provide COTS traffic warning technology to prevent midairs
  - TCAD
  - TCAS
  - ADSB (less practical due to coverage limits)
- All helicopters need wire detection technology
- Installation of wire cutters has value
- USAF H-60 CSAR mission needs new vehicle or Δ

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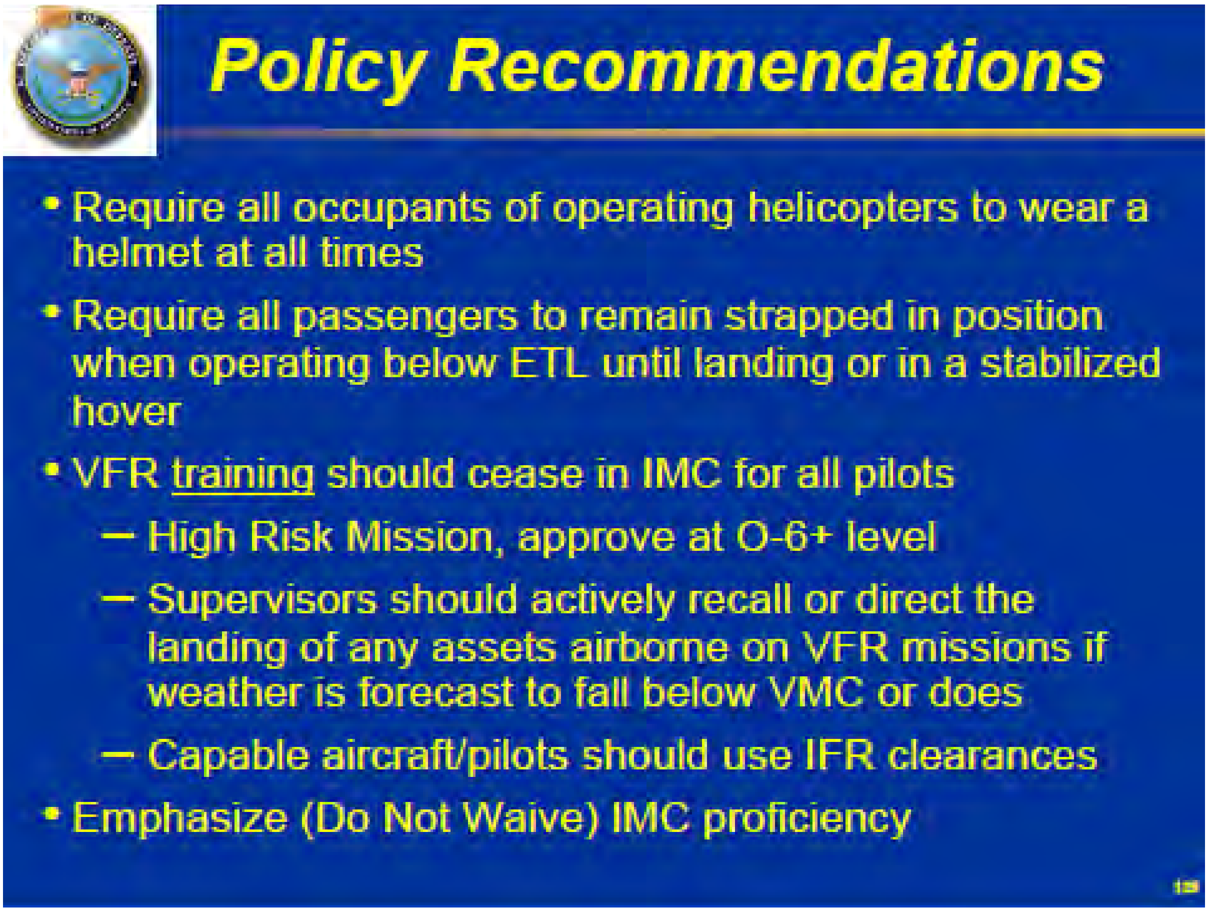


まとめ

● IHSTの作業に米軍も参加している
（DoD等の機関としての参加か否かは不明）

● 事故データ分析はJHSATの手法に基づくと思われ、Data drivenで Recommendationを抽出している
（発表PPでは論理展開までは確認できず）

● Implementation Activityの計画等については不明

Regional Development

European Helicopter Safety Team の活動

- 2006.Nov.14　　EHEST 発足
- 2007　　主に EHSAT の作業を実施
  （9カ国に regional analysis team）
- 2008.Mar.6　　EHEST 1st 08 meeting
- 2008.June.3-4　　EHSAT 2nd 08 meeting
  （regional team analysis review ）
- 2008.Sep.23-24　　EHSAT 3rd 08 meeting
- 2008.Sep.25　　EHEST 2nd 08 meeting
- 2008.Oct.13　　EHEST 2008 Conference
- 2008.Nov TBD　　EHSIT 1st 08 meeting

European Helicopter Safety Team – EHEST

Estoril, Portugal
Agenda
Thu, 13th October 2008, 09:30 - 16:00 hrs

09:00-09:15 - Welcome	[15 min]
09:15-09:45 - International Helicopter Safety Team (IHST experience)	[30 min]
09:45-10:15 - European Helicopter Safety Team	[30 min]
10:15-10:30 - Questions and answers	
10:30-11:00 - Break	**[30 min]**
11:00-12:00 - The safety analysis methodology (illustrated)	[60 min]
12:00-12:15 - Questions and answers	
12:15-13:15 - Lunch	**[1 hour]**
13:15-15:00 - Safety analysis results: Europe, US, and the worldwide picture	[1:45 h]
15:00-15:15 - Questions and answers	
15:15-15:45 - Break	**[30 min]**
15:45-16:15 - US implementation experience	[30 min]
16:15-17:00 - Panel – How to turn safety analysis into 80% reduction in Europe?	[45 min]
17:00-17:15 - Wrap up and adjournment	[15 min]

Japan Helicopter Safety Team は ？

日本HST ： Mr.Flater and Mr.Chowdhury

- 2008横浜の状況は理解した
- Authority の参加は重要
- AHS/IHSTは何時でも支援する

IHST 全体計画 と Regional HST ： Mr.Chowdhury

- Regional Ownership
  共通の procedure（analysis、Implementation）
  各国の環境、実情に沿った検討
- IHST は procedure 等の支援

Blank

2008年AHS Forum 報告（梁忠模）

日本ヘリコプタ協会 Japan Helicopter Society
日本ヘリコプタ協会 2008年度総会

「2008年AHS Forum 報告」

梁 忠模 （宇宙航空研究開発機構）

1. AHS Forum 紹介

2. HART II Workshopと
   HART III Preparatory Meeting紹介

3. AHS Forum 発表論文紹介

AHS International Forum 64
Technical Program
April 28 - May 1, 2008 - Montréal, Canada

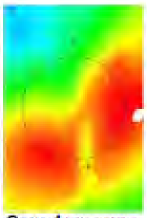
Monday 4/28/08	Tuesday 4/29/08	Wednesday 4/30/08	Thursday 5/1/08
	Morning 8:00 am - 12:00 noon		
International HART II Workshop 8:00 am - 12 noon Technical Council Meeting 8:00 am - 11:30 am Session Chair Meeting 11:30 pm - 12:30 pm Journal Editor's Meeting 11:30 pm - 1:30 pm Distinguished Technology Panel 1:30 pm - 4:00 pm *Student Volunteer Meeting* 3:00 pm - 4:00 pm *AHS History Reception* 4:00 pm - 5:00 pm *AHS Historical Film Festival* 5:00 pm - 6:30 pm HART III Meeting 13:00pm-17:00pm	TECH SESSION A *Special Session: Dr. Thomas Barnett - "Global Strategy & Security"* Aerodynamics I Aircraft Design I Dynamics I Flight Simulation I History Structures & Materials I Test & Evaluation I Board of Directors Meeting 11:00 pm - 1:00 pm	TECH SESSION B *Special Session: Navy/Marine Aviation Briefings* Acoustics I *(1/2 Session)* Advanced Vertical Flight Crash Safety Crew Stations - *Begins at 10:00 a.m.* Dynamics II Flight Simulation II Propulsion I Test & Evaluation II	TECH SESSION D *Special Session: Army Aviation Briefings* Aerodynamics III Aircraft Design II - *Begins at 10:00 a.m.* Avionics Handling Qualities II HUMS II Operations II Structures & Materials III Test & Evaluation III *(1/2 Session)*
	Afternoon 1:30 pm - 5:30 pm		
	Opening General Session – *"Straight Talk from the CEOs" Panel* 1:30 pm - 3:30 pm *Nikolsky Lecture* 4:00 pm - 5:00 pm Exhibitor/Industry Reception 5:00 pm - 7:00 pm	TECH SESSION C Aerodynamics II Aircraft Design II Handling Qualities I HUMS I Operations I Structures & Materials II Systems Engineering I Unmanned VTOL I Grand Awards Banquet	TECH SESSION E *IHST Safety Session* Acoustics II Dynamics III Flight Simulation III Product Support *(1/2 Session)* Propulsion II Structures & Materials IV System Engineering II *(1/2 Session)* Uninhabited VTOL II *(1/2 Session)*

2008年7月1日、日本ヘリコプタ協会 2008年度総会

HART II Project

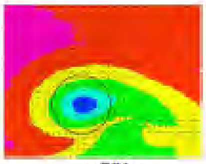
HART (Higher Harmonic Control Aeroacoustic Rotor Test) Project

- NASA Langley, US Army, DLR, DNW, ONERA..
- Wind-tunnel test conducted in October 2001
- Using 40%-geometrically and aeroelastically scaled model of a BO-105 main rotor
- To investigate the characteristics of rotor wake and its influence on rotor blade-vortex interaction (BVI) noise on the condition with/without higher harmonic pitch control (HHC)
- Comprehensive Data available!!!



Sound pressure

Blade Elastic Motion



PIV

- Blade surface pressure
- Blade loading
- Elastic deformation
- Noise
- Wake, Velocity field
- PIV measurement

2008年7月1日、日本ヘリコプタ協会 2008年度総会

International HART II Workshop

- ONERA
- Georgia Tech University
- NASA Langley
- NASA
- AFDD
- DLR

→

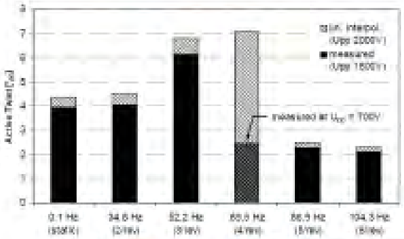
Vortex capturing
Blade loading prediction
Noise prediction
CFD/CSD coupling

HART III Preparatory Meeting

2008年7月1日、日本ヘリコプタ協会 2008年度総会

Invitation to the 1st HART III Preparatory Meeting

64th Annual Forum of the AHS, Montreal, Canada, April 28, 2008, 1-5pm, Room 510D



Organized by DLR and AFDD

Agenda:

- *Presentation of the HART III Proposal*
- *Objectives and Approach*
- *Status of DLR active twist blade*
- *Content and cost estimate of DNW test*
- *Possible partner contributions*

Point of contact:
DLR:
Berend G. van der Wall
berend.vanderwall@dlr.de

AFDD:
Joon W. Lim
jwlim@mail.arc.nasa.gov

Detailed agenda HART III preparatory meeting, Montreal, April 28, 2008, room 51(

1:00pm – Welcome (DLR)

1:05pm – Presentation HART III proposal (DLR)
- ATB rotor, DNW test ca. 2011
- Goals (hover FM, BVI noise, vibration, high speed performance)
- Instrumentation and measurement techniques

1:30pm – Current status of DLR active twist blade (DLR)
- Design of current demonstrator blade
- Performance of current demonstrator blade vs. RPM, n/rev control at full RPM
- Blade properties of current demonstrator blade
- First code validations with current demonstrator blade

2:00pm – Possible partner contributions to DNW test (DLR, all)
- Cost estimate of DNW test
- Presentation of possible contributions
- Test matrix
- Policy: participation, data exchange agreement, publication
- Next meeting, actions

5:00pm – Adjourn

HART III Preparatory Meeting

- •1994~ HART
- •2001~ HART II
- •2004.6~ ATB I (Active Twist Blade) by DLR
- •2006.8~ ATB II
- •2009.11~ ATB III ….. No DNW test!!!

HART III Project

- Europe: DLR/ DNW/ ONERA/
- USA: NASA/ AFDD/ US Army
- Asia: JAXA(Japan), KARI, Konkuk Univ.(Korea)

Total Budget = 1,355,000 Euro ≅ 2,000,000$ ≅ 20億円

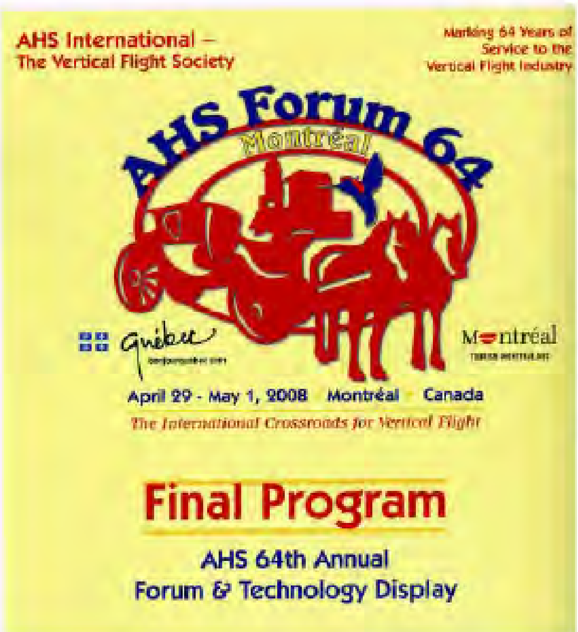
- DNW test : 63,000Euro/day × 12 days = 755,000 Euro (55.7%)

NASA
JAXA
KARI & Konkuk Univ

Policies:

1. Partnership participation (No fund No data!)
2. Data release:

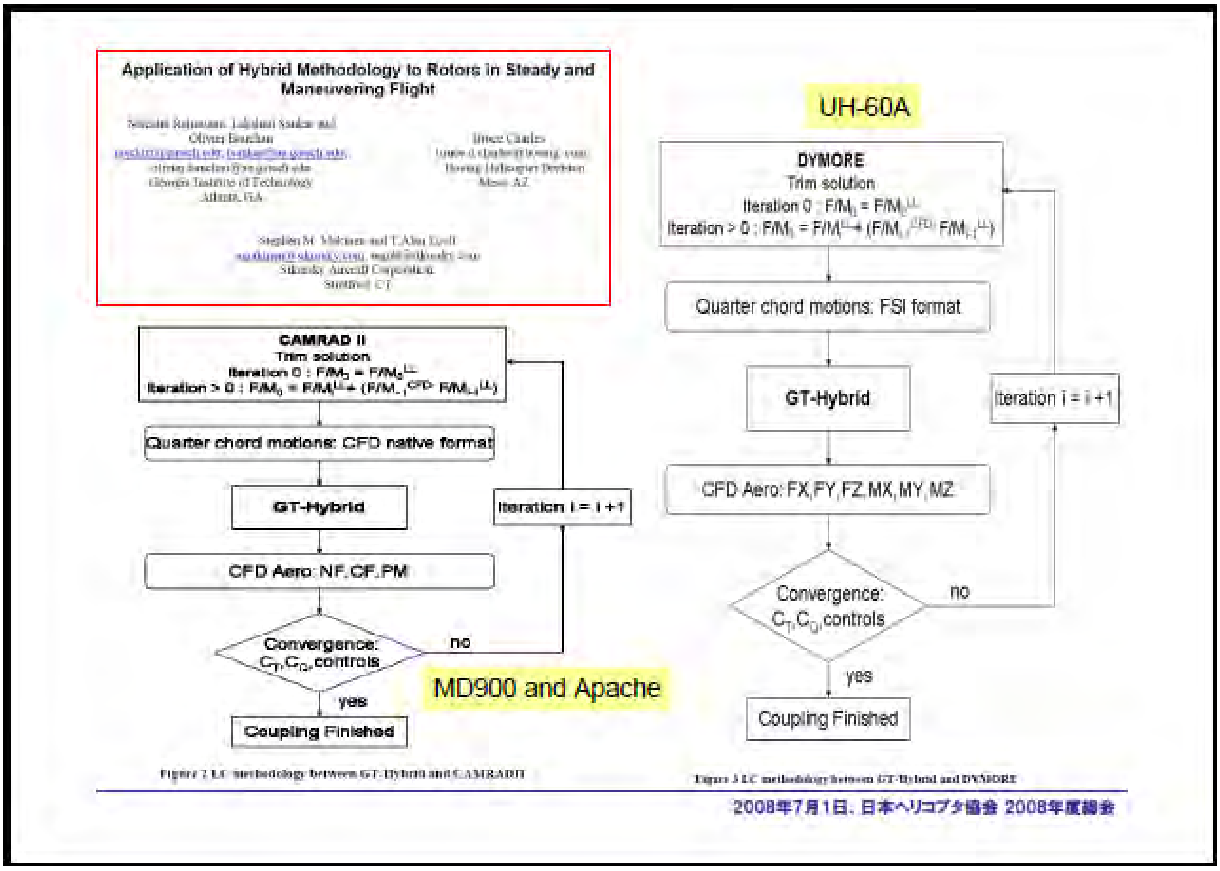
1st Step (3 years)	2nd Step (2 years)	3rd Step
Only to participants	to others of same countries	Worldwide open

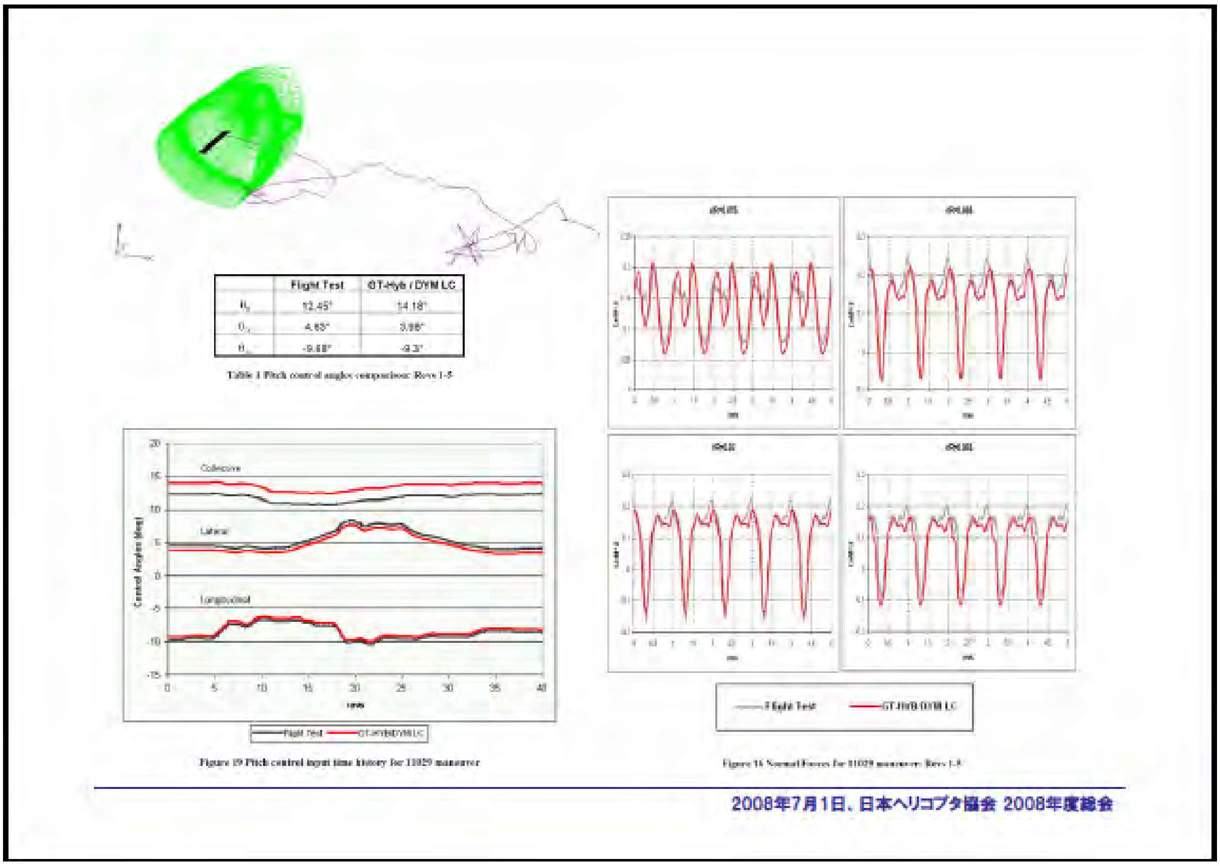


発表論文

USA	190件	研究所 44件
		大学 56件
		会社 90件
Europe	30件	
Asia	9件	日本 3件
		その他 6件

2008年7月1日、日本ヘリコプタ協会 2008年度総会


Application of Hybrid Methodology to Rotors in Steady and Maneuvering Flight
CAMRAD II
Trim solution
Iteration 0 : F/M0 = F/M0LL
Iteration > 0 : F/M0 = F/MiLL+ (F/Mi-1CFD- F/Mi-1LL)
Quarter chord motions: CFD native format
GT-Hybrid
Iteration i = i +1
CFD Aero: NF,CF,PM
Convergence: CT,CQ,controls
no
yes
Coupling Finished
MD900 and Apache
UH-60A
DYMORE
Trim solution
Quarter chord motions: FSI format
GT-Hybrid
Iteration i = i +1
CFD Aero: FX,FY,FZ,MX,MY,MZ
Convergence: CT,CQ,controls
no
yes
Coupling Finished
2008年7月1日、日本ヘリコプタ協会 2008年度総会


Flight Test
GT-Hyb / DYM LC
12.45°
14.18°
4.63°
3.88°
-9.88°
-9.3°
Collective
Lateral
Longitudinal
Control Angles (deg)
Flight Test
2008年7月1日、日本ヘリコプタ協会 2008年度総会

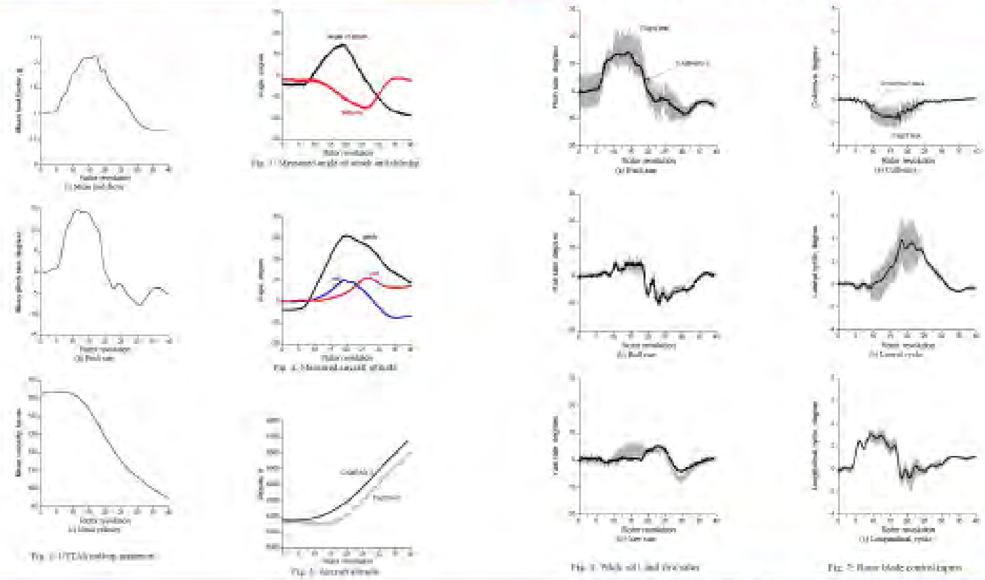
Investigation of Rotor Airloads and Structural Loads in Maneuvering Flight

Hyeonsoo Yeo
hyeo@mail.arc.nasa.gov

Aeroflightdynamics Directorate (AMRDEC)
U.S. Army Research, Development, and Engineering Command
Ames Research Center, Moffett Field, California

UTTAS pull-up maneuvering flight
UTTAS : Utility Tractical Transport Aerial System
- for UH-60A Black Hawk development in the early 1970's

- Measured data from NASA/Army UH-60A Airload program vs.Calculation using CAMRAD II
- Semi-empirical ONERA EDLIN dynamic stall model
- 0.001 second = about 1.53 deg. azimuth angle



2008年7月1日、日本ヘリコプタ協会 2008年度総会

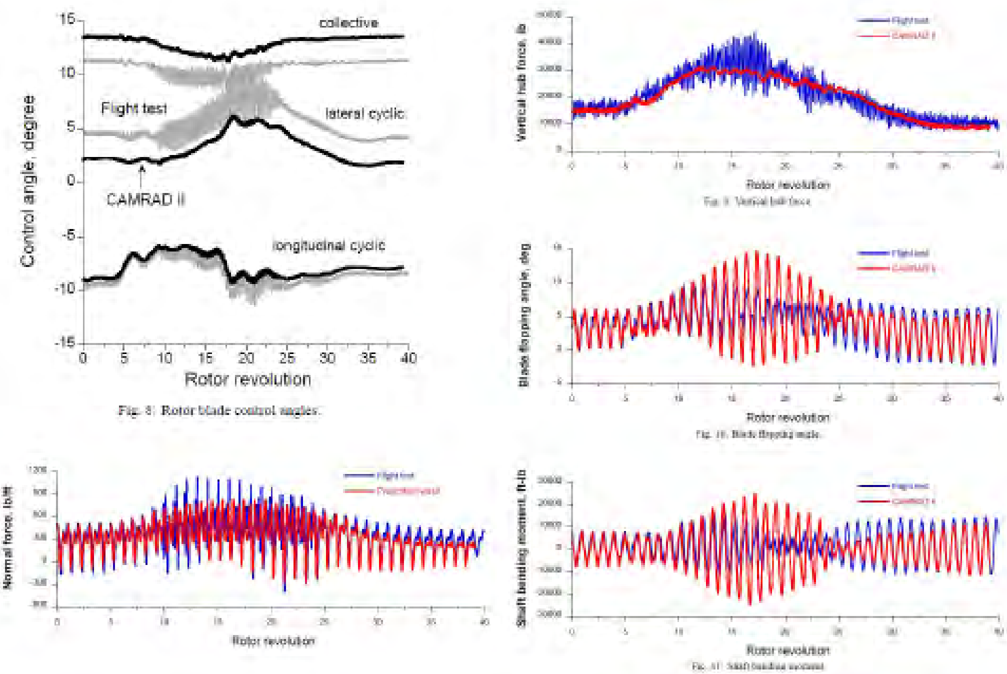


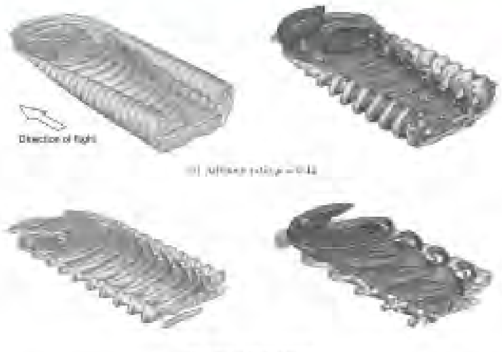
Fig. 8: Rotor blade control angles.

2008年7月1日、日本ヘリコプタ協会 2008年度総会

Aeroacoustics of a Coaxial Rotor in Level Flight

Hyo Won Kim, Visiting Researcher
Karthikeyan Duraisamy, Lecturer
Richard Brown, Mechan Chair of Engineering
Rotorcraft Aeromechanics Laboratory
Department of Aerospace Engineering
University of Glasgow
Glasgow G12 8QQ
United Kingdom

1. aeroacoustic characteristics of a coaxial system with teetering rotors in level forward Flight vs. equivalent articulated single rotor with the same solidity.
2. Brown's Vorticity Transport Model
3. Ffowcs Williams-Hawkings equation
4. Impulsive noise due to BVI for the coaxial rotor is higher by 20-35 dB compared to the equivalent single rotor.
5. The overall and impulsive noise characteristics of the coaxial system are weakly sensitive to changes in rotor separation and the relative phasing of the rotors.



(a) Advance ratio $\mu = 0.12$

(b) Advance ratio $\mu = 0.24$

Figure 2: Overall wake structure in forward flight visualised by a surface of constant vorticity. (Left: equivalent single rotor. Right: coaxial rotor. Coaxial rotor: Wake from upper rotor shaded darker than that from the lower rotor.)

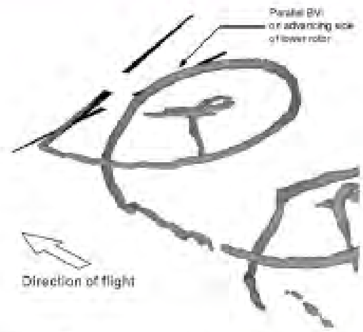
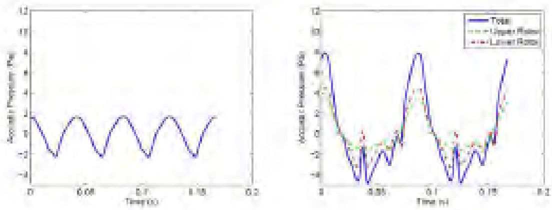


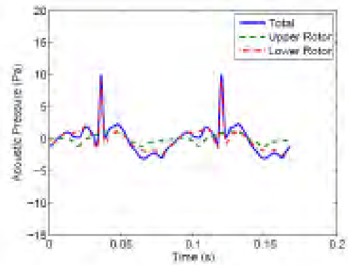
Figure 13: *Tip vortex structure from the upper rotor of the coaxial system impinging on an advancing lower rotor blade showing parallel inter-rotor BVI at $\mu = 0.24$.*



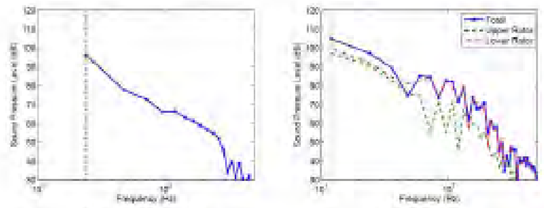
(a) Equivalent single rotor

(b) Coaxial rotor

Figure 4: *A time history of acoustic pressure over one rotor revolution one rotor radius below the tip of the rotor disc at $\psi = 0°$ for $\mu = 0.12$.*



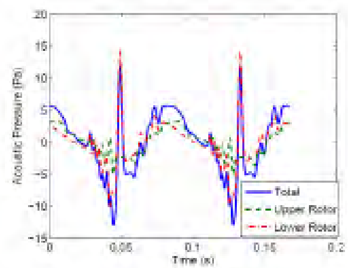
(a) $\mu = 0.12$



(a) Equivalent single rotor

(b) Coaxial rotor

Figure 5: *Frequency spectrum of the sound pressure level one rotor radius below the tip of the rotor disc at $\psi = 0°$ for $\mu = 0.12$. The vertical dotted line represents the fundamental blade passage frequency.*



(b) $\mu = 0.24$

Figure 8: *Time history of acoustic pressure at the BVI hot spot (see Figure 6) for coaxial rotor.*

Turbulent Tip Vortex Measurements Using Dual-Plane Digital Particle Image Velocimetry

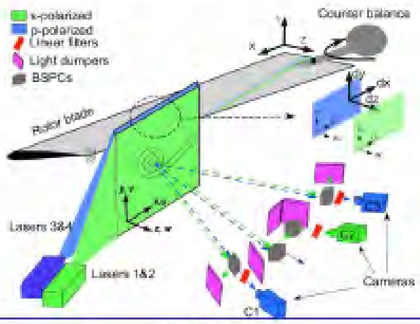
Manikandan Ramasamy* Bradley Johnson† J. Gordon Leishman‡

Department of Aerospace Engineering
Glenn L. Martin Institute of Technology
University of Maryland, College Park, MD 20742

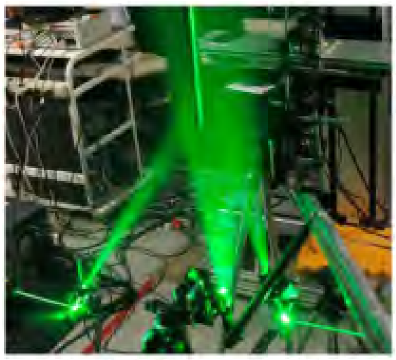
N–S equations in the RANS equations

$$\frac{D\overline{u_i}}{Dt} = \frac{\partial}{\partial x_j}\left[-\frac{\overline{p}\,\delta_{ij}}{\rho} + \nu\left(\frac{\partial \overline{u_i}}{\partial x_j} + \frac{\partial \overline{u_j}}{\partial x_i}\right) - \overline{u_i' u_j'}\right]$$

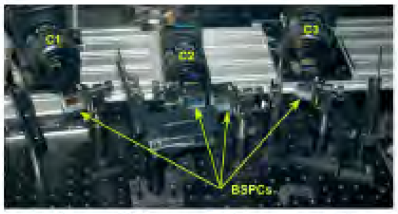
$$\nabla V = \begin{bmatrix} \partial u/\partial x & \partial u/\partial y & \partial u/\partial z \\ \partial v/\partial x & \partial v/\partial y & \partial v/\partial z \\ \partial w/\partial x & \partial w/\partial y & \partial w/\partial z \end{bmatrix}$$



(a) Schematic



(b) Three dual Nd-YAG lasers illuminating the flow



(c) Close-up of CCD cameras and beam splitting cubes

Figure 3: Schematic and photographs of the DPS-DPIV system as used for the rotor wake studies: (a) Schematic, (b) Lasers used to image the flow, (c) Close-up of cameras and beam splitting cubes.

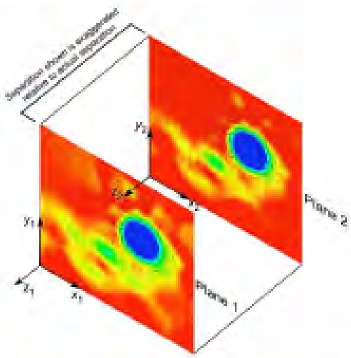


Figure 4: Typical instantaneous velocity fields measured using DPS-DPIV. Interplane separation is exaggerates; actual plane separation is much smaller than vector-to-vector spacing within each plane.

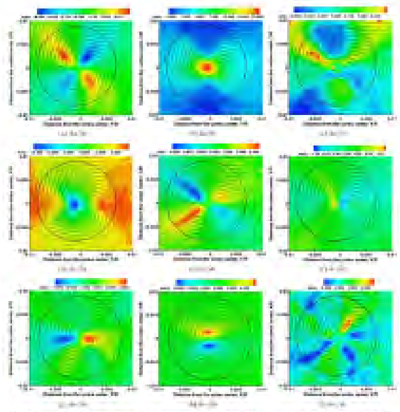


Figure 15: DPS-DPIV measurements of the nine velocity gradients inside the tip vortex core of a wake age of 1?.

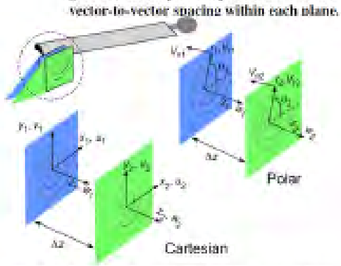


Figure 7: Schematic showing the coordinates systems used for the present experiments.

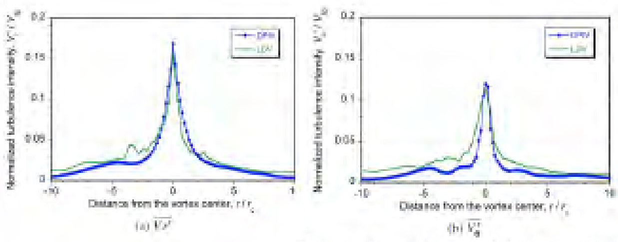


Figure 19: Comparison of turbulence measurements using DPIV and LDV: (a) $\overline{V_r'}$, (b) $\overline{V_\theta'}$.

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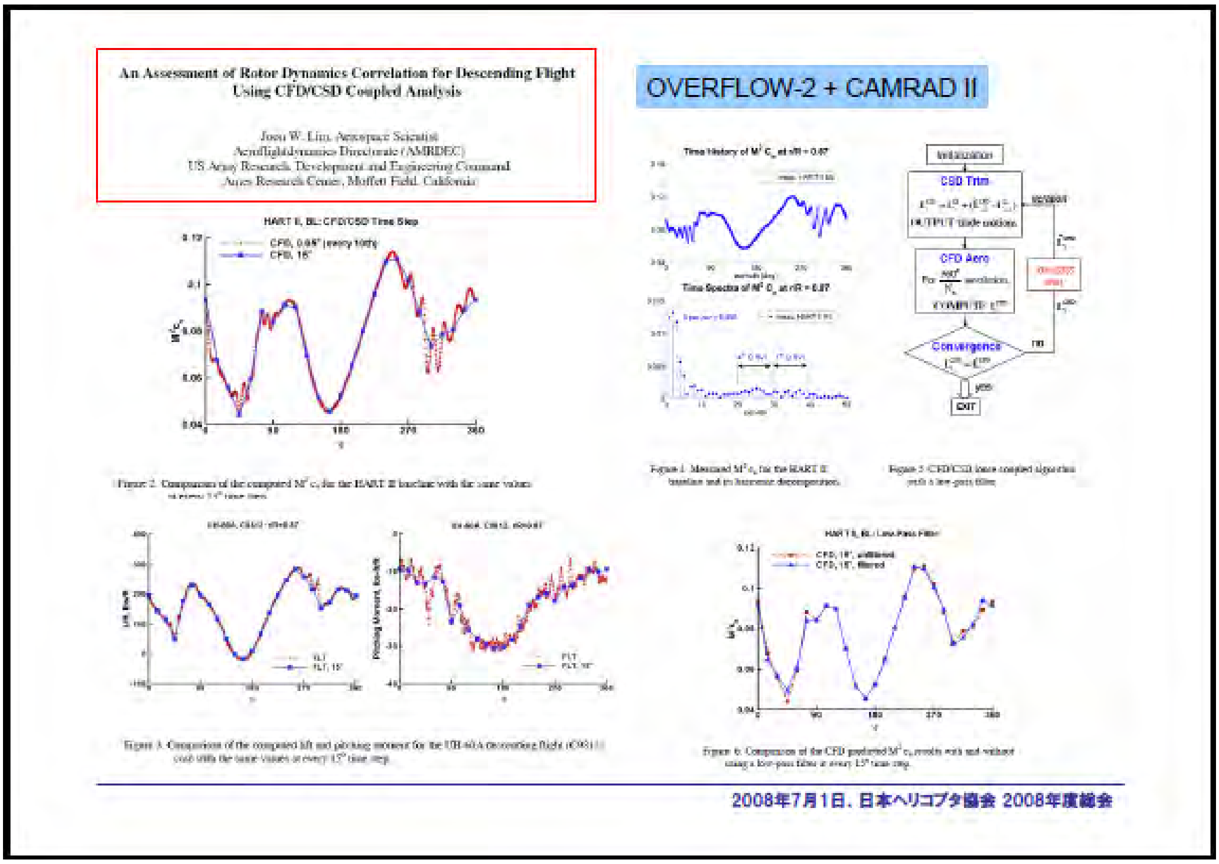
An Assessment of Rotor Dynamics Correlation for Descending Flight Using CFD/CSD Coupled Analysis
Joon W. Lim, Aerospace Scientist
Aeroflightdynamics Directorate (AMRDEC)
US Army Research, Development and Engineering Command
Ames Research Center, Moffett Field, California
OVERFLOW-2 + CAMRAD II
HART II, BL: CFD/CSD Time Step
CFD, 0.05° (every 10th)
CFD, 15°
Figure 2. Comparison of the computed M² cₙ for the HART II baseline with the same values at every 15° time step.
Time History of M² Cₙ at r/R = 0.87
Time Spectra of M² Cₙ at r/R = 0.87
Figure 1. Measured M² cₙ for the HART II baseline and its harmonic decomposition.
Initialization
CSD Trim
OUTPUT blade motion
CFD Aero
COMPUTE
Convergence
yes
no
EXIT
Figure 5. CFD/CSD loose coupled algorithm with a low-pass filter.
FLT
FLT, 15°
Figure 3. Comparison of the computed lift and pitching moment for the UH-60A descending flight (C9311) case with the same values at every 15° time step.
HART II, BL: Low Pass Filter
CFD, 15°, unfiltered
CFD, 15°, filtered
Figure 6. Comparison of the CFD predicted M² cₙ results with and without using a low-pass filter at every 15° time step.
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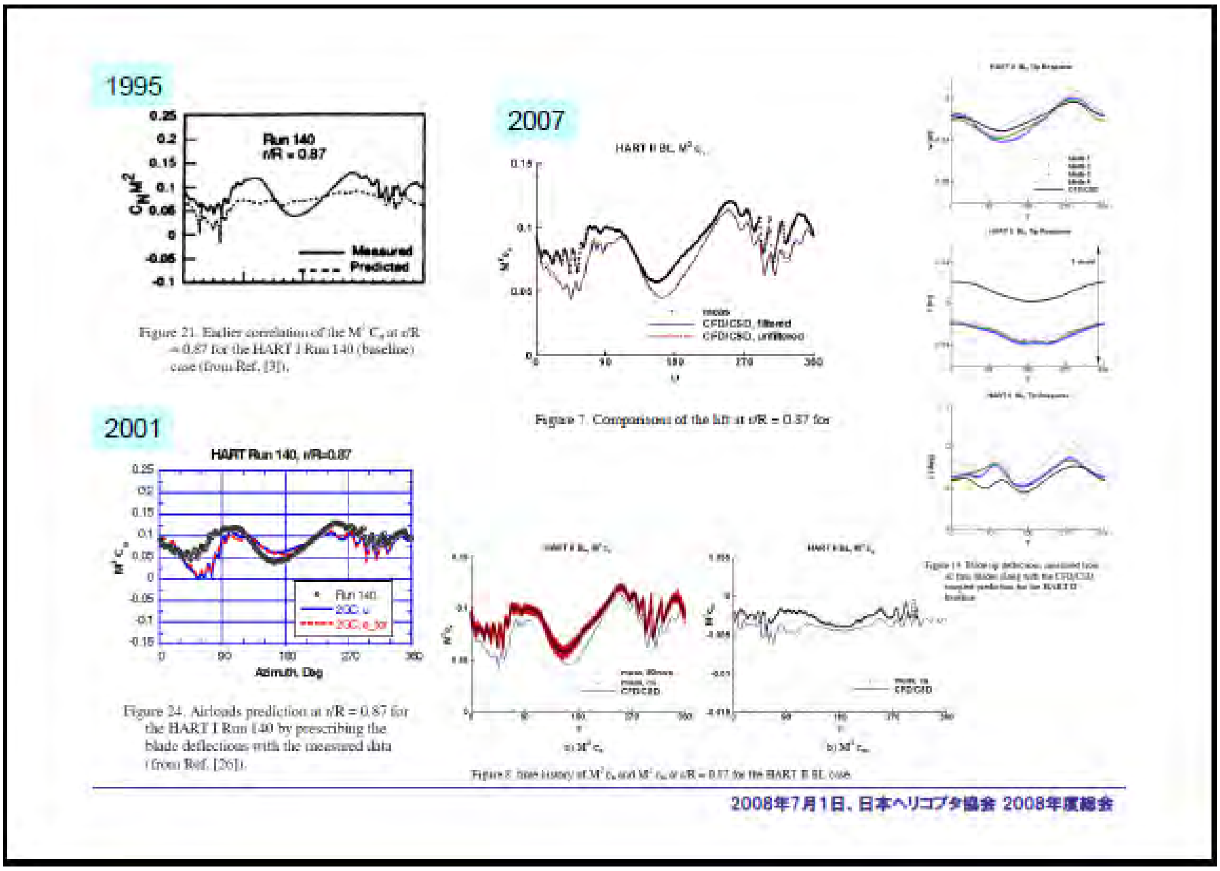
1995
Run 140
r/R = 0.87
Measured
Predicted
Figure 21. Earlier correlation of the M² Cₙ at r/R = 0.87 for the HART I Run 140 (baseline) case (from Ref. [3]).
2007
HART II BL, M²cₙ
meas
CFD/CSD, filtered
CFD/CSD, unfiltered
Figure 7. Comparisons of the lift at r/R = 0.87 for
2001
HART Run 140, r/R=0.87
Run 140
2GC ..
2GC, e_for
Azimuth, Deg
Figure 24. Airloads prediction at r/R = 0.87 for the HART I Run 140 by prescribing the blade deflections with the measured data (from Ref. [26]).
a) M² cₙ
b) M² cₘ
Figure 8. Time history of M² cₙ and M² cₘ at r/R = 0.87 for the HART II BL case.
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Ground Effect of a Rotor Hovering above a Confined Area

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Lakshmi N. Sankar, Professor, lsankar@ae.gatech.edu
School of Aerospace Engineering
Georgia Institute of Technology, Atlanta, GA

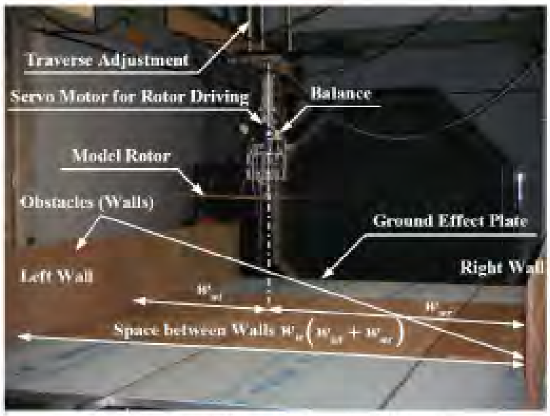

Figure 1. General View of the Experimental Facility

Table 1. Major Parameters of a Model Rotor and Experiment

Rotor Diameter	1.138m
Blade Chord	0.06m
Airfoil	NACA0015
Built-in Twist	NA
Rotor Solidity	0.0671
Rotor Rotational Speed	94.2 rad/s
Root Cutout	0.2
Flapping Hinge Offset	0.03
Lift Curve Slope	5.73
Lock Number	4.72
Collective Pitch Angle	6.46°~8.95°
Thrust Coefficient	0.0740
Rotor Height	0.35~2.20
Wall Height	0.185, 0.25, 0.5, 0.75, 1.0
Space between Walls	2.5, 3, 4, 5, 6

1. Wall effect: required torque coefficient of the rotor hovering above the confined area with walls increases.
2. Steady and vibratory parts of the torque coefficient are significantly influenced by the asymmetrically place two walls.
3. re-circulatory flow upward along the wall causes the steady and vibratory torque coefficients to increase.

Performance Evaluation of Full Scale On-board Active Flap System in Transonic Wind Tunnel

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7-44-1, Jindaijihigashi-machi, Chofu, Tokyo 182-8522, Japan

1. transonic wind tunnel test for full scale on-board active flap system
2. active flap deflection 6deg at 2/rev active flap frequency is achieved on hover and landing/approach (BVI) conditions.
3. unsteady Cp database is obtained on both the blade and active flap portion - correlation for analytical code

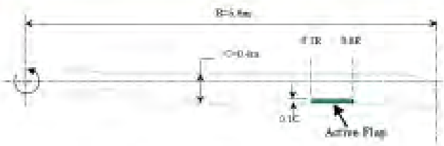
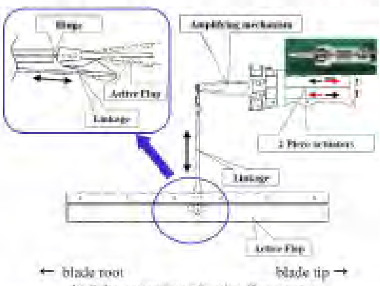


Fig.1 Experimental blade with active flap



b) Schematic view of active flap system

Fig.2 Full scale on-board active flap system

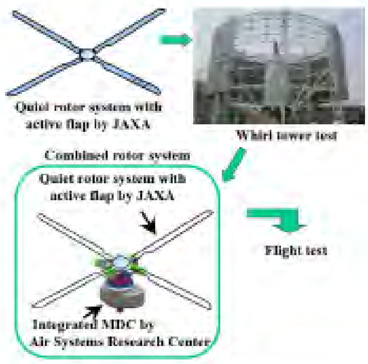


Fig.3 Research cooperation agreement between JAXA and Air Systems Research Center

Fig.4 Wind tunnel set up (from downstream side)

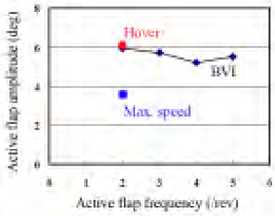


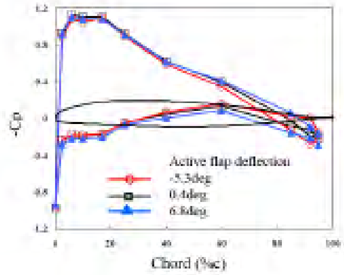
Fig.11 Achieved active flap amplitude

Table 1 Features of wind tunnel test model

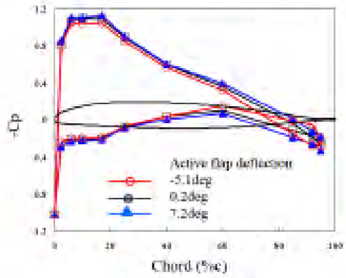
Blade span	1.0m
Blade chord length	0.4m
Airfoil	AK120G
Active Flap	Span 0.58m
	Chord length 0.04m

Table 3 Test case

Blade		Active Flap		Assumed flight condition
M	α	δ_{AF}* (intended)	Freq.	
0.47	2.5 deg	6 deg	2/rev**	Hover
0.55			2,3,4,5/rev	BVI
0.70			2/rev	Max. speed



a) Hover condition
M=0.47, α=2.5deg, active flap frequency=2/rev (11Hz)



b) BVI condition
M=0.55, α=2.5deg, active flap frequency=2/rev (11Hz)

Fig.12 Unsteady Cp distribution with active flap operation

Blade Planform Optimization to Reduce HSI Noise of Helicopter in Hover

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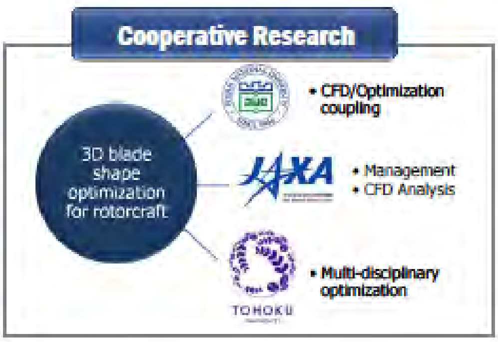
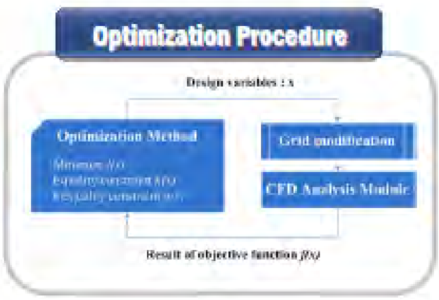
Sanghyun Chae and Kwanjung Yee
Department of Aerospace Engineering, Pusan National University
San 30, Jangjeon-dong, Geumjeong-gu, Busan, 609-735, Korea

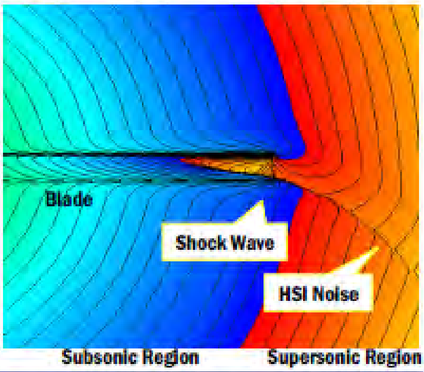
Shinkyu Jeong and Shigeru Obayashi
Institute of Fluid Science, Tohoku University
2-1-1 Katahira, Aoba-ku, Sendai-shi, Miyagi, 980-8577, JAPAN





High Speed Impulsive noise

- One of the most serious noise problems of helicopter
- Recognized as detectability problem
- Quadruple noise generated by the shock wave on the advancing side rotor



Mach contour around blade in blade coordinate

Design Method

Gradient Based Method	Non-gradient Based Method
Sequential Quadratic Programming (SQP)	Generic Algorithm (GA)

CFD Method

- Governing Equation : 3D unsteady Euler equations
- Space : Beam-Warming scheme
  + TVD scheme
  - 2^{nd} order accuracy
  - MUSCL approach using minmod limiter
- Time : Euler backward implicit time integration and Newton iterative method in unsteady calculation

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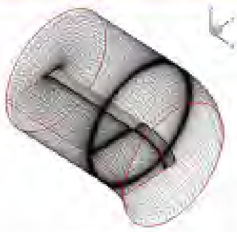
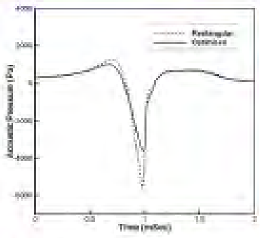
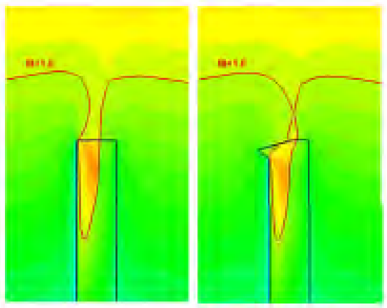
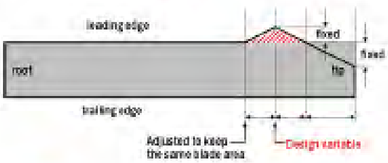
Preliminary Study with One Design Variable



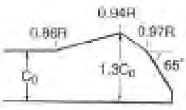


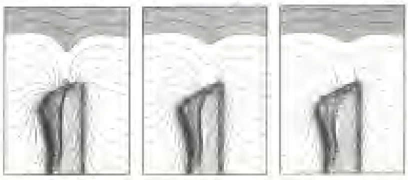




Results from previous parametric study

Arbitrary blade design with many design variables





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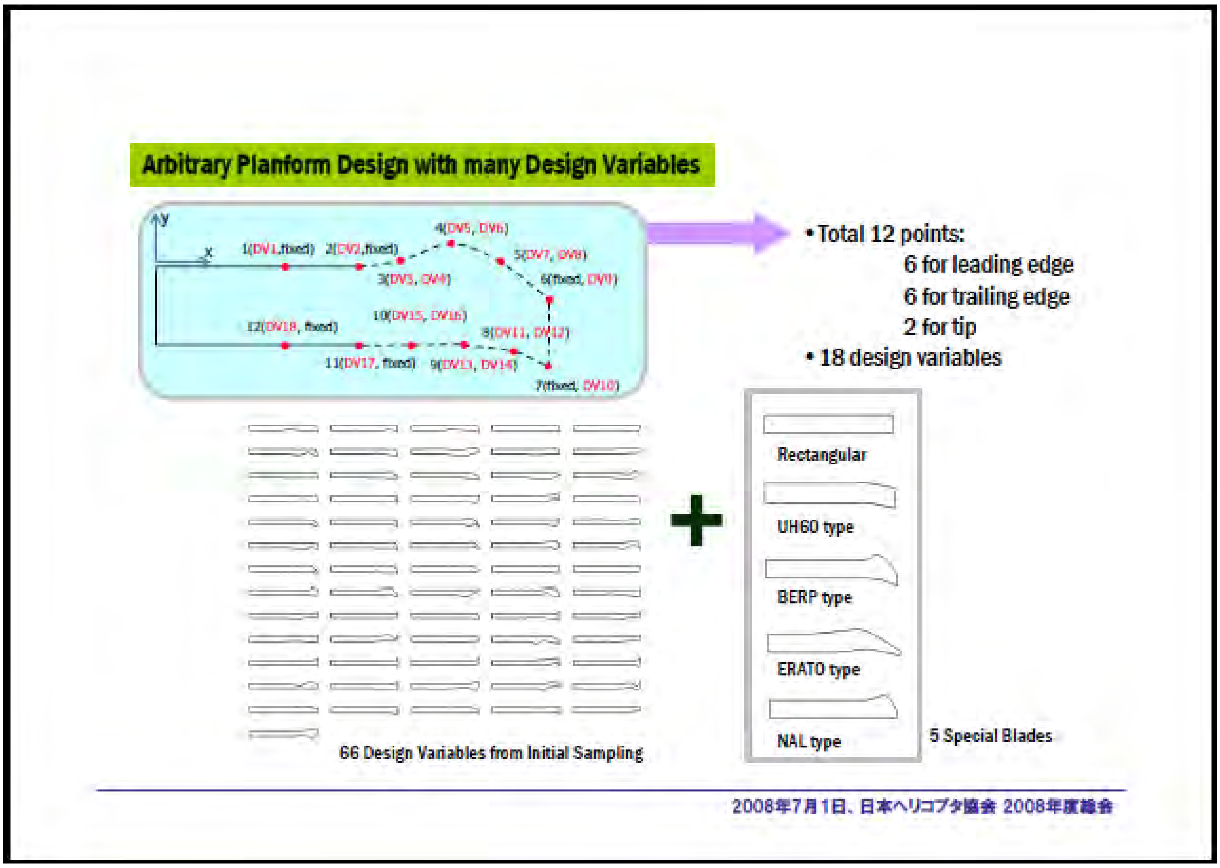
Arbitrary Planform Design with many Design Variables
y
x
1(DV1,fixed)
2(DV2,fixed)
3(DV3, DV4)
4(DV5, DV6)
5(DV7, DV8)
6(fixed, DV9)
7(fixed, DV10)
8(DV11, DV12)
9(DV13, DV14)
10(DV15, DV16)
11(DV17, fixed)
12(DV18, fixed)
• Total 12 points:
6 for leading edge
6 for trailing edge
2 for tip
• 18 design variables
Rectangular
UH60 type
BERP type
ERATO type
NAL type
5 Special Blades
66 Design Variables from Initial Sampling
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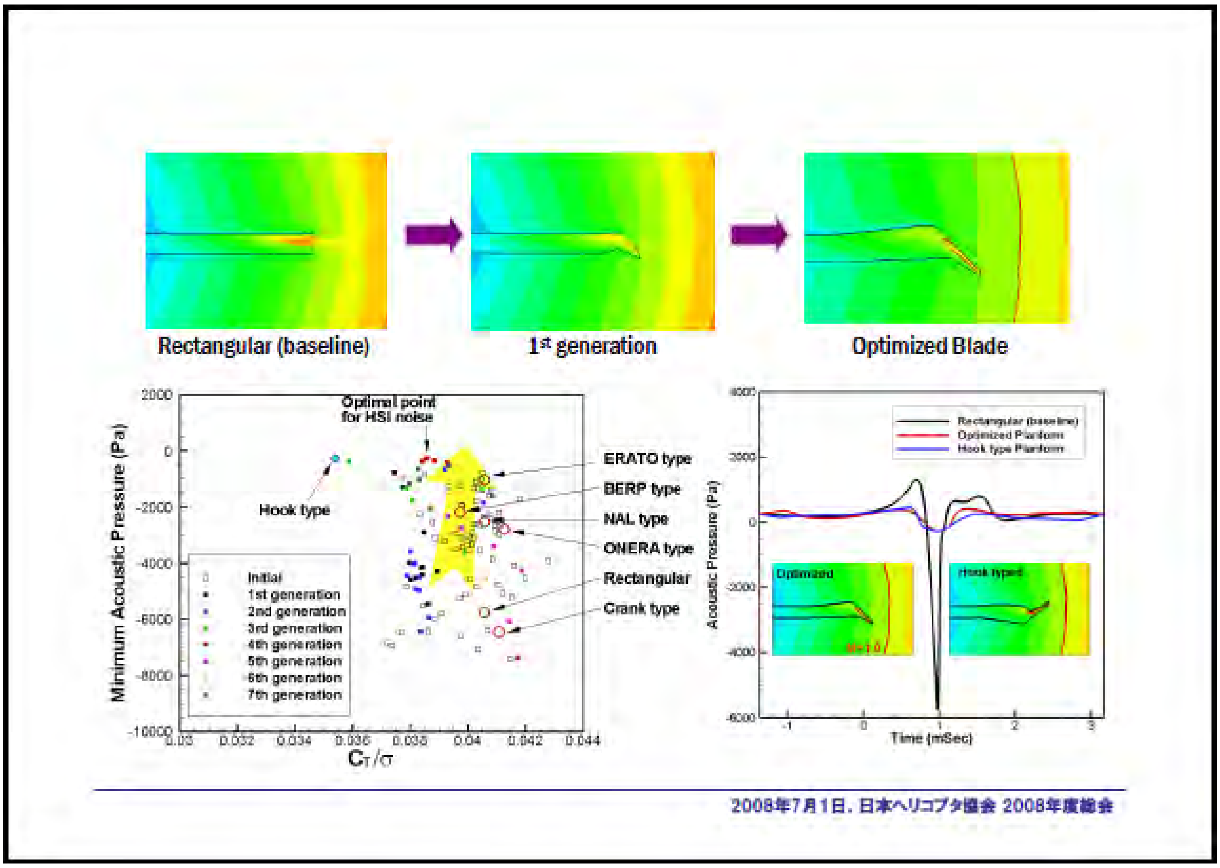
Rectangular (baseline)
1st generation
Optimized Blade
Optimal point for HSI noise
Hook type
ERATO type
BERP type
NAL type
ONERA type
Rectangular
Crank type
Initial
1st generation
2nd generation
3rd generation
4th generation
5th generation
6th generation
7th generation
Minimum Acoustic Pressure (Pa)
CT/σ
Rectangular (baseline)
Optimized Planform
Hook type Planform
Optimized
Hook typed
Acoustic Pressure (Pa)
Time (mSec)
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- Company name and logo on Awards Program, cocktail napkins, glasses and signage
- Ten Banquet Tickets for company representatives
- Company name and logo on Grand Awards Banquet Announcements
- Short video clip to be played at the Awards dinner

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SIKORSKY

- Three Complimentary Full-Page *Vertiflite* Advertisements
- Company name and logo on all food & beverage station signage in the exhibit hall
- Company name and logo on reception cocktail napkins
- Public address "thank you" announcement in the exhibit hall
- Small gift distribution with AHS and company logo as guests exit the reception

Exhibit Hall Lunch - $25,000 Sold to

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- Company name and logo on reception lunch napkins
- Public address "thank you" announcement in the exhibit hall

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AgustaWestland

- Company logo to be imprinted on bottle water to be distributed in all technical sessions
- Four Complimentary Full-Page *Vertiflite* Advertisements
- Complimentary Full-Page advertisement in the *Forum 64 Final Program*
- Company name and logo on sponsorship signage

Registration Tote Bags - $15,000 Sold to

american eurocopter

- Company name and logo imprinted on one side of high quality tote bag or portfolio (AHS logo will be imprinted on the reverse side)
- Four Complimentary Full-Page *Vertiflite* advertisements

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LOCKHEED MARTIN

- Company name and logo on header, plastic shopping bags (one side reserved for AHS logo)
- Distribute a one-page printed handout to attendees from the shop
- Complimentary Full-Page *Vertiflite* Advertisement
- Small novelty item distributed from Novelty Shop

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Pratt & Whitney

- Company name and logo imprinted on lanyards
- Complimentary Full-Page *Vertiflite* Advertisement

Badge Holders - $10,000 Sold to

THE PURDY CORPORATION

- Company name/logo on attendee badge holders
- Complimentary Full-Page *Vertiflite* Advertisement

Hotel Key Card - $10,000 Sold to

GOODRICH

- Company name and logo hotel key card
- Complimentary Full-Page *Vertiflite* Advertisement

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Aerodynamics Laboratory Programs

- Fixed Wing Aerodynamics
  – RDT&E in support of military and civilian fixed-wing aircraft (Performance, Design, Stores and Missiles, Icing and Loads)
- Rotary Wing Aerodynamics
  – RDT&E in support of military and civilian rotary-wing aircraft (Performance, Design, Icing and Loads)
- Bluff Body Aerodynamics
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Experimental Capabilities:

- 8 wind tunnels: subsonic to supersonic
- Icing capability in two facilities
- Glycerin facility (Low Reynolds)
- Advanced Measurement Techniques (PSP, PIV, Infrared)

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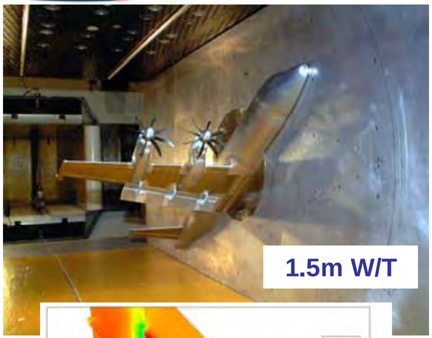
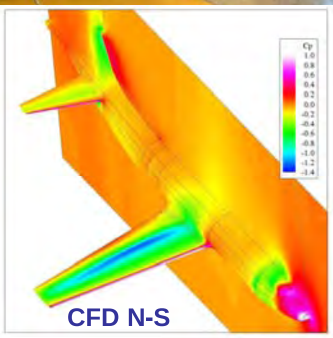
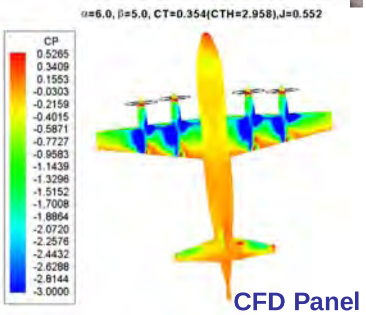
Experimental & Computational Aerodynamics





CP-140 (Aurora)
SLAP Program



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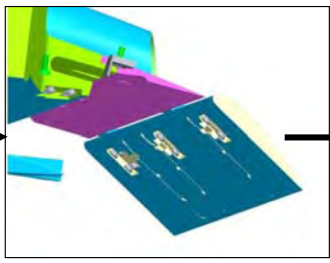
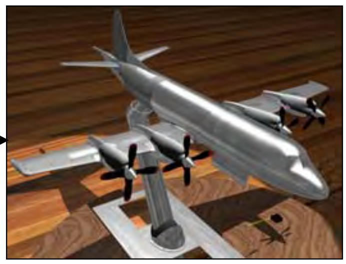
Modeling & Simulation CAD Capabilities

- New Design
  - Drawings
  - CAD software (PRO/E)

- Reverse Engineering
  - Scan geometry
  - CAD Software (PRO/E)





• CFD Research & Development Activities within Rotary-Wing Program

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CFD Research & Development Activities within Rotary-Wing Program

Hongyi Xu and Norman Ball
Rotary Wing Program-Aerodynamic Lab
Institute for Aerospace Research
National Research Council of Canada

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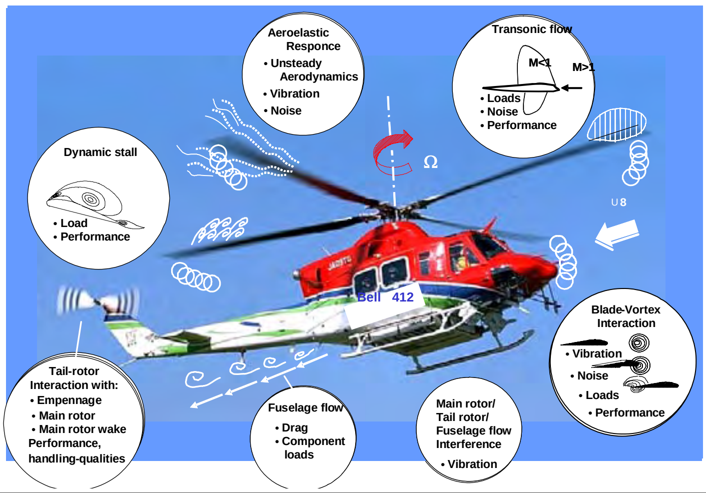
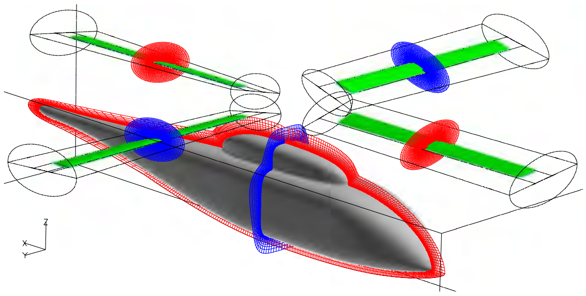
RW CFD R&D research

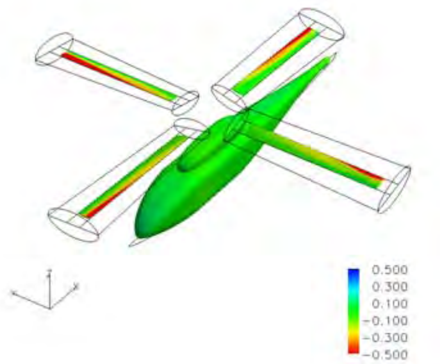
- Bell412 helicopter modeling and simulation
  - Grand challenge in aerodynamic research



Earlier Research

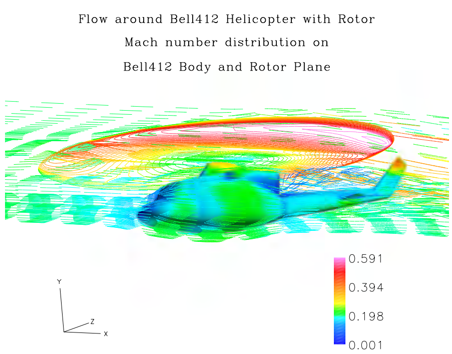
(1) Quasi-unsteady Simulation of Flow past Robin helicopter based on Chimera moving grid (2001-2003)
(2) Flow solver: WIND for quasi-unsteady simulation
(3) Blade motion include rotation and cyclic pitching





Earlier Research

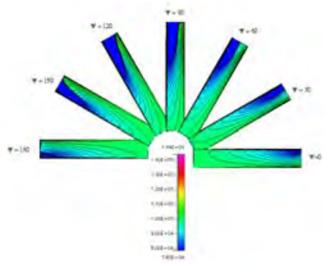
(1) Earlier Simulation of Flow past Bell 412 helicopter (1997-2000)
(2) Flow solver: NPARC for steady simulation
(3) Rotor model based on Blade element method and actuator-disc assumption

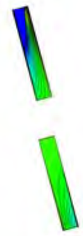


Recent Research

Unsteady flows past two-bladed rotor

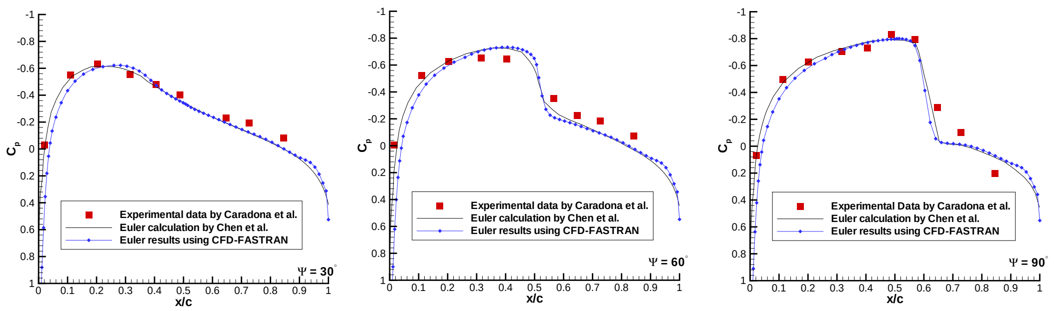
- Simple two-bladed rotor in forward flight condition
  - The common benchmark set by Caradonna
  - Blade operated at zero collective pitch angle
  - Benchmarked by experiment and Euler results
  - Good agreement with experiment and capable of capturing the shock wave location
- CFD-FASTRAN code for unsteady helicopter simulation





Two-bladed rotor

- **Case I:**
  - Aspect ratio at 7; tip Mach number at 0.8; advance ratio at 0.2 and r/R=0.89, see Chen et al. 1991



Two-bladed rotor

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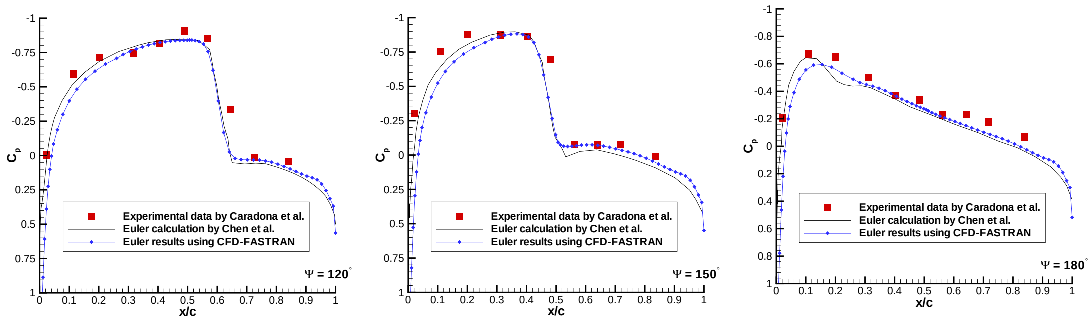
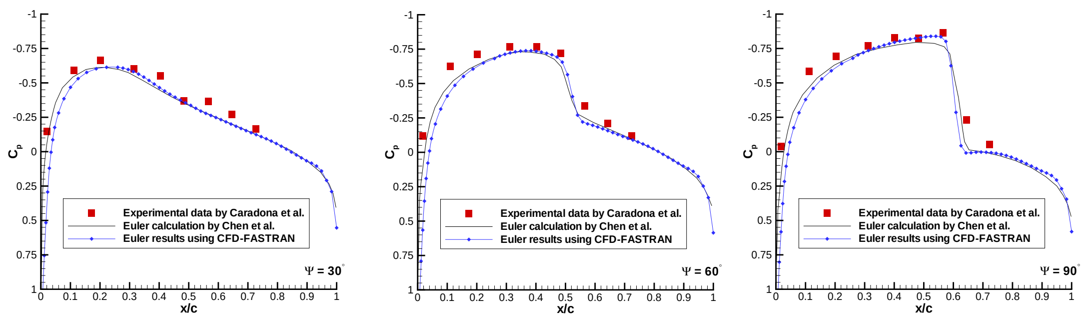


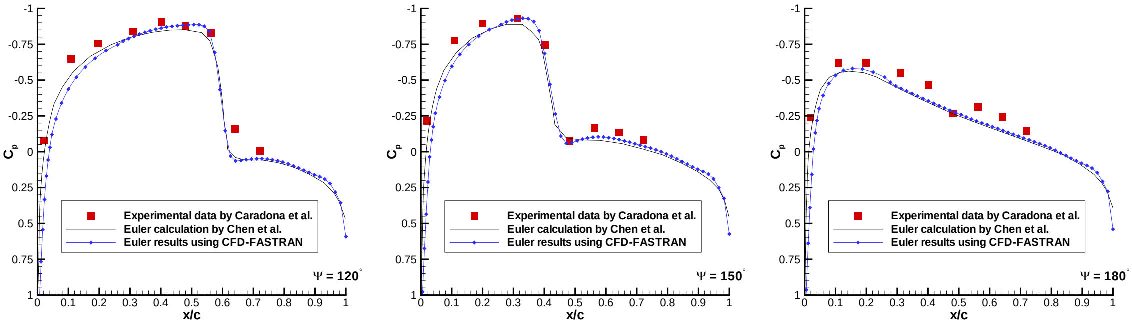
Two-bladed rotor

- **Case II:**
  - Aspect ratio at 7.125; tip Mach number at 0.76; advance ratio at 0.25 and r/R=0.88, see Chen et al. 1991



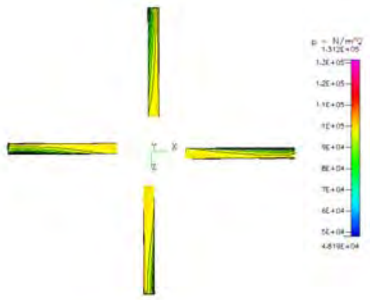
Two-bladed rotor

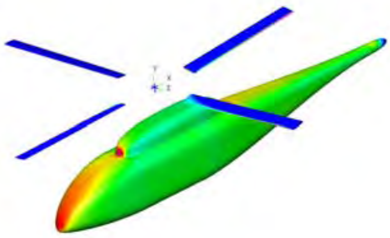
- **Case II:**
  - Aspect ratio at 7.125; tip Mach number at 0.7634; advance ratio at 0.25 and r/R=0.88, see Chen et al. 1991



Recent Research

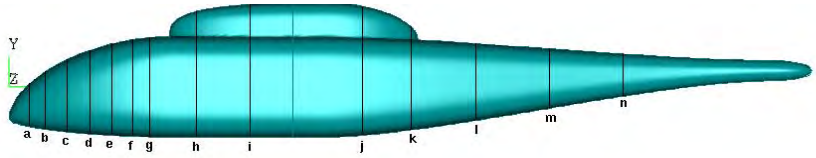
- Fully unsteady rotor and Robin helicopter modeling and simulation
- Flow solver: CFD-FASTRAN
- Full helicopter configuration with rotor blade moving with rotation and cyclic feathering motions

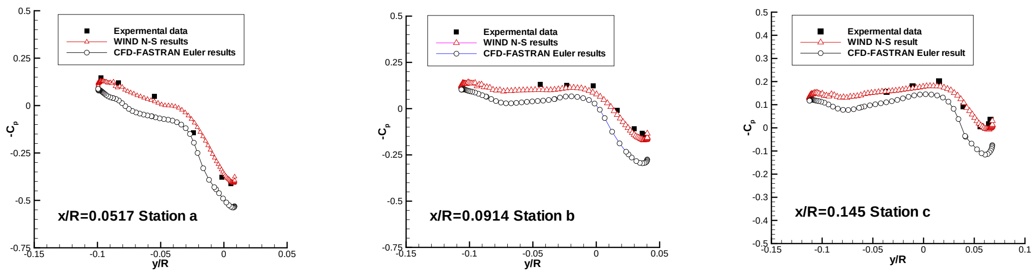




Robin fuselage

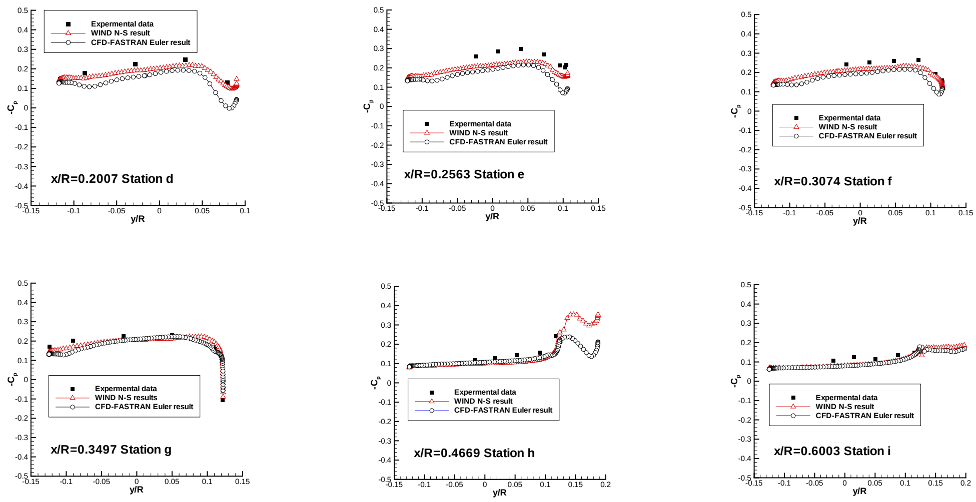
- **Isolated RoBin fuselage**
  - Pressure coefficient prediction compared with experimental data (NASA report by Chaffin et al.)





Robin fuselage

- **Isolated RoBin fuselage**
  - Pressure coefficient prediction compared with experimental data



$\mu_i = v / V_{tip}$

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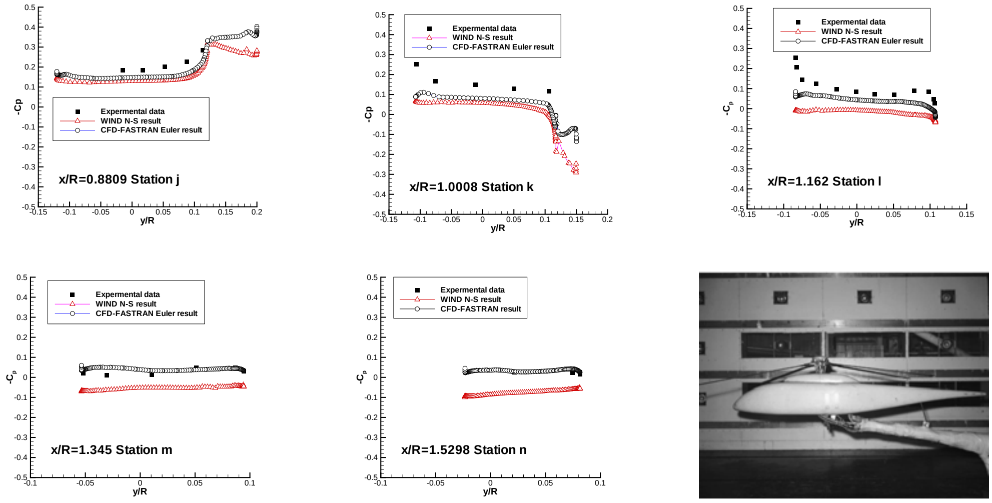
Robin fuselage

- **Isolated RoBin fuselage**
  - Pressure coefficient prediction compared with experimental data



$\mu_i = v / V_{tip}$

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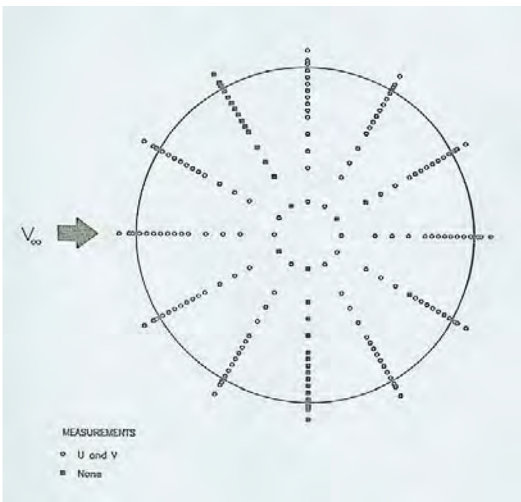
Robin helicopter

- **RoBin Helicopter compared with measurement by Elliott at NASA**
  - Induced inflow ratio definition and measurement location

$$\mu_i = v / V_{tip}$$

$$V_{tip} = \Omega R$$

$$\frac{v}{\Omega r} = \sqrt{\frac{C_T}{2}}$$



$\mu_i = v / V_{tip}$

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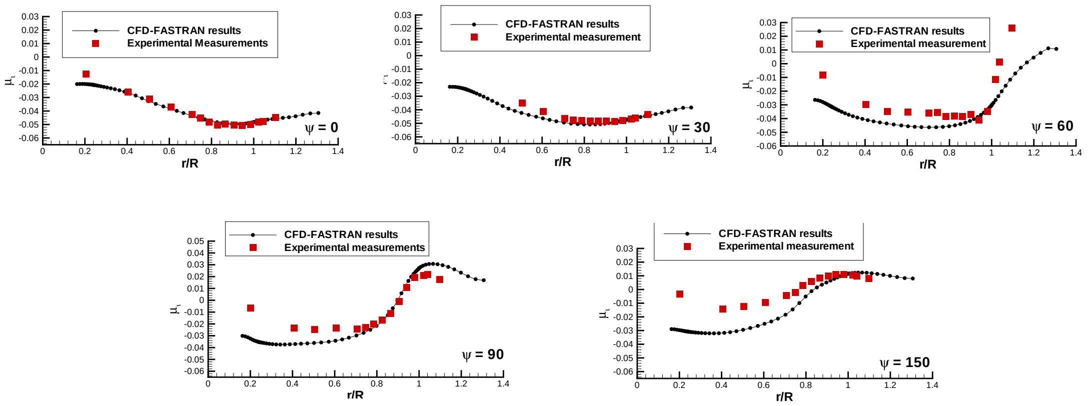
Robin helicopter

- **RoBin Helicopter with rotor moving at complex schedule**
  - Predicted induced inflow ratio compared with experimental data



$\mu_i = v / V_{tip}$

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Robin helicopter

- **RoBin Helicopter with rotor moving at complex schedule**
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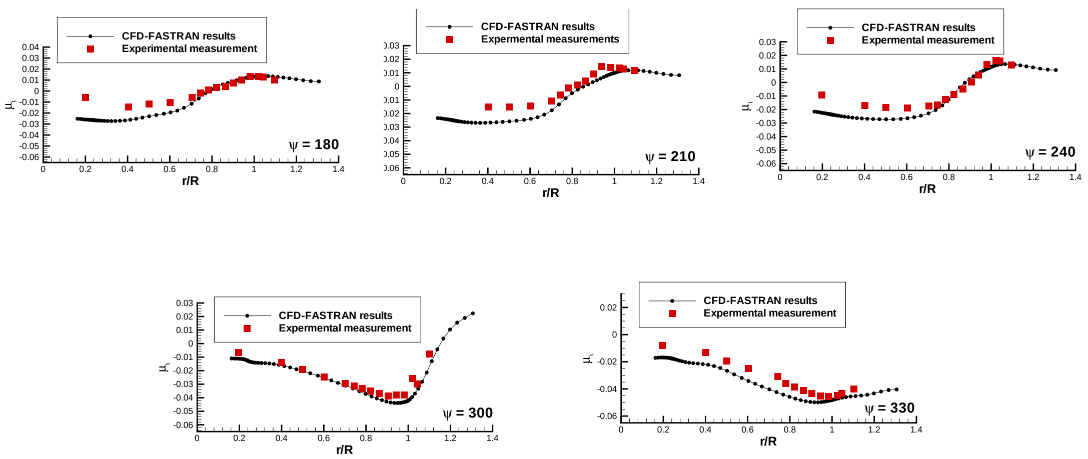

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DRDC Bell 412 Helicopter Modeling & Simulation

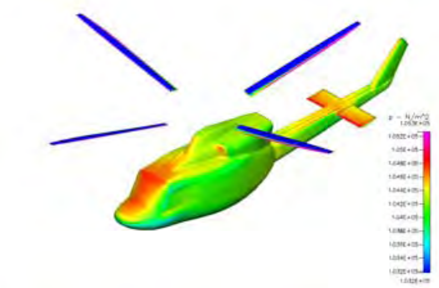
Objective: Developing M&S capability for Bell412 helicopter by combining the expertise and efforts from AL and FRL.

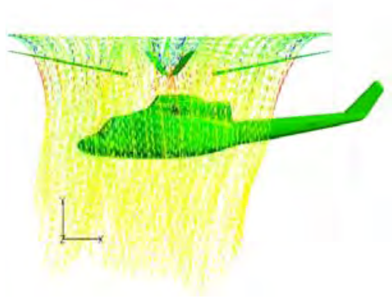
AL: a. W/T powered model design and test
 b. CFD study of Bell 412 with main rotor

FRL: a. Real-time blade motion measurements
 b. Pressure measurement on fuselage

CFD

1. Study of Bell 412 isolated rotor performance
2. Investigation of Bell 412 hover performance under realistic hover conditions
3. Investigation of Bell 412 in realistic forward flight conditions





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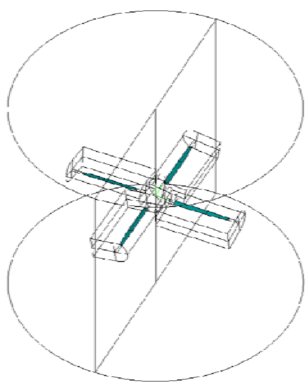
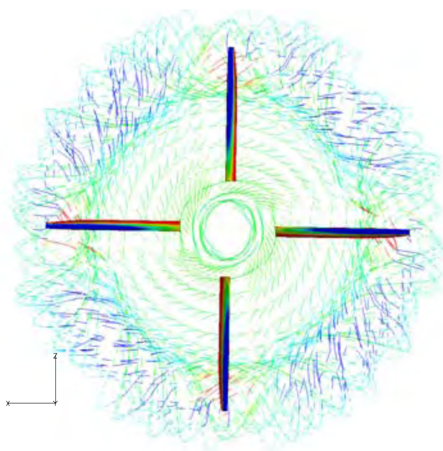
Key CFD components in DRDC project

(1) Study of Bell 412 isolated rotor performance (downwash, tip vortex and strong swirling flow)





Key CFD components in DRDC project

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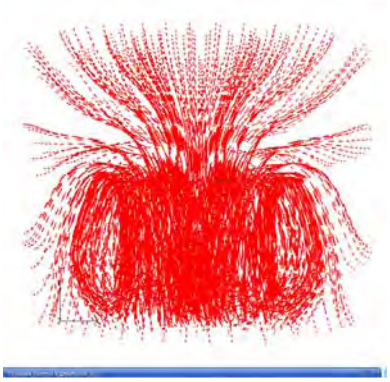
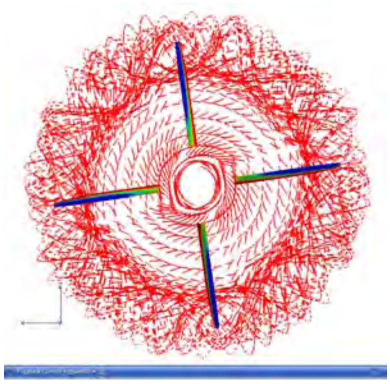
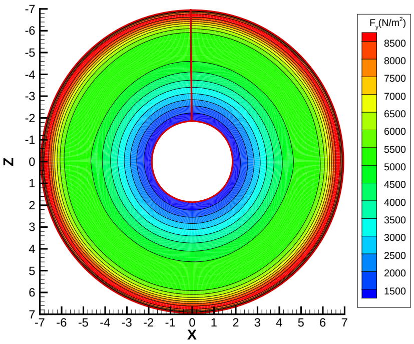
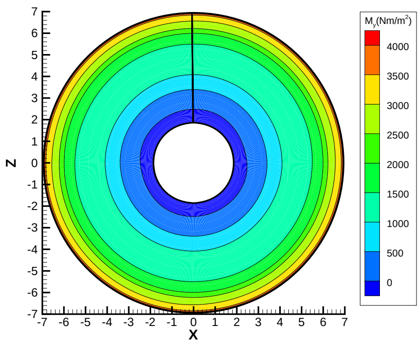




Key CFD components in DRDC project

(2) Isolated Bell 412 rotor in ideal-hover condition: Thrust and Torque on rotation plane





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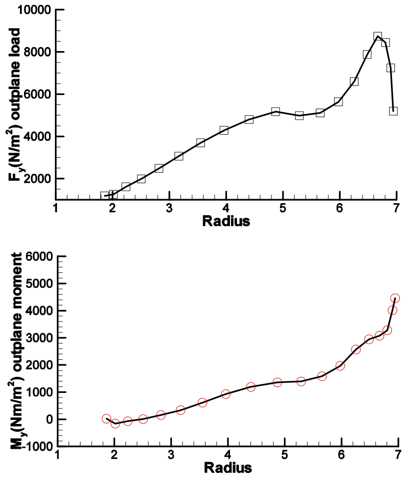
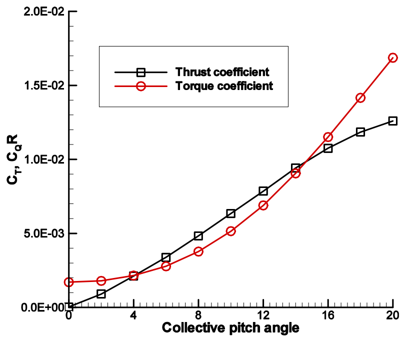
Key CFD components in DRDC project

(2) Isolated Bell 412 rotor in ideal-hover condition: Radial distribution of thrust and Power consumption





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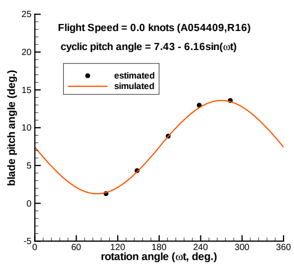
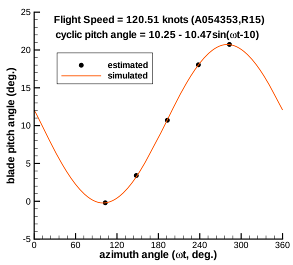
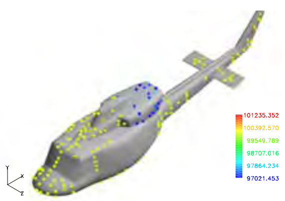
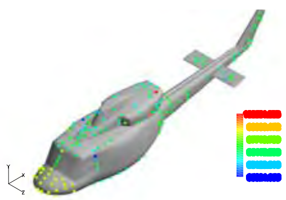
Key CFD components in DRDC project

(3) Investigation of Bell 412 performance under realistic hover and forward flight conditions: Collective and cyclic pitch; FRL measurements





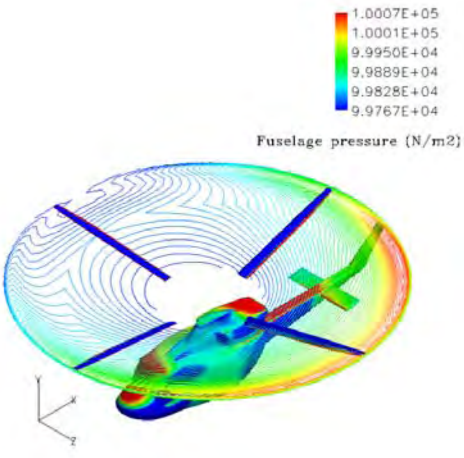




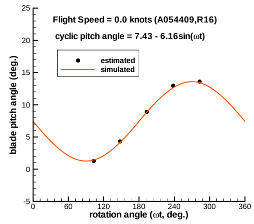
Key CFD components in DRDC M&S project

Bell 412 hover performance under realistic flight conditions

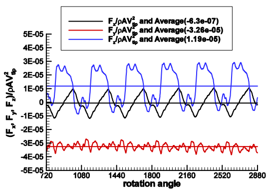
(1) Rotor-fuselage interactions and Aero-load on rotor rotating plane

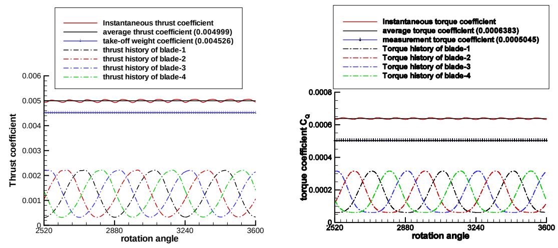


(2) Blade motion schedule



(3) Aero force on fuselage

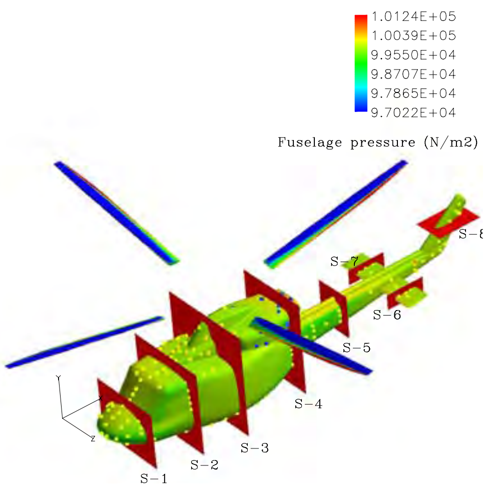


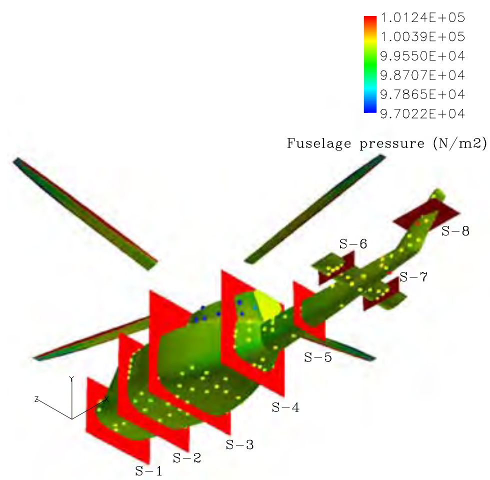


(4) Lift and torque comparison with EXP

Key CFD components in DRDC project

(2) Investigation of Bell 412 hover performance under realistic hover conditions: Pressure comparisons





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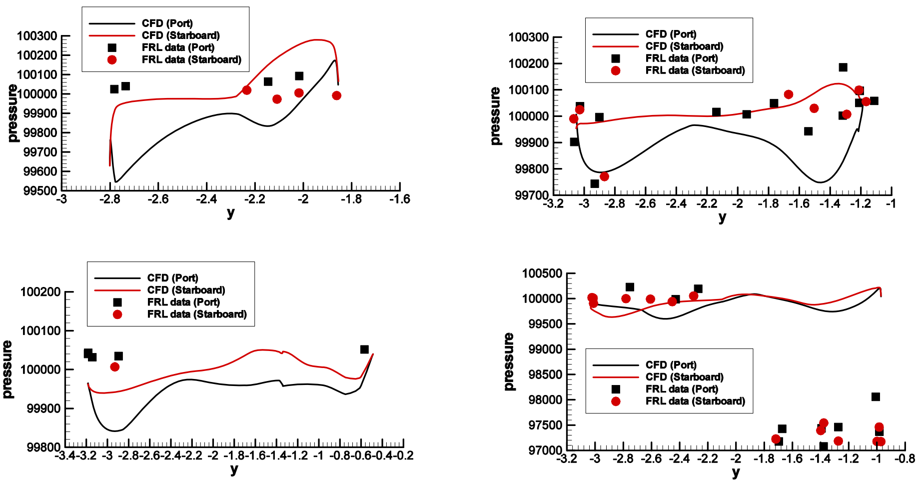
Key CFD components in DRDC project

(2) Investigation of Bell 412 hover performance under realistic hover conditions: Pressure comparisons



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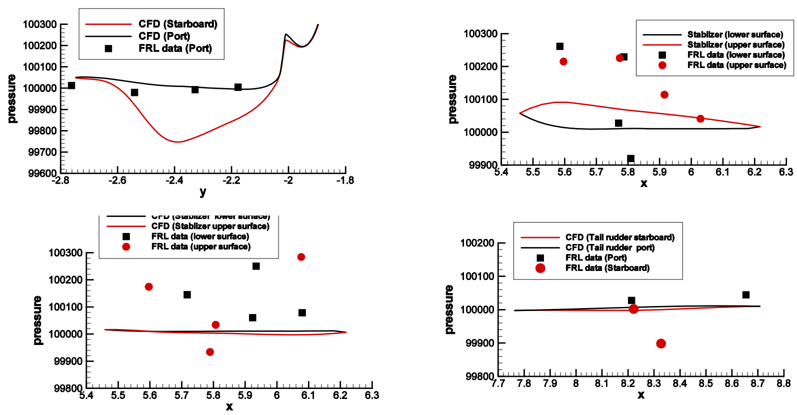
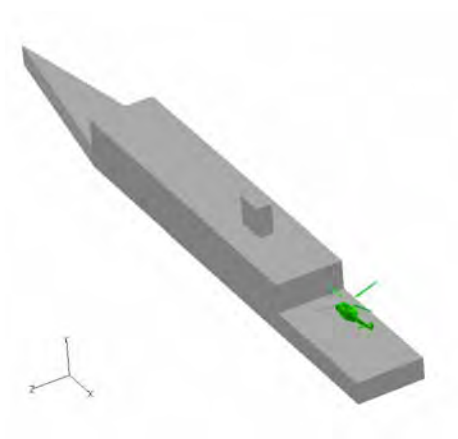
Key CFD components in DRDC project

(2) Investigation of Bell 412 hover performance under realistic hover conditions: Pressure comparisons

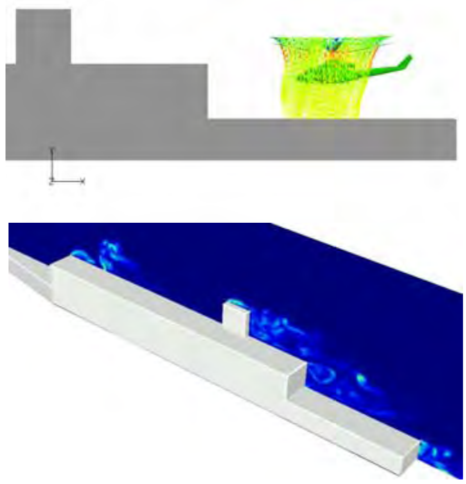


DRDC Helicopter-Ship Interaction project

(1) Bell 412 helicopter and Simplified Frigate Ship (SFS2) model



(2) Bell 412 helicopter landing on ship-deck in the environment of ship airwake

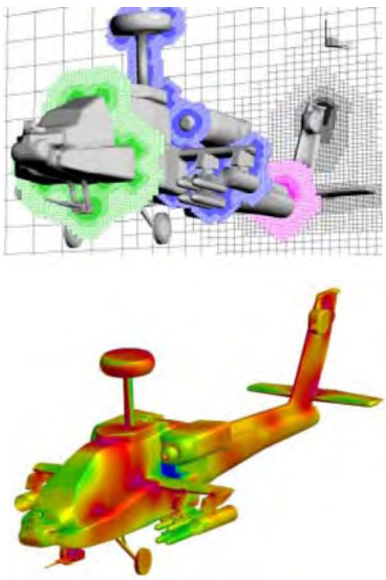


Future research

– Potential research project:
  - In-house development of LES/DNS capability, next-generation CFD tool, for unsteady flow simulation past helicopter:

(1) LES/DNS solving technique

(2) Adaptive Mesh Refinement



Future research

Next target: Helicopter-Ship interaction

Major challenges:

(1) Accurate modeling rotor aerodynamics and rotor-fuselage interactions

(2) Appropriate way to capture air-wake from ship:

Incompressible, unsteady separation and vortex shedding, turbulence

(3) Interactions between rotor flow and air-wake

Compressible and transonic, moving geometry, airwake-, rotor interactions

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From Discovery to Innovation...

Development of Engineering Turbulence Simulation Capability with High-Fidelity to Turbulence Physics using LES/DNS

Hongyi Xu

Rotary-wing program, Aerodynamic Lab

Institute for Aerospace Research,

National Research Council of Canada

National Research Council Canada   Conseil national de recherches Canada   Canada

Turbulence Simulation Research

- Uncertainty Analysis in Turbulence Simulation

1. Turbulence: A centenary problem for Fluid Mechanics community
2. Prediction of turbulence: (1) Hardware: computer with sufficient RAM and CPU; (2) Software: Navier-Stokes solution technology
3. An uncertainty analysis with two tasks:

   (1) Identifying the sources of errors based on turbulence physics
   (2) Developing technology to efficiently reduce or eliminate these errors

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Turbulence Simulation Research

- Computational uncertainty study in turbulence

1. Model errors (RANS, LES)
2. Discretisation errors
3. Solution errors
4. Boundary and initial condition errors

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Model errors

- Criticism on eddy viscosity concept
- Conservation laws $\frac{\partial \rho}{\partial t}+\frac{\partial \rho u_i}{\partial x_i}=0$ $\frac{\partial \rho u_i}{\partial t}+\frac{\partial \rho u_i u_j}{\partial x_j}=-\frac{\partial p}{\partial x_i}+\frac{\partial \tau_{ij}}{\partial x_j}$
- Constitutive equation for Newtonian fluid

$$\tau_{ij}=\mu_{ijkm}\left(\frac{\partial u_k}{\partial x_m}+\frac{\partial u_m}{\partial x_k}\right) \quad \textit{isotropy assumption} \Rightarrow \quad \tau_{ij}=\lambda\left(\frac{\partial u_k}{\partial x_k}\right)\delta_{ij}+\mu\left(\frac{\partial u_i}{\partial x_j}+\frac{\partial u_j}{\partial x_i}\right)$$

$$\frac{\partial \rho u_i}{\partial t}+\frac{\partial \rho u_i u_j}{\partial x_j}=-\frac{\partial p}{\partial x_i}+\frac{\partial}{\partial x_j}\left(\mu\left(\frac{\partial u_i}{\partial x_j}+\frac{\partial u_j}{\partial x_i}\right)\right)$$

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Model errors

- Criticism on eddy viscosity concept
- Boussinesq hypothesis (1877) $\rho\overline{u'v'} = \mu_T \dfrac{\partial \overline{u}}{\partial y}$
- Prandtl (1926) mixing length hypothesis
- Kolmogorov (1942) $\rho\overline{u'_i u'_j} = A\delta_{ij} + \mu_T \left(\dfrac{\partial \overline{u}_i}{\partial x_j} + \dfrac{\partial \overline{u}_j}{\partial x_i} \right)$

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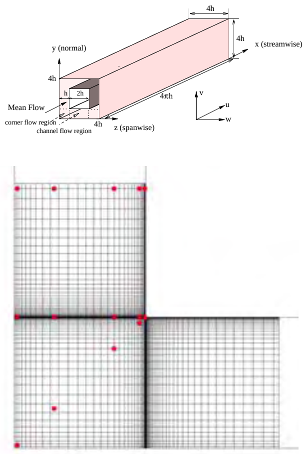
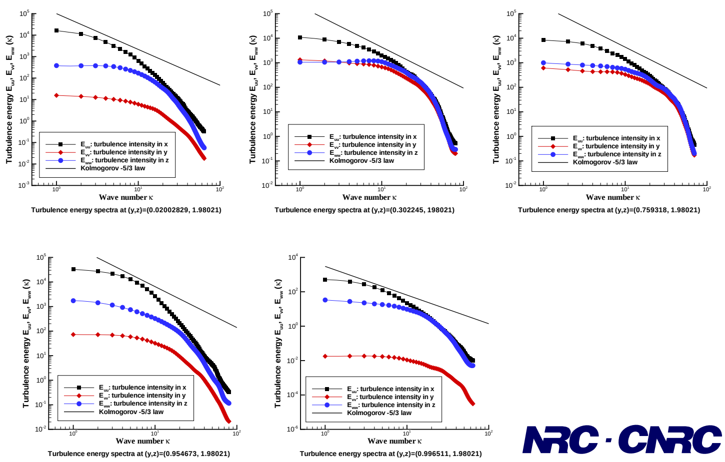
Turbulent eddy viscosity check

- Temporal DNS- turbulence energy spectra (wall-bisector)





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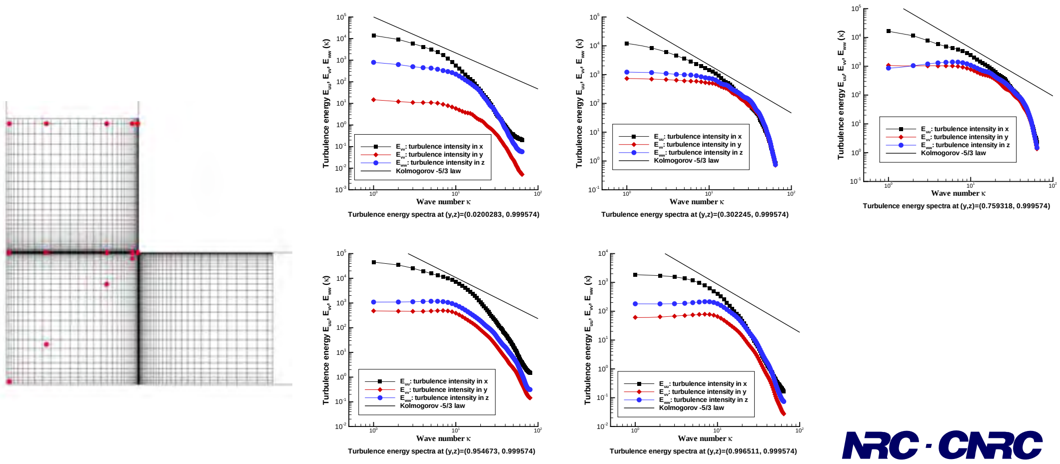
Turbulent eddy viscosity check

- Temporal DNS- turbulence energy spectra (line passing convex corner tip)



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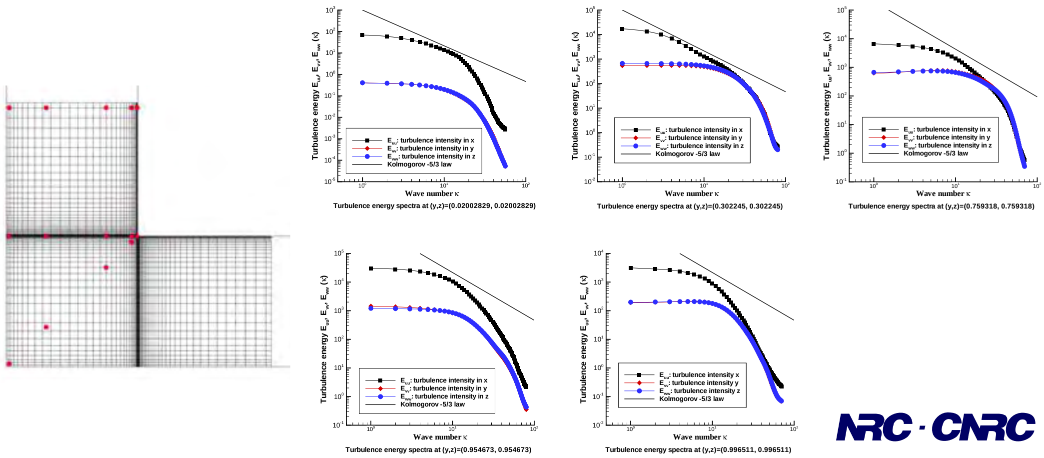
Turbulent eddy viscosity check

- Temporal DNS- turbulence energy spectra (corner-bisector)



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Model errors

- Solutions:
- Anisotropic model based on more general form:

$$\rho \overline{u'_i u'_j} = A\delta_{ij} + \mu_{ijkm}\left(\frac{\partial \bar{u}_k}{\partial x_m} + \frac{\partial \bar{u}_m}{\partial x_k}\right)$$

- Grid-dependence study of LES and Ultimate grid-independent results of DNS

$$\frac{\partial \bar{u}_i}{\partial t} + \frac{\partial \overline{u_i u_j}}{\partial x_j} = -\frac{\partial \bar{p}}{\partial x_j} + \left\{\frac{\partial}{\partial x_j}\left[\left(\nu + \bar{\nu}_t\right)\left(\frac{\partial \bar{u}_i}{\partial x_j} + \frac{\partial \bar{u}_j}{\partial x_i}\right)\right]\right\}$$

$$\bar{\nu}_t = \left(C_s D \bar{\Delta}\right)^2 \sqrt{\left[\frac{1}{2}\left(\frac{\partial \bar{u}_i}{\partial x_j} + \frac{\partial \bar{u}_i}{\partial x_j}\right)\right]^2}$$

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Discretization errors

1. Caused by the implementation of numerical algorithms to discretize the governing equations
2. Methods to minimize the errors:

(1) High-order schemes (Global minimize)

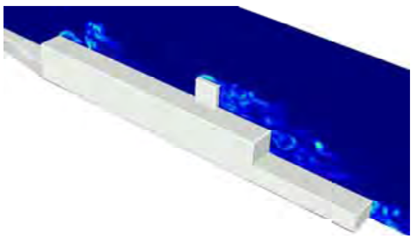
(2) Increase grid resolution (Smart minimize-AMR)

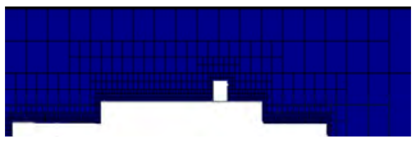
a. Geometry adaptive--solution for complex geometry

b. Solution adaptive--solution for unsteady vortex flow

3. RANS(upwind scheme)

4. LES/DNS (central scheme)





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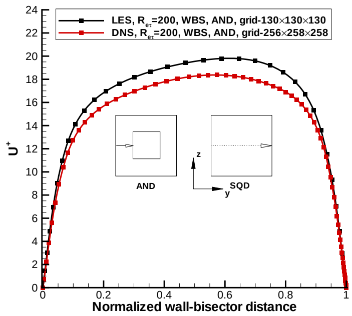
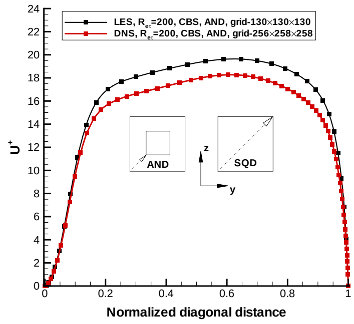
Discretization errors

3. Demonstration of discretization error reduction through grid dependence study (grid refinement)





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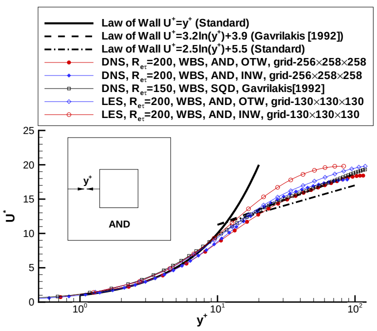
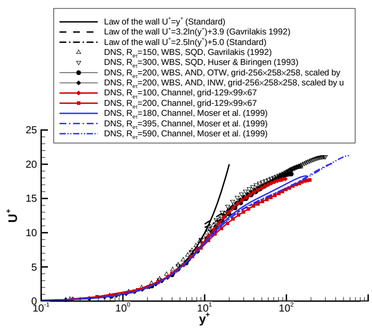
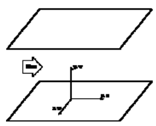
Discretization errors

3. Demonstration of discretization error reduction through grid dependence study







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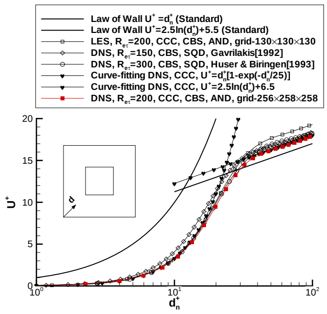
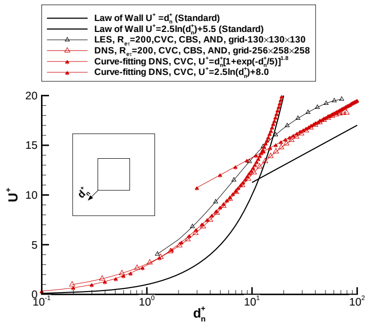
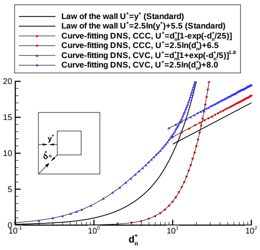
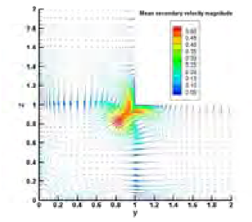
Discretization errors

3. Demonstration of discretization error reduction through grid dependence study

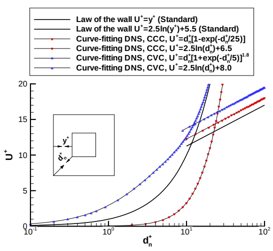








Discretization errors



1. Law-of-the-Wall:

$$U^+ = y^+, \quad y^+ \le 10 \qquad U^+ = 2.5\ln\left(y^+\right) + 5.0, \quad y^+ \ge 20$$

2. Law-of-the-Concave Corner:

$$U^+\left(d_n^+\right) = d_n^+\left(1 - e^{-d_n^+/25}\right), \quad 0 \le d_n^+ \le 20 \qquad U^+\left(d_n^+\right) = 2.5\ln\left(d_n^+\right) + 6.5, \quad 30 \le d_n^+ \le 100$$

3. Law-of-the-Convex Corner

$$U^+ = d_n^+\left(1 + e^{-d_n^+/5}\right)^{1.8}, \quad 0 \le d_n^+ \le 10 \qquad U^+ = 2.5\ln\left(d_n^+\right) + 8.0, \quad 20 \le d_n^+ \le 100$$

Solution errors

- ➢ Caused by the inability to completely converge the discretized equations (the sparse algebraic system) using an iterative method

- *As commented in Wesseling (2001), solving Poisson's equation for the pressure correction takes most of the time in computing non-stationary incompressible viscous flows on staggered grids, unless a fast Poisson solver is used. Without it large eddy simulation of turbulence would not be feasible.*

- ➢ Solutions:

More robust solving technique based on Multigrid method;

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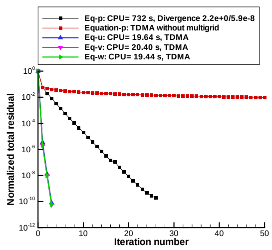
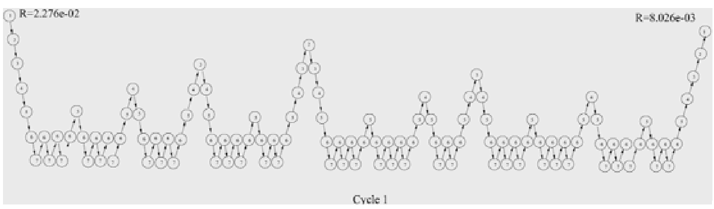
Solution errors

- High-performance unsteady N-S solution technology
  - – Conventional and modified TDMA
  - – Flexible-cycle Additive-correction Multigrid
  - – proved being feasible for LES/DNS
    - Square annular duct and Flow past square blocks





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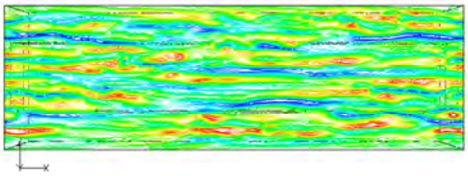
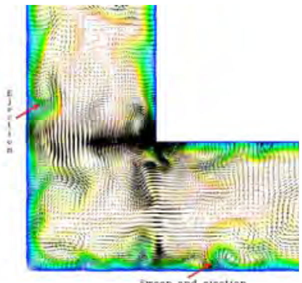
Turbulence Simulations in Square Annular Duct

- Streaky structures

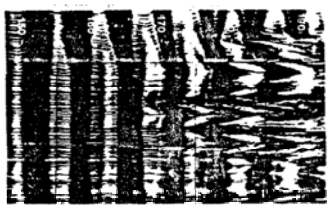


- Sweep and Ejection (Burst) events



Turbulence Simulations in Channel Flow

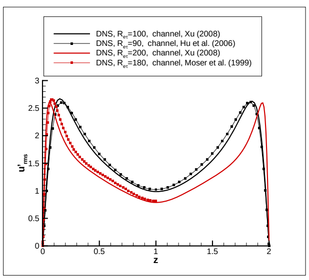
- λ – wave found by Saric et al. (1984)

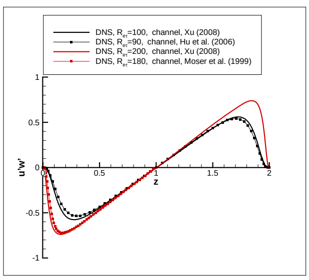


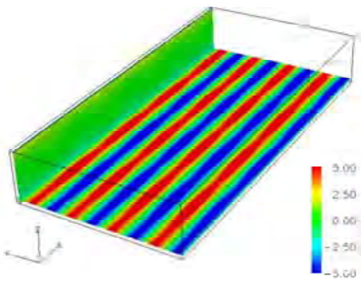
- Comparison with other DNS

Channel Flow Development visualized by Streamwise Vorticity

Visualization at Z cutting plane at 15

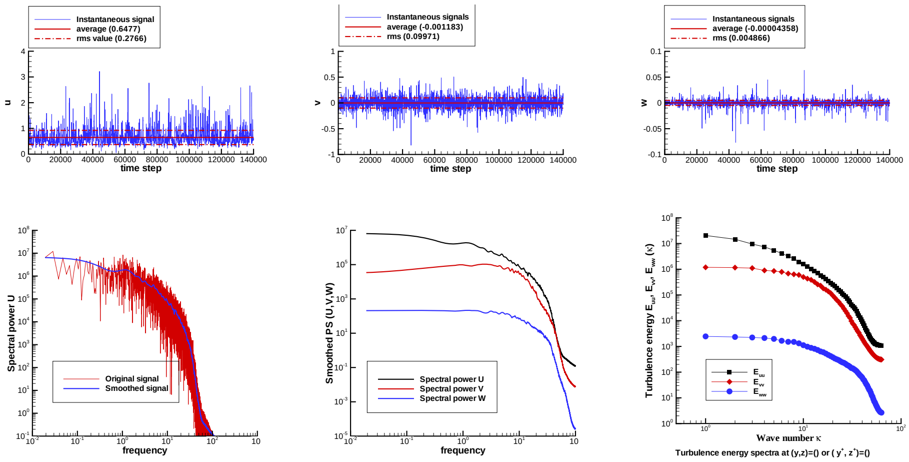






Turbulence Simulations in Channel Flow

- Turbulence signals and their temporal and spatial power spectra



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Errors from BC and IC

- Boundary and initial conditions (BC and IC)
  - For RANS: (1) uniform flow assumption is adequate for steady flow; (2) model errors often prevail the incorrectness in BC and IC
  - For LES/DNS: BC and IC are unequivocal issues for resolving the turbulence motions on a continuous spectra

- Turbulence simulation strategies
  - Temporal simulation (TS): generate fully-developed turbulence
    - A strategy used by turbulence simulation community
  - Spatial simulation (SS): capture spatial evolution of turbulence
    - The method already popularly used by CFD community

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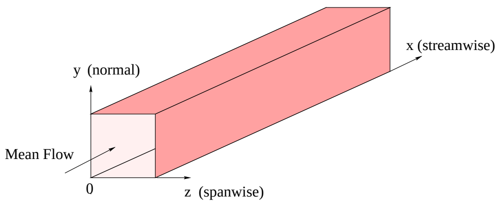
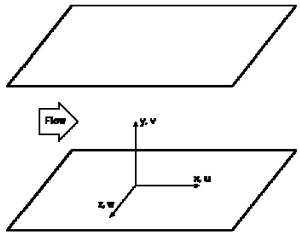
Errors from BC and IC

- Turbulence simulation strategies
  - Temporal simulation:

    a strategy used by turbulence simulation community





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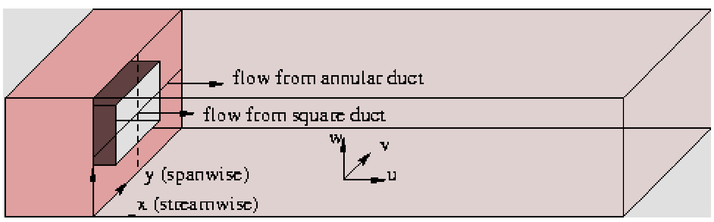
Errors from BC and IC

- Turbulence simulation strategies
  - Spatial simulation:

    a common practice within CFD community



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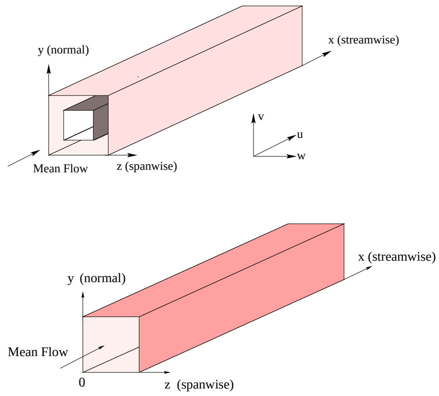
Importance of BC and IC

- Temporal LES/DNS
  - Square duct and Square Annular duct
  - Importance of the simulations
  - (1) understand the turbulence for these particular flow configuration
  - (2) build the turbulent inlet condition for spatial simulation



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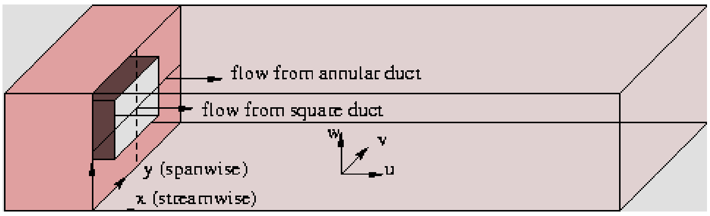
Importance of BC and IC

- Spatial LES/DNS
  - Confined Square Coaxial Jet
  - Turbulence at inlet: fully-developed turbulence in square duct and square annular duct



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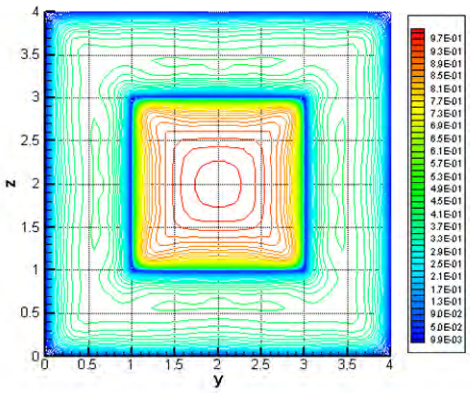
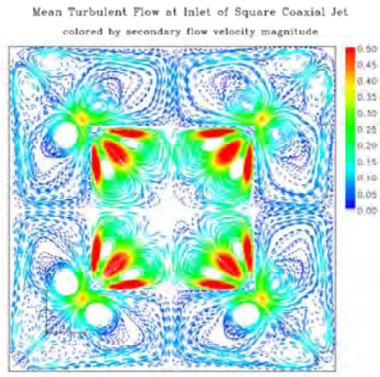
Importance of BC and IC

– Turbulent Flow at Inlet of Square Coaxial Jet

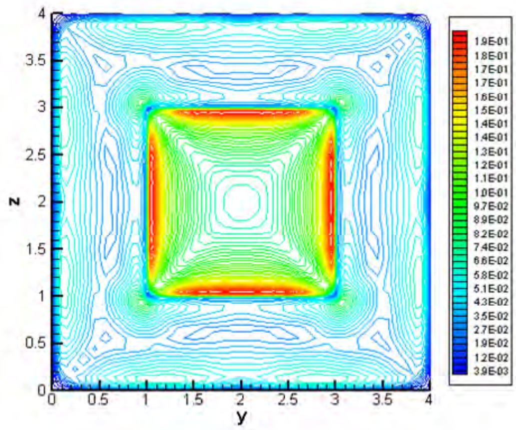
- Mean streamwise velocity and Turbulence-driven secondary flow

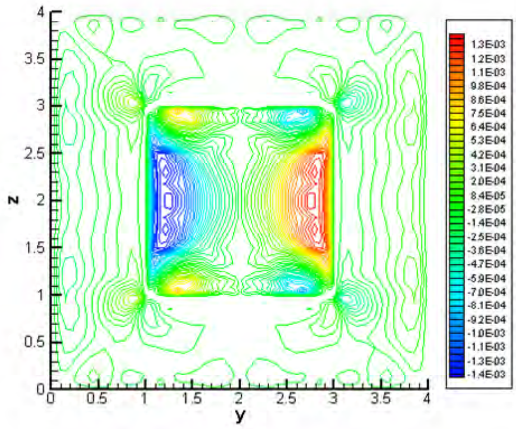




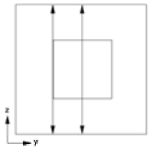
Importance of BC and IC

- Reynolds stress distributions of $\overline{u'u'}$ and $\overline{u'v'}$ at jet inlet

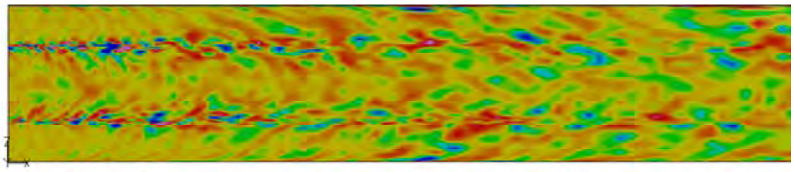




Importance of BC and IC



- Animations of streamwise vorticity distributions on the two typical cutting planes of y=2 and y=1



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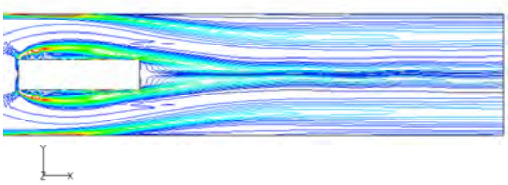
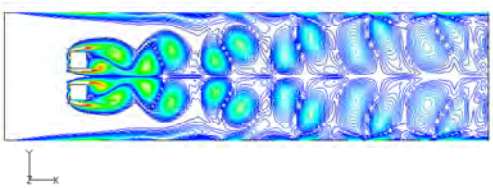
Importance of BC and IC

- Animations of streamwise vorticity evolution
  - Laminar, instability and periodic vortex shedding





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Conclusions

- Computational uncertainty analysis is conducted for turbulence simulation: four major sources of errors are identified
- A robust unsteady solution technology, Flexible-cycle Additive-correction multigrid (FCAC-MG), is developed
- Temporal and spatial simulation strategies are elaborated, which leads to more accurate LES/DNS with realistic turbulent inlet conditions
- Technical roadmap: turbulence simulation capability with high-fidelity representation of turbulence physics

RANS-LES-DNS comparisons

	RANS	LES	DNS
Equations	N-S Eq. with turbulence closure model	N-S Eq. with sub-grid scale model	N-S Eq.
Grids	Collocated grid	Staggered grid	Staggered grid
Discretization	Upwind scheme	Central scheme	Central scheme
Time-marching	Dual time stepping	Fractional step	Fractional step
Solving and convergence	One to two order of magnitudes	As high as possible (solvability condition)	As high as possible (solvability condition)
B.Conditions	Steady, uniform flow	Realistic turbulence, temproal simulation	Realistic turbulence, temp[illegible]

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Overview of the Activities of the Fixed Wing Group

National Research Council Canada
Conseil national de recherches Canada

Canada

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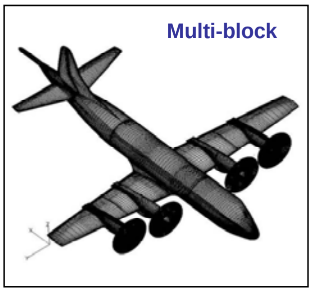
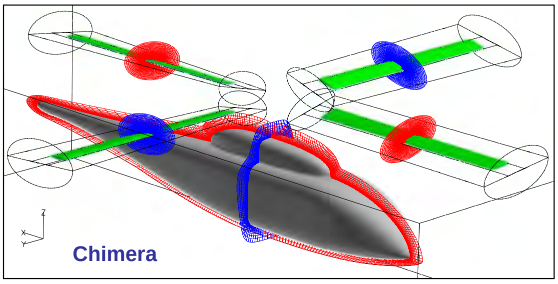
OVERVIEW

- Introduction
- Modeling and Simulation (CFD)
  - Unsteady Aerodynamics, Morphing Wings
  - Store Release
  - Low Reynolds Number Airfoils
  - Missiles, Supersonic Hypersonic Code Development
  - Fixed-Wing Icing (Morphogenetic Techniques)
  - Turbulence Models (LES, DNS, DES)
- Experimental
  - Store Release Testing (CTS Development)
  - Large Aircraft Tests
  - Bombardier Tests
  - Icing Tests
  - Low Reynolds Number Tests

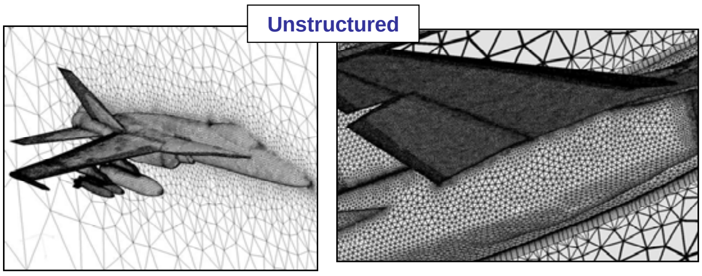
Modeling & Simulation
Grid Generation Capabilities

- Structured Multi-block Grids
- Structured Chimera Grids
- Unstructured/Hybrid Grids

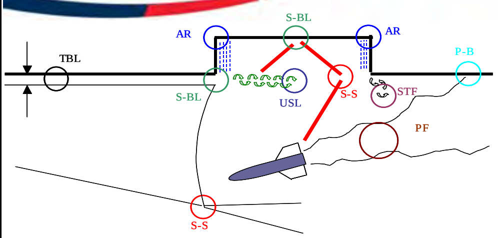




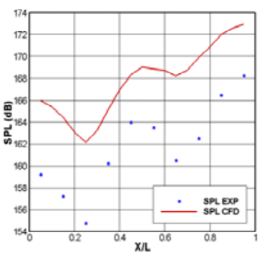
Unstructured

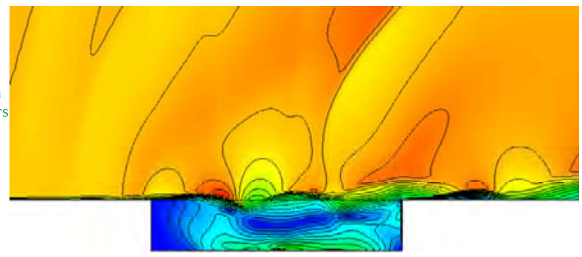


Modeling & Simulation
Store release program
Cavity flows challenge



AR Acoustic resonance
P-F Plume flows
S-S Shock-shock interaction
TBL Turbulent boundary layer
P-B Plume-body interaction
S-BL Shock boundary layers
STF Separated flow regions
USL Unsteady shear layer





L/D = 5
M = 0.85
Rey = 6.78 M

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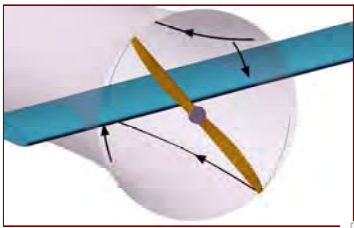
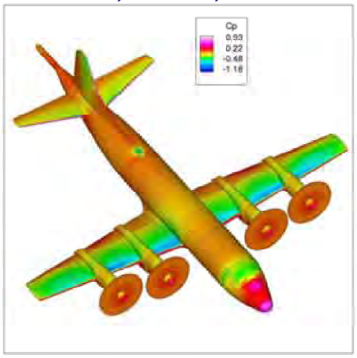
Modeling & Simulation
Loads Prediction of Aurora aircraft

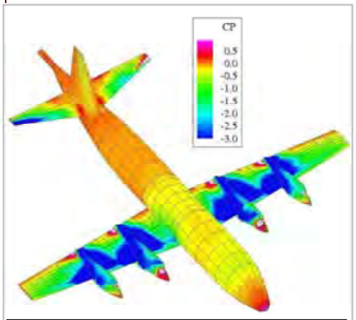


N-S Solution:
M=0.564, J=3.13, α=3.9°



CP-140 (Aurora) SLAP Program

- Combination of RANS and in-house panel CFD codes.
- Actuator disc and blade-element propeller models.



Panel solution: *α = 6°, J = 0.552*

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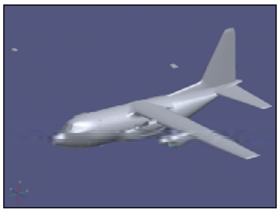
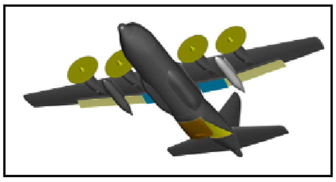
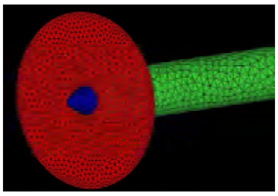
CC130H CFD Loads Prediction Open Ramp Door Effects

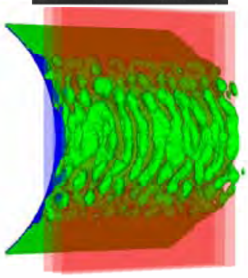
- **Impact:** contribution to service life assessment and repair assessment of the CF's CC-130 fleet by providing accurate estimates of aerodynamic loads



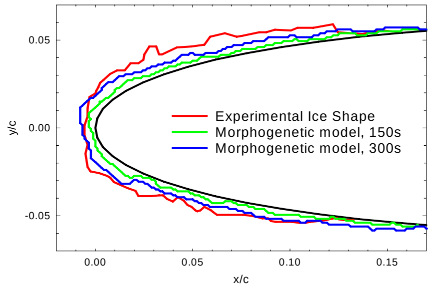


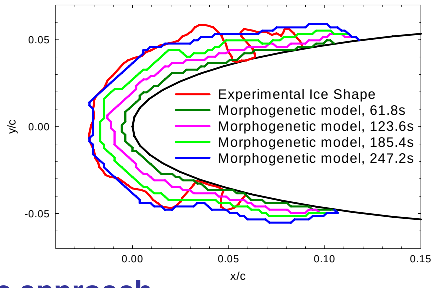


Modeling & Simulation Icing



“Lobster tails” on swept wing





Morphogenetic approach

Bombardier Half - Model Testing

- ½ Model (7% scale) Tests performed in 1.5m x 1.5m tri-sonic blowdown wind tunnel
- Investigation of high-lift aerodynamic characteristics of the CRJ900-X configuration
  - Extended fore and aft fuselage
- Icing study on the Global Express (electric de-icing capabilities)
  - Aerodynamic characteristics with simulated icing

Continued IAR support towards performance enhancement of the RJ, GE

CRJ900-X

Global Express

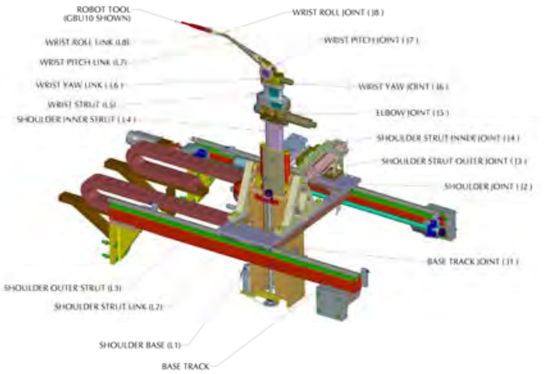
DND Store Carriage and Release Wind Tunnel Test Program

- Three tests to be performed
- Grid Survey Investigation of launch and Jettison of AIM-120 C-5
  - February 2007
  - Mach 0.6 and 0.8
  - FLIR Pod / GBU10 / EFT
- Captive Load Tests of MK-84
  - March 2007
  - Mach 0.8, 0.9 and 0.95
  - FLIR Pod / AIM-7
  - Review lateral loading of Mk84
  - PSP study on wing and store surfaces
- Roll Characteristics of CF-18
  - Effect of FLIR Pod on aircraft aerodynamics
  - Tests conducted through Mach 1
    - From Mach = 0.97 to 1.05

Grid Survey test within flow field of the 6% CF-18 stores model

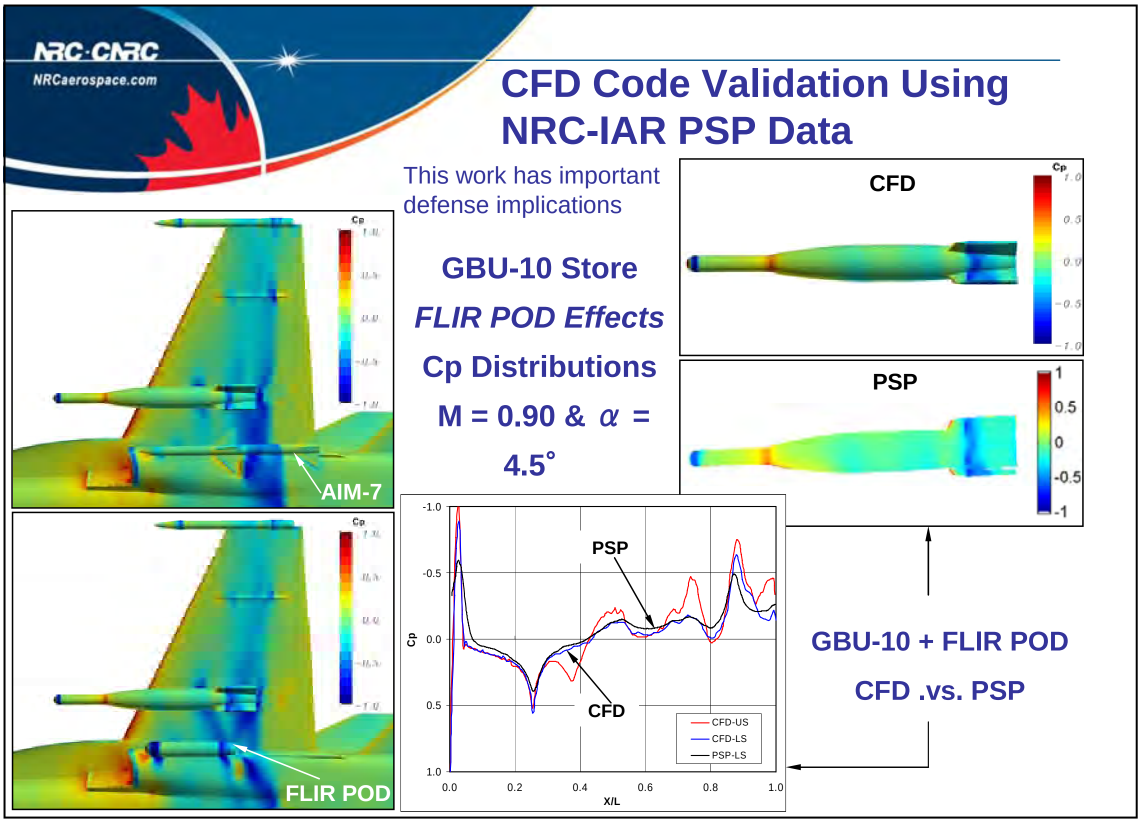
CTS - Final Mechanical Design

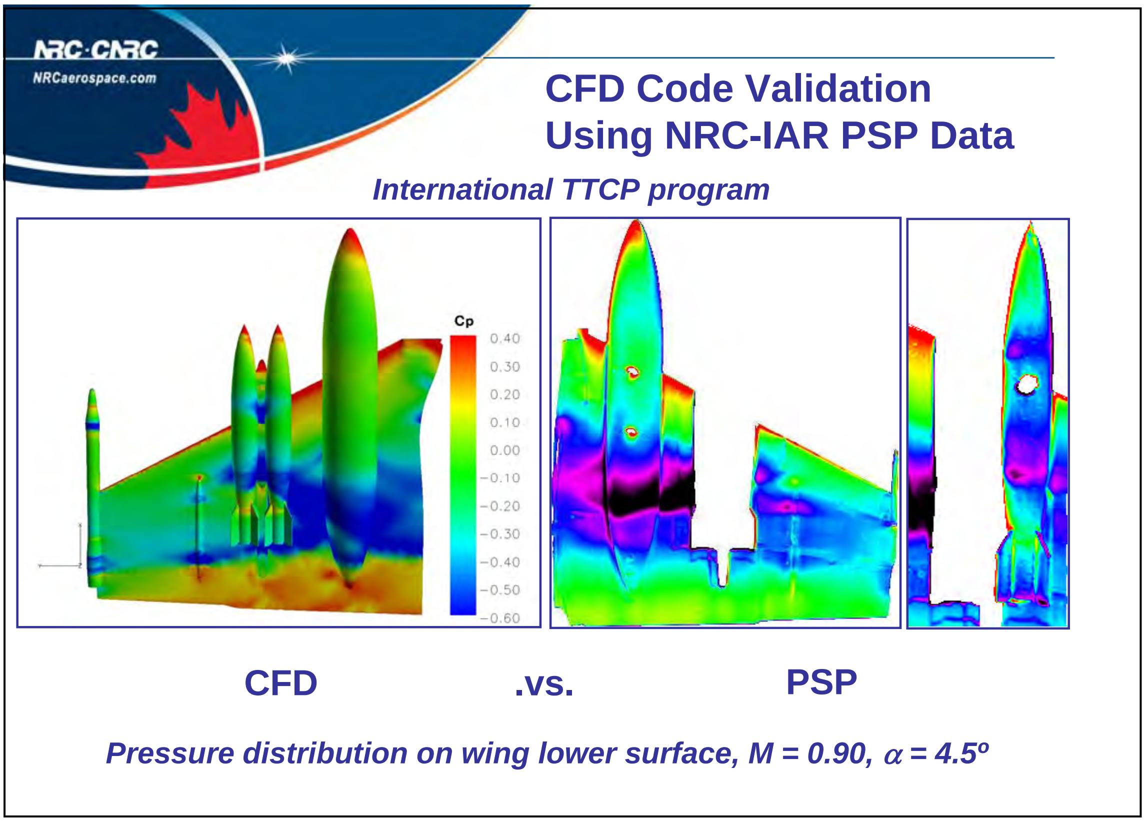
- Final design and in-house compone completed
- Custom motors completed
  - Wrist, elbow and roll joints
  - Delivered by end Jan '07
- Instrumentation, cabling and softwa integration in progress
  - Robotics and control algorithms
  - Store positioning system (Optotrak)
  - Multi-objective optimization
  - Collision detection
- CTS assembly completed and installed on calibration rig by end Feb. '07
  - System commissioning
  - Integration with tunnel system



Assembly of CTS

New CTS system will make current store release capability more economical and efficient

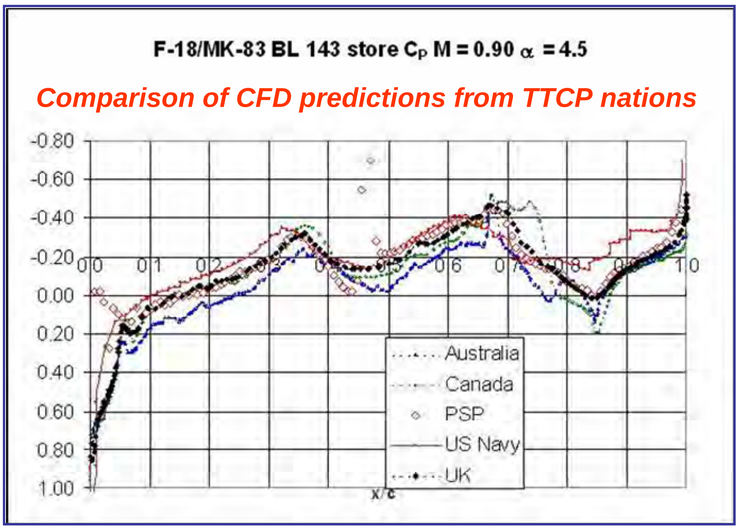

NRC·CNRC
NRCaerospace.com
CFD Code Validation Using NRC-IAR PSP Data
This work has important defense implications
GBU-10 Store
FLIR POD Effects
Cp Distributions
M = 0.90 & α = 4.5°
CFD
PSP
AIM-7
FLIR POD
GBU-10 + FLIR POD
CFD .vs. PSP
CFD-US
CFD-LS
PSP-LS
X/L
Cp


NRC·CNRC
NRCaerospace.com
CFD Code Validation Using NRC-IAR PSP Data
International TTCP program
Cp
0.40
0.30
0.20
0.10
0.00
−0.10
−0.20
−0.30
−0.40
−0.50
−0.60
CFD
.vs.
PSP
Pressure distribution on wing lower surface, M = 0.90, α = 4.5°

CFD Code Validation Using NRC-IAR PSP Data

International TTCP program

PSP Data provided by NRC-IAR



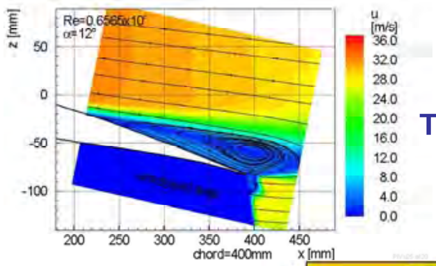
Cp distribution on lower surface of MK-83 LD store, M = 0.90, α = 4.5º

Low Re Facility Status

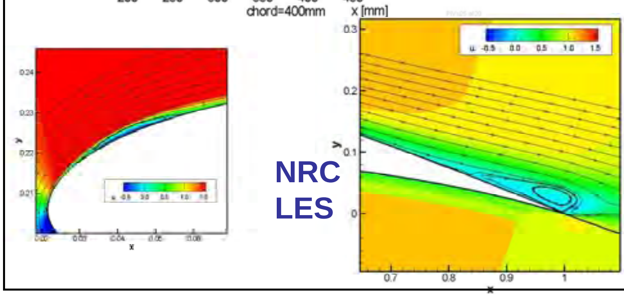
- Completed
  - Tank & access section
  - Model & optical tracks & carriages
  - Mixing/filtering plumbing
- Outstanding
  - Motion system
  - Services in M-22
  - Access platform (minor)

Modeling & Simulation
Low Reynolds Number

LES LE AND TE SEPARATION
HGR-01 AIRFOIL: α = 10, RE = 0.65M

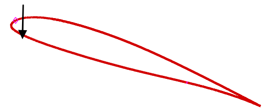


TUBS PIV

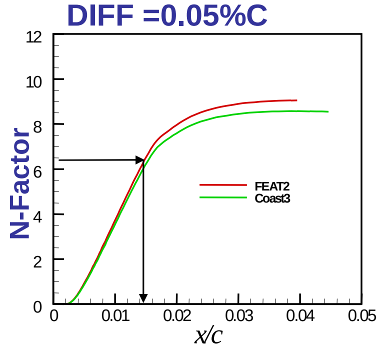


NRC LES

TRANSITION LOCATION α = 10º



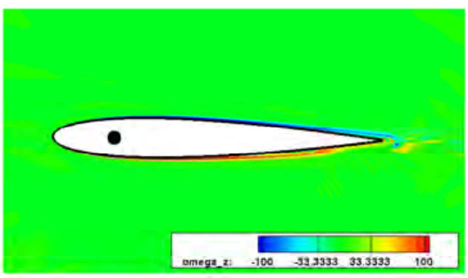
NRC XT = 0.0154
TUBS XT = 0.0159
DIFF =0.05%C



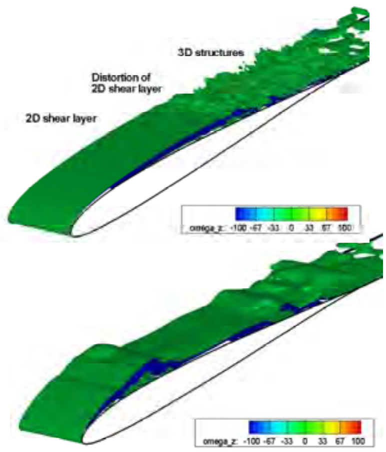
Modeling & Simulation
Low Reynolds Number

RTO AVT-101

LES LOW-AMPLITUDE OSCILLATIONS (RMC)

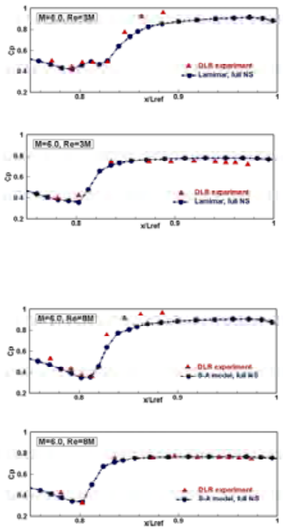


SPANWISE VORTICITY OVER NACA 0012 PITCHING AIRFOIL AT RE=77K.



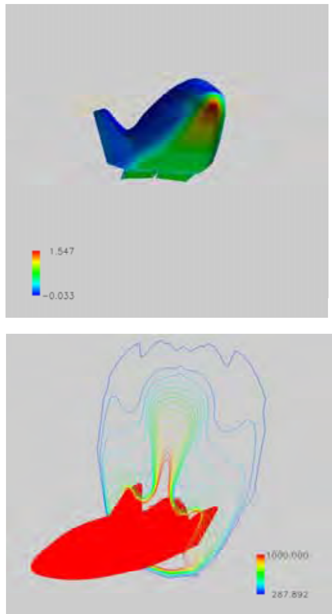
SPANWISE VORTICITY OVER STATIONARY α=4° AND PLUNGING α=5.5 °+3°cos(0.5πt) SD7003 AIRFOIL, RE=60K.

Hypersonic Flows



Laminar

Turbulent



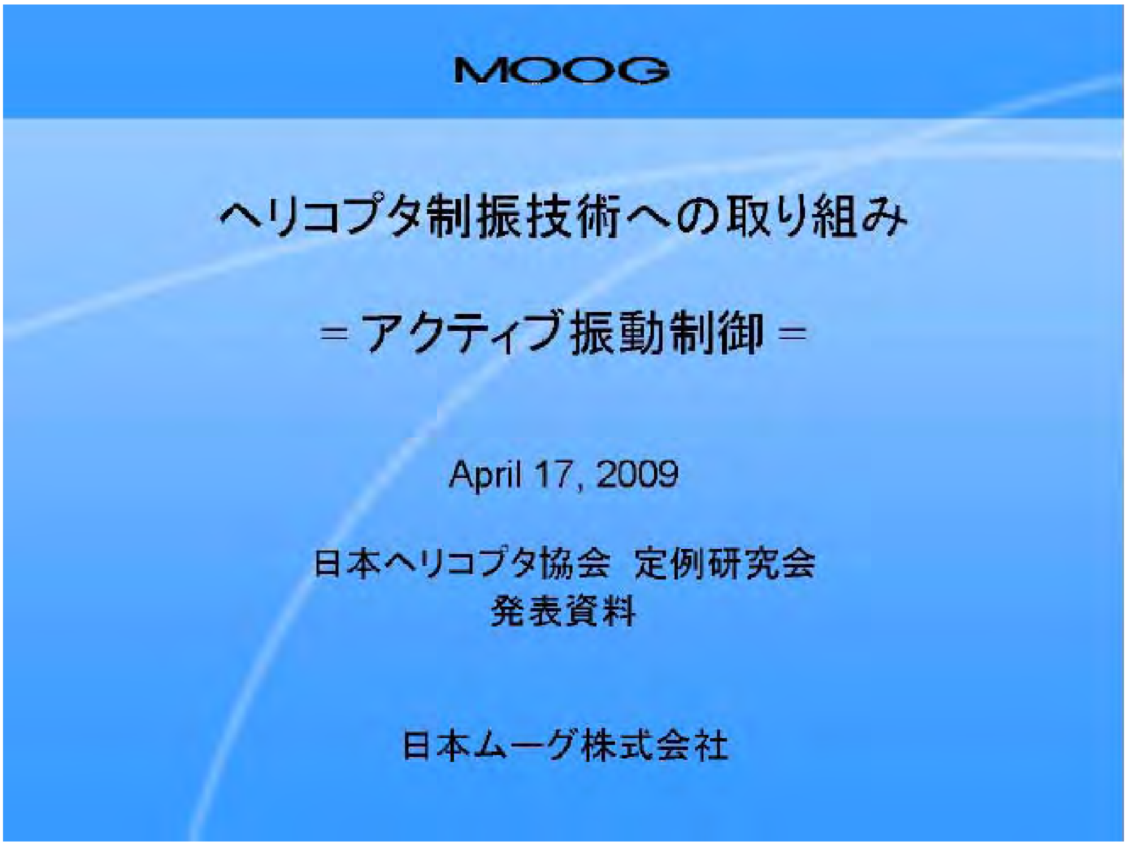
Pressure coefficient temperature (bottom) distribution on the space orbiter surface at M = 6 and Re = 3×106

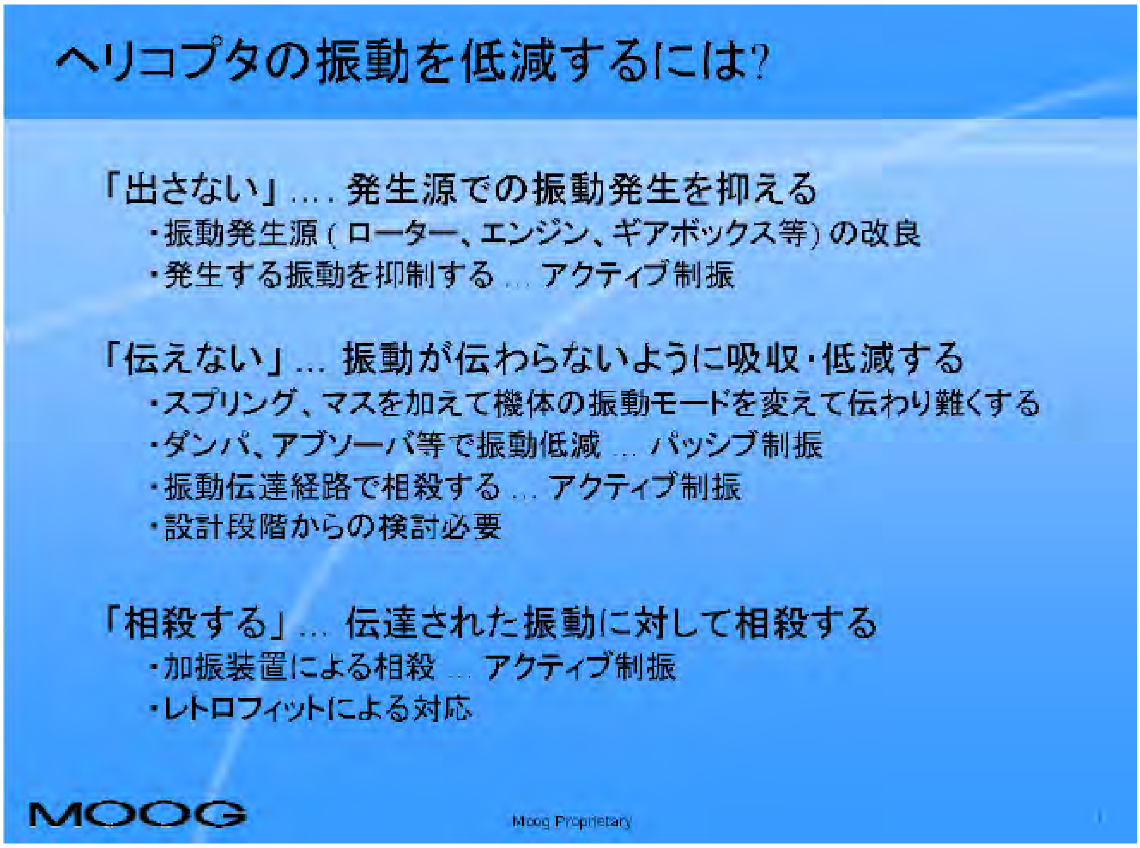
Closing Remarks

- The FWA Program of the Aerodynamics Laboratory has been engaged in a number of projects involving numerical modeling methods and wind tunnel tests.
- The FWA program of AL has healthy collaborative projects with DND, Industry and Academia
- The FWA tables some good plans for future projects:
  - Aeroelasticity
  - Aeroacoustic Studies
  - Wing stall – roughness and ground effects
  - High Wing Loading Large Transport Aircraft
  - Morphing Aircraft
  - Blunt Trailing Edge Jets

Any Questions?

Blank


MOOG
ヘリコプタ制振技術への取り組み
＝アクティブ振動制御＝
April 17, 2009
日本ヘリコプタ協会　定例研究会
発表資料
日本ムーグ株式会社


ヘリコプタの振動を低減するには?
「出さない」…. 発生源での振動発生を抑える
・振動発生源（ローター、エンジン、ギアボックス等）の改良
・発生する振動を抑制する … アクティブ制振
「伝えない」… 振動が伝わらないように吸収・低減する
・スプリング、マスを加えて機体の振動モードを変えて伝わり難くする
・ダンパ、アブソーバ等で振動低減 … パッシブ制振
・振動伝達経路で相殺する … アクティブ制振
・設計段階からの検討必要
「相殺する」… 伝達された振動に対して相殺する
・加振装置による相殺 … アクティブ制振
・レトロフィットによる対応
MOOG
Moog Proprietary

振動制御の有効性

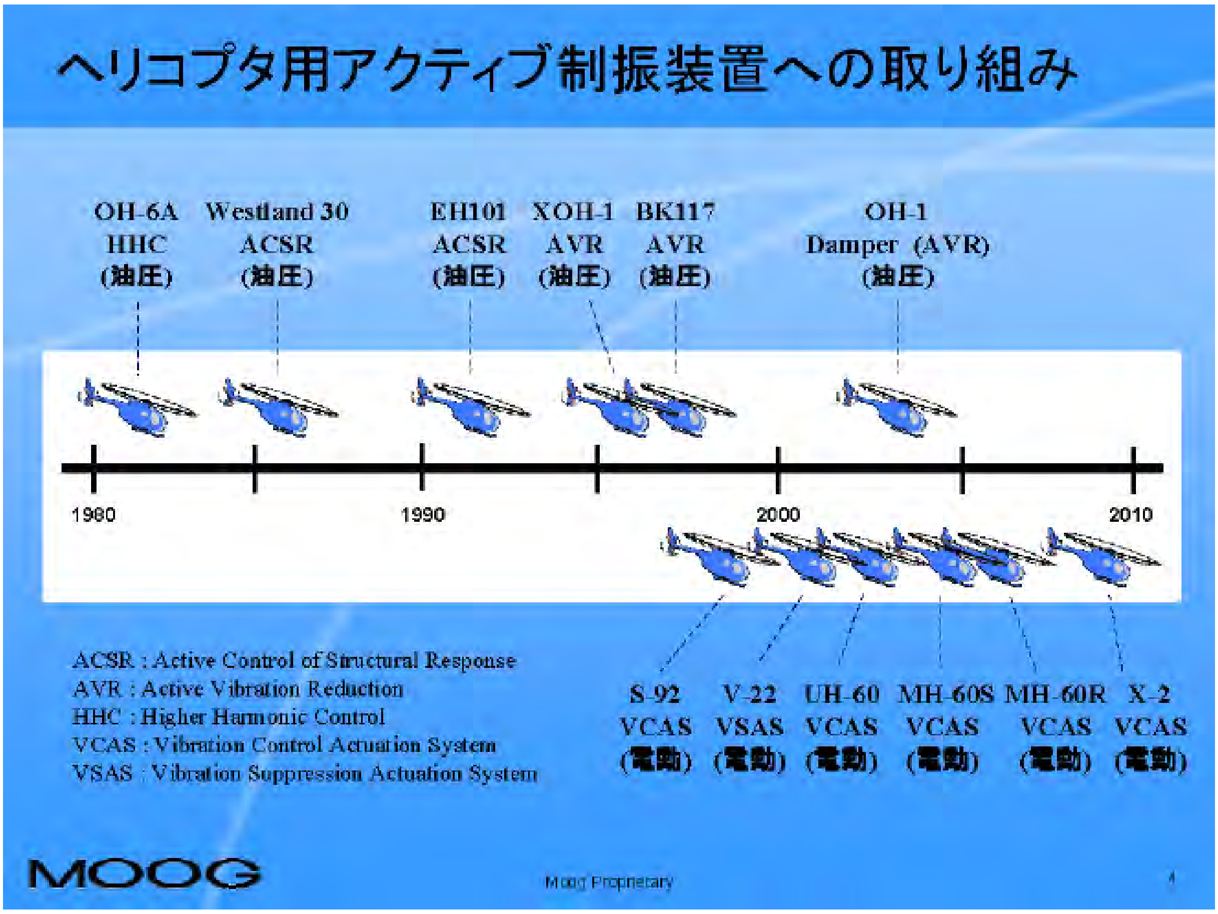
・機体構造の疲労低減
・構造から発生するノイズの低減
・乗員の快適性向上及び疲労低減
・機体・搭載機器の寿命延長
・搭載武器の照準動作・精度の向上
・振動起因の不具合発生低減
・保守回数・コストの低減
・運用コストの低減

↓ さらに

・飛行性能の向上
振動低減による機動性向上等

パッシブ(受動的)振動制御
・エラストマ、スプリング等のダンパーやアブソーバ
・振動制御可能な周波数は機器に依存
・振動の「低減」、「吸収」、「絶縁」
・低減レベル 0.1G 以下が困難

アクティブ(能動的)振動制御
・アクチュエータ(油圧、電動)による加振制御
・電源、油圧源、コントローラ(コンピュータ)等の追加機材が必要
・振動周波数の変化に対応可能
・振動の「低減」、「相殺」
・低減レベル 0.1G以下が可能


ヘリコプタ用アクティブ制振装置への取り組み
OH-6A HHC (油圧)
Westland 30 ACSR (油圧)
EH101 ACSR (油圧)
XOH-1 AVR (油圧)
BK117 AVR (油圧)
OH-1 Damper (AVR) (油圧)
1980
1990
2000
2010
S-92 VCAS (電動)
V-22 VSAS (電動)
UH-60 VCAS (電動)
MH-60S VCAS (電動)
MH-60R VCAS (電動)
X-2 VCAS (電動)
ACSR : Active Control of Structural Response
AVR : Active Vibration Reduction
HHC : Higher Harmonic Control
VCAS : Vibration Control Actuation System
VSAS : Vibration Suppression Actuation System
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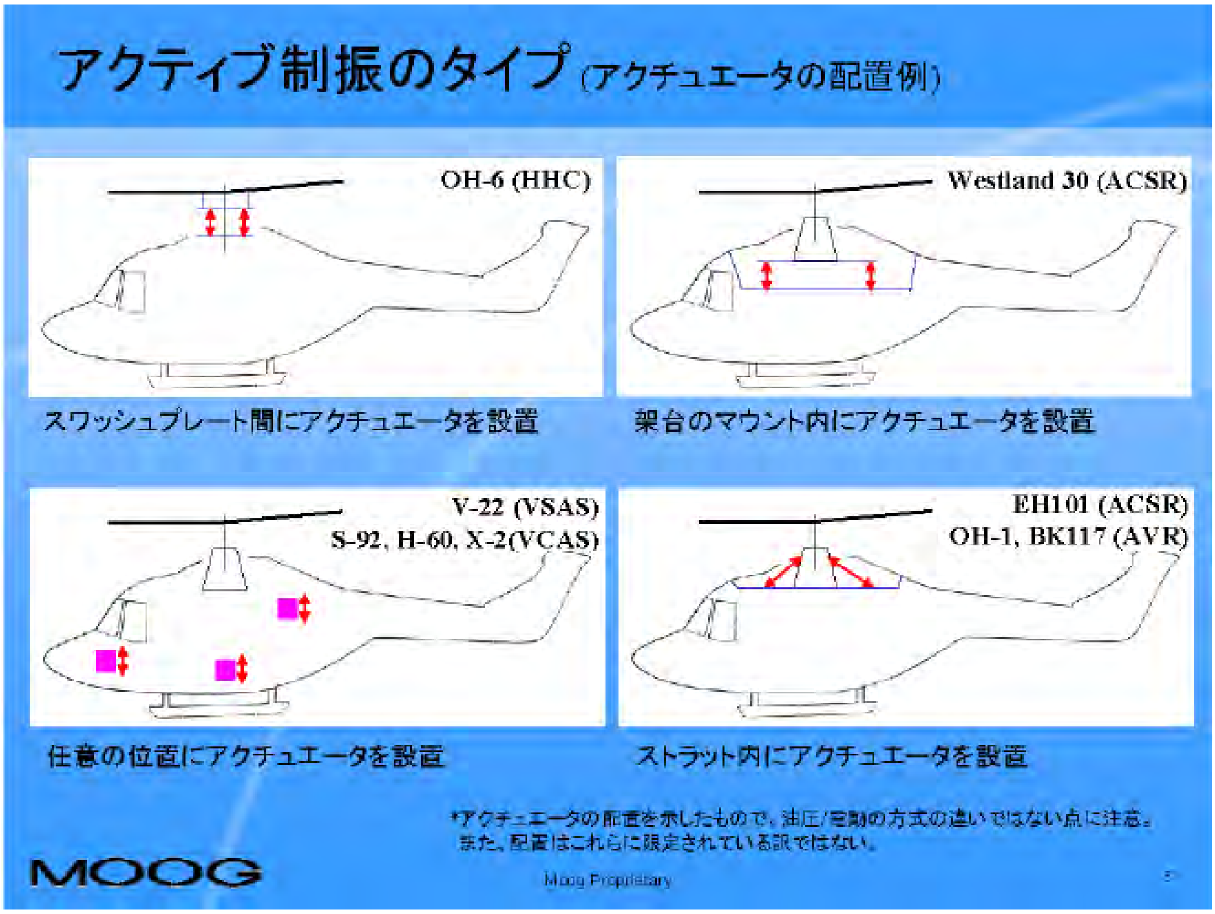
アクティブ制振のタイプ (アクチュエータの配置例)
OH-6 (HHC)
スワッシュプレート間にアクチュエータを設置
Westland 30 (ACSR)
架台のマウント内にアクチュエータを設置
V-22 (VSAS)
S-92, H-60, X-2(VCAS)
任意の位置にアクチュエータを設置
EH101 (ACSR)
OH-1, BK117 (AVR)
ストラット内にアクチュエータを設置
*アクチュエータの配置を示したもので、油圧/電動の方式の違いではない点に注意。
また、配置はこれらに限定されている訳ではない。
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5

アクティブ振動制御装置の現状

・HHC (Higher Harmonic Control) (1982) 等の研究

・量産(正式採用)された制振装置

・油圧方式
- ・ACSR (Active Control of Structural Response) …..W30, EH101
- ・AVR (Active Vibration Reduction) ……………... BK117, OH-1

・電動方式
- ・VSAS (Vibration Suppression Actuation System) ……….. V-22
- ・VCAS (Vibration Control Actuation System)… S-92, H-60, X-2

* 空力ペナルティなし
* 飛行中にON/OFFが可能 … 飛行制御装置とは別扱い
* レトロフィット可能 (油圧タイプはやや困難)

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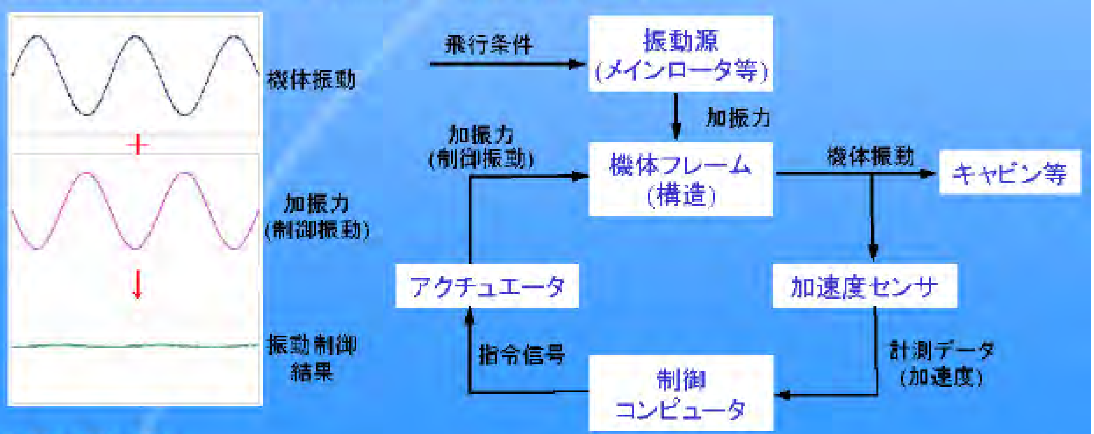
アクティブ振動制御 Active Vibration Control

制御方式:

・制御対象の振動に逆位相の振動を重畳して振動低減を図る。

・フィードバック制御 … 加振力制御(力、振動周波数)

加速度センサにより機体振動力の計測を行い、コントローラにより逆位相の振動力を計算し、アクチュエータにより加振して振動を低減する。



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油圧/電動方式の特徴

油圧方式

・ローターからキャビン等への振動伝達経路である、ストラットやマウントの内部にアクチュエータを組込み、振動低減を図るタイプが多い。

・トランスミッション重量等の荷重は本来のストラット部が受け、アクチュエータには荷重が掛からない構造となっている。

・ストラット等を上記の様なアッセンブリに改修・交換することで現用機にレトロフィット可能。その際、油圧源等が追加で必要になる場合もある。

電動方式

・振動低減を行いたい箇所の近傍、例えば、キャビン構造部、計器類マウント部等に取付ける。

・取り付け位置に自由度があるため、油圧方式に比較すると現用機へのレトロフィットが行いやすい。

・ヘリコプタに限定せず、他の分野への応用も可能。

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アクチュエータ - 油圧方式 (1)

油圧アクチュエータ:

・構成　a) 流量制御サーボ弁 + シリンダーピストン + 圧力センサ
　　　　b) 圧力制御サーボ弁 + シリンダーピストン

・サーボ弁

アクチュエータの力制御 = シリンダ圧制御であるため、流量制御弁選択時は圧力センサが必要。圧力制御弁選択時はセンサ不要であるが、弁種類が少ないため、特注仕様になる場合が多い。

・シリンダーピストン

動的シールの無い「ラミナーシール・タイプ」(油膜シール)とし、摺動抵抗の低減及び高応答を図る。また、ベローズにより外部露出部のシールを行う。

＊圧力制御サーボ弁を使用したタイプは、電気入力(制御)が無くても、油圧が印加されていれば、ダンパとして作動する。

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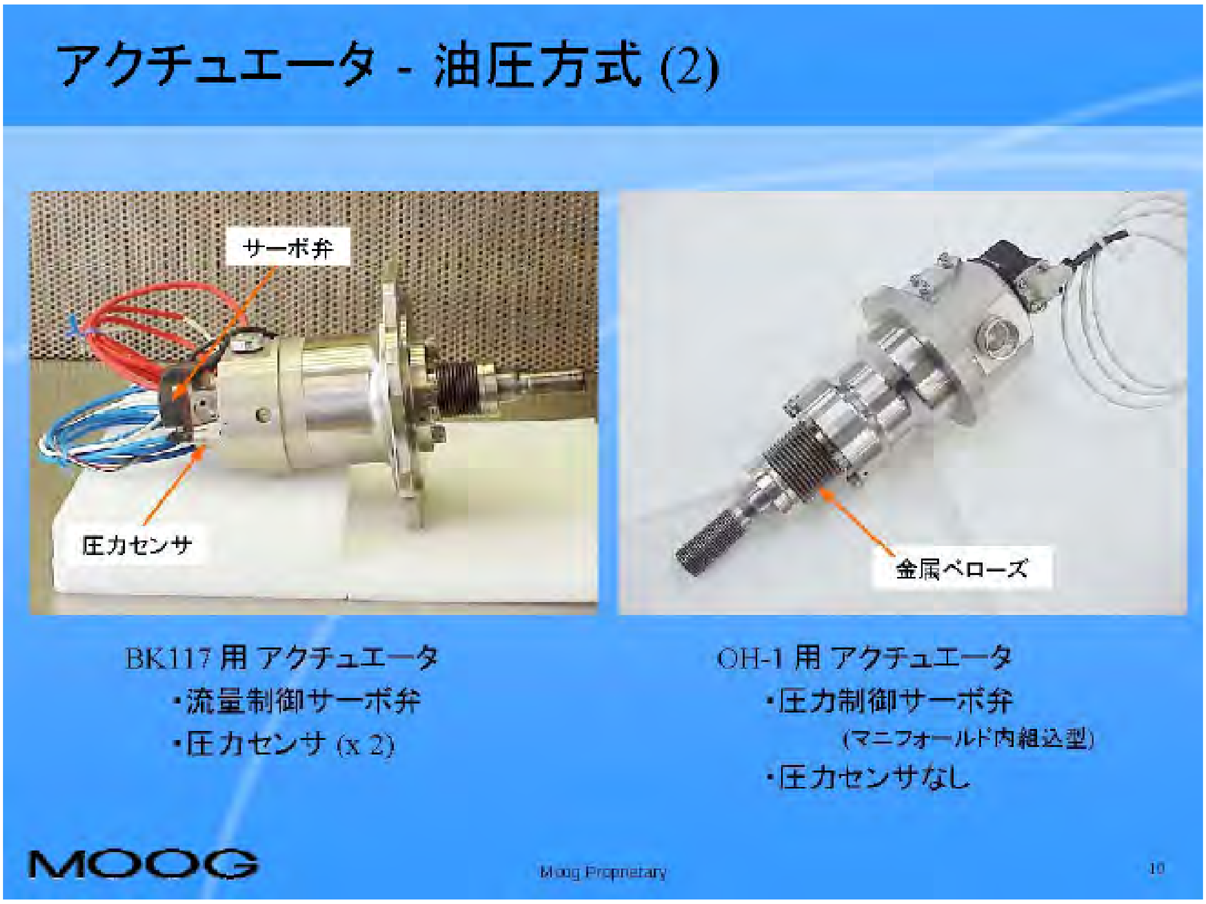
アクチュエータ - 油圧方式 (2)
サーボ弁
圧力センサ
金属ベローズ
BK117 用 アクチュエータ
・流量制御サーボ弁
・圧力センサ (x 2)
OH-1 用 アクチュエータ
・圧力制御サーボ弁
(マニフォールド内組込型)
・圧力センサなし
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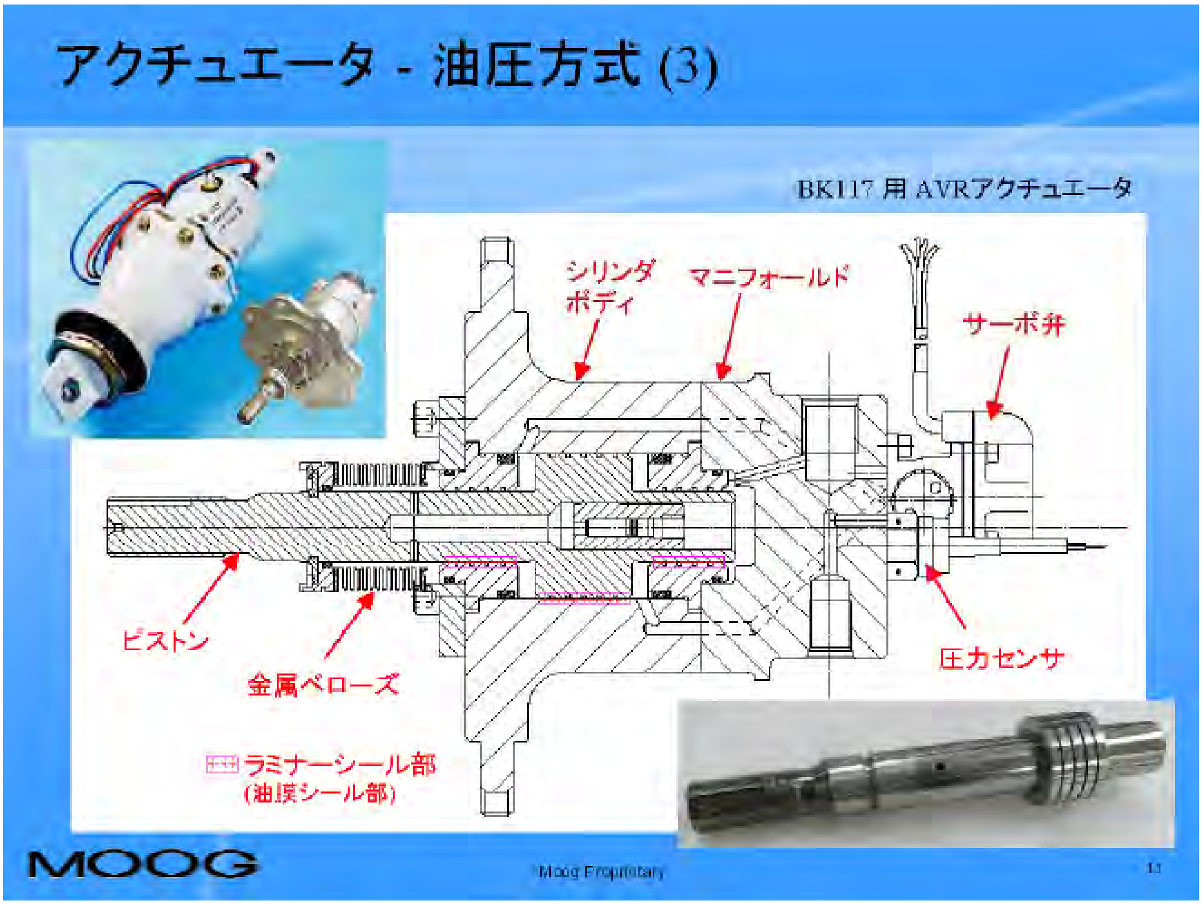
アクチュエータ - 油圧方式 (3)
BK117 用 AVRアクチュエータ
シリンダ
ボディ
マニフォールド
サーボ弁
ピストン
金属ベローズ
圧力センサ
ラミナーシール部
(油膜シール部)
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アクチュエータ -電動方式 (1)

電動アクチュエータ

フォースジェネレータ と呼ぶ。CRFG (Counter Rotating Force Generator)

・構成　モータ + ギアボックス + 偏芯マス

偏芯マスを回転させることにより振動を発生させる。
(携帯電話のバイブレータ等と同じ原理)

フォースジェネレータ1台内に対向する2つの偏芯マス回転機構を内蔵。

フォースジェネレータ 2台で1式として制御し、フォースジェネレータの振動を組み合わせて、制御振動パターンを発生させる。

* 製品構成としては、フォースジェネレータ 2台 + コントローラ 1台 が基本。
この組合せを 1チャンネル と呼ぶ。(=制御可能な加振力の数)

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アクチュエータ -電動方式 (2)

フォースジェネレータ

コントローラ(左) と
フォースジェネレータ(右) 2台

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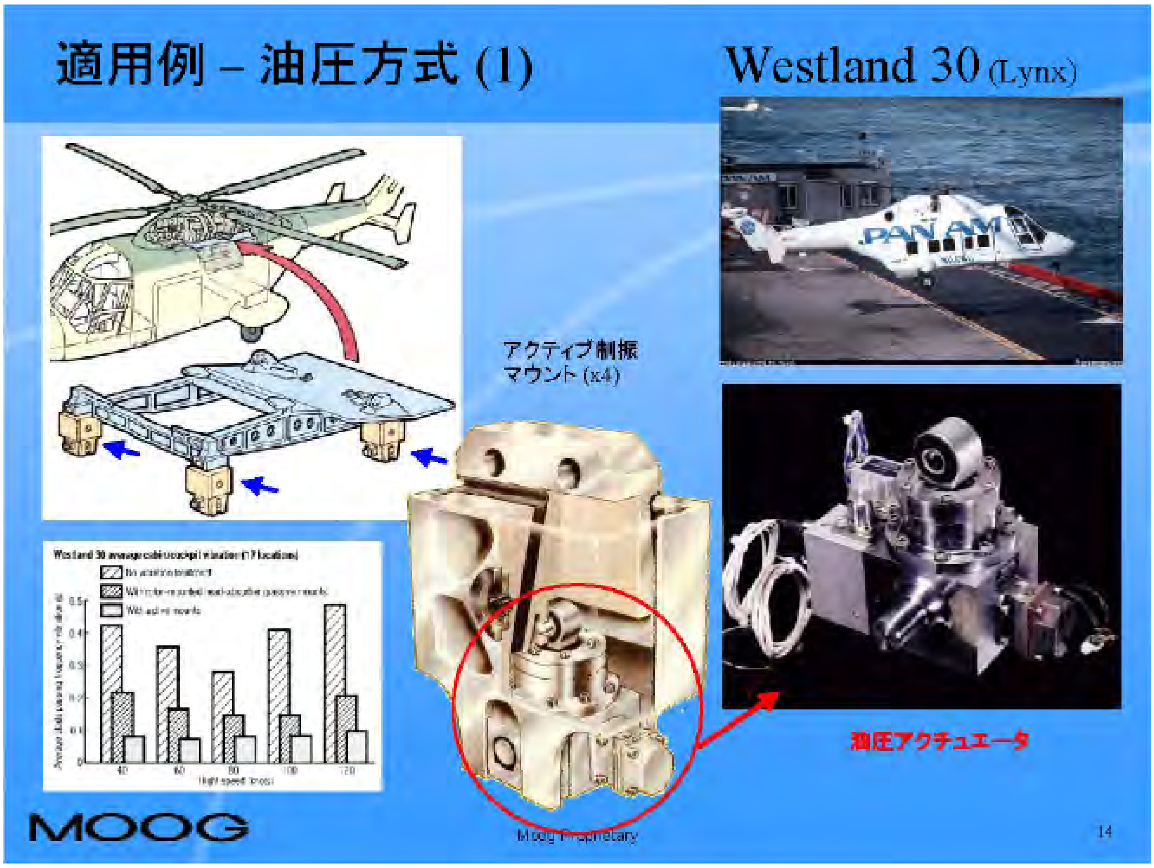
適用例 – 油圧方式 (1)
Westland 30 (Lynx)
アクティブ制振
マウント (x4)
油圧アクチュエータ
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適用例 – 油圧方式 (1)
EH101
前部
(2)
後部
(2)
ストラット/アクチュエータ
アッセンブリ配置図
メイン
ギアボックス
AV VIBRATION
COCKPIT &
CABIN
FORWARD SPEED / KTS
ACSR
アクチュエータ
前部ストラット
ACSRアクチュエータ
アッセンブリ
ACSR :
Active Control of Structural Response
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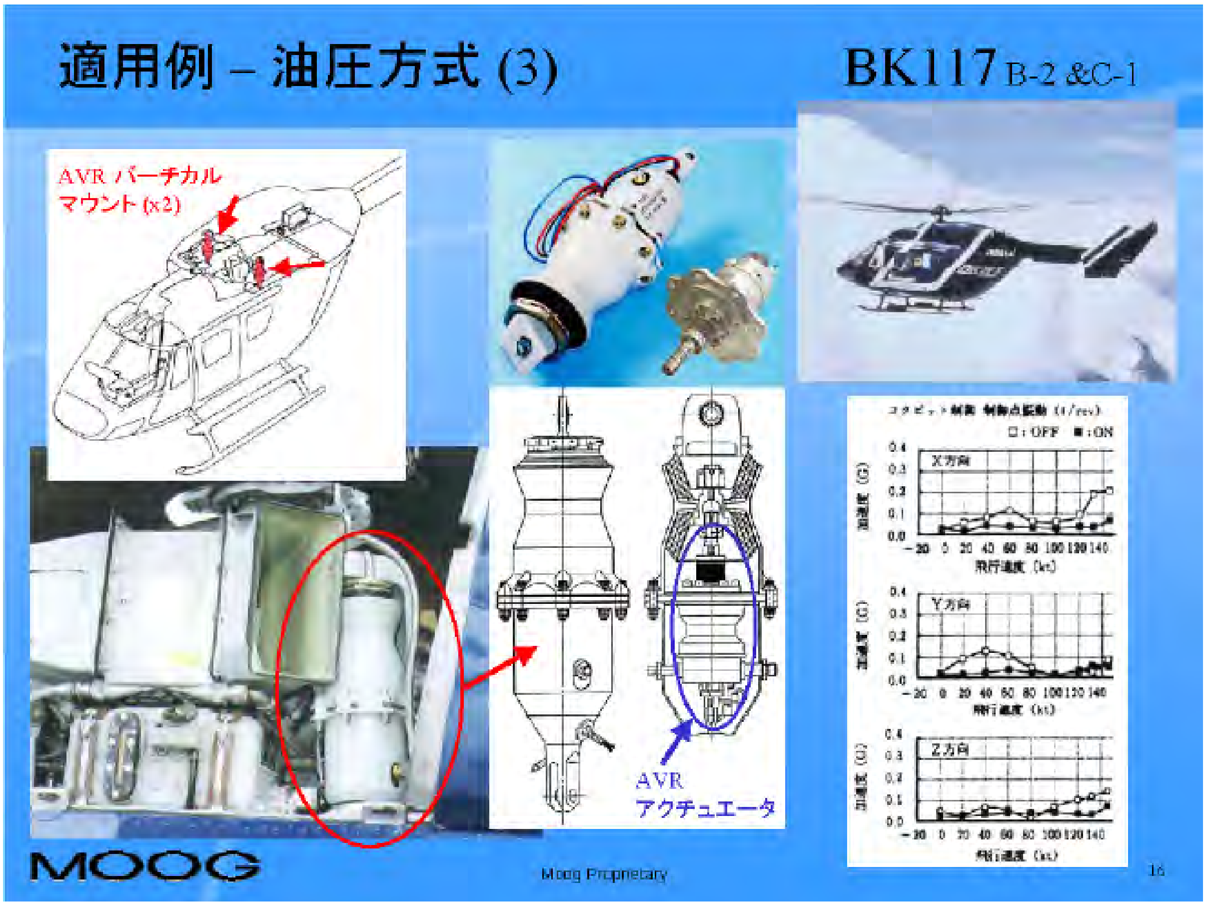
適用例 – 油圧方式 (3)
BK117 B-2 &C-1
AVR バーチカル
マウント (x2)
AVR
アクチュエータ
□: OFF ■: ON
X方向
Y方向
Z方向
飛行速度 (kt)
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適用例 – 油圧方式 (4)
OH-1
* XOH-1 (開発時) は AVR アクチュエータとして
アクティブ制御していたが、OH-1 (現在)は、
油圧印加･制御なしのパッシブ･ダンパとして使用。
ストラット内に
ダンパ(*)を内臓
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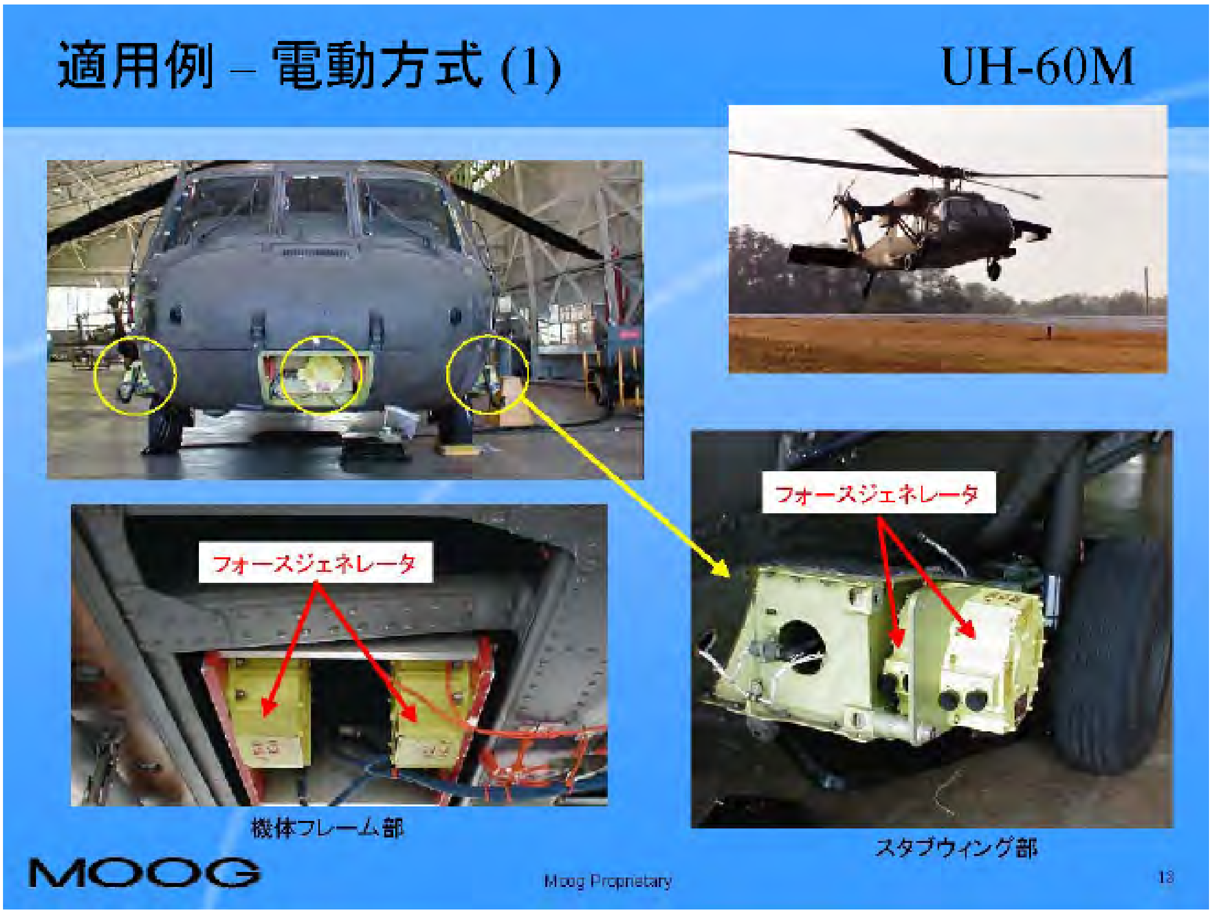
適用例 – 電動方式 (1)
UH-60M
フォースジェネレータ
フォースジェネレータ
機体フレーム部
スタブウィング部
MOOG
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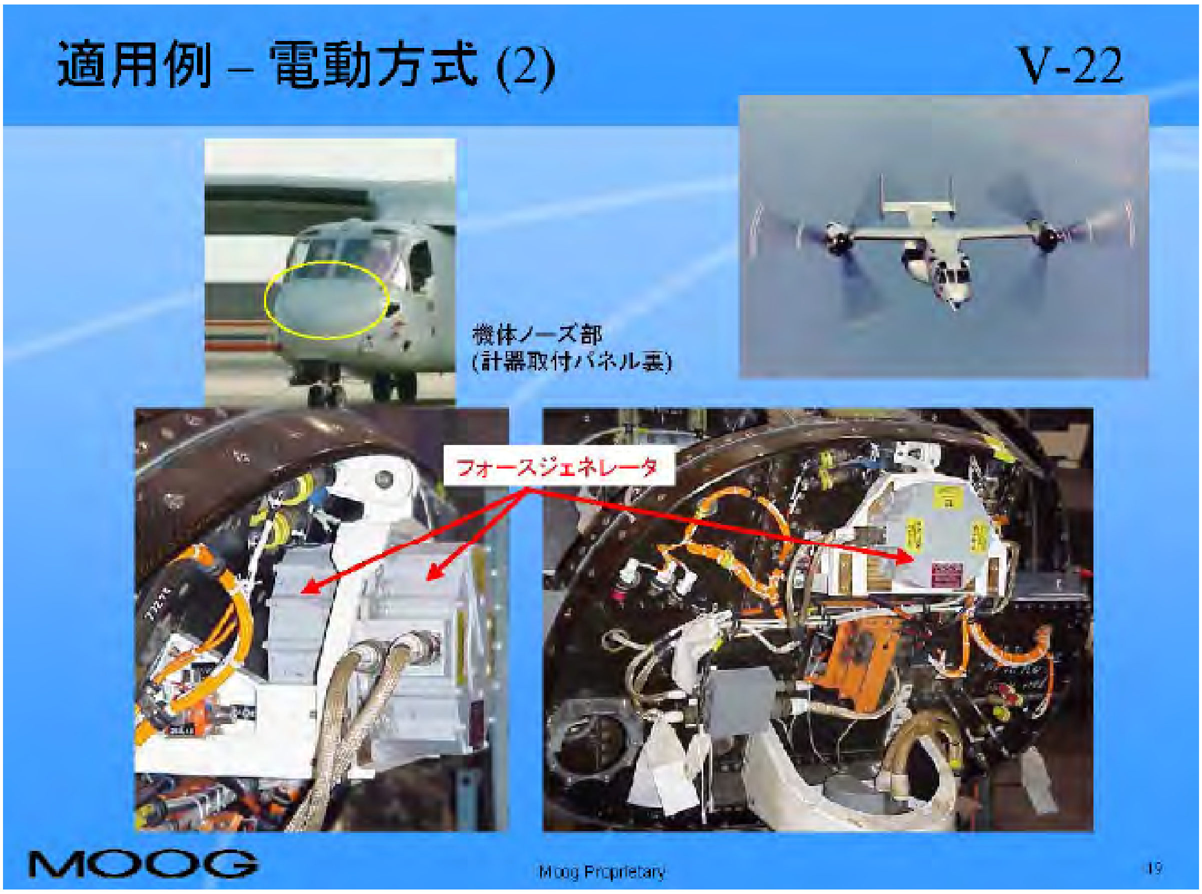
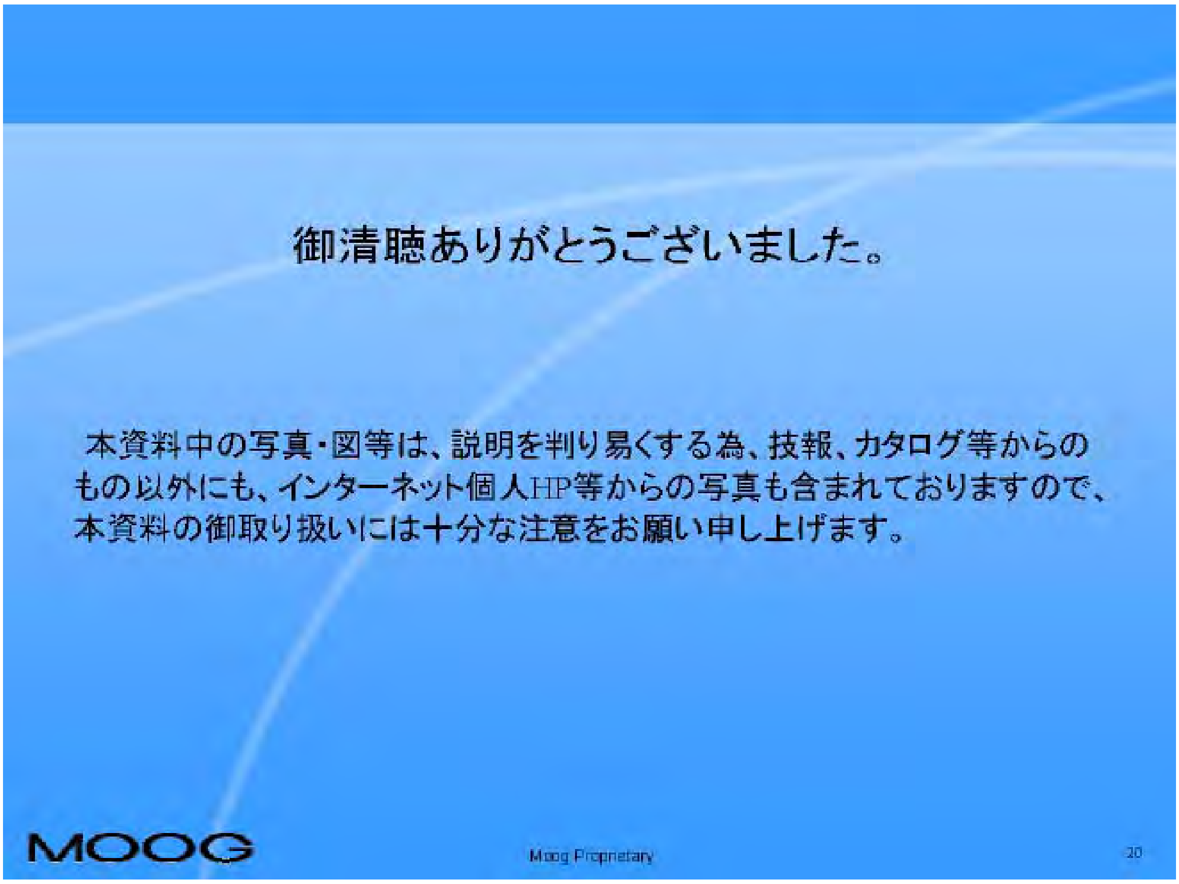
18


適用例 – 電動方式 (2)
V-22
機体ノーズ部
(計器取付パネル裏)
フォースジェネレータ
MOOG
Moog Proprietary
19


御清聴ありがとうございました。
本資料中の写真・図等は、説明を判り易くする為、技報、カタログ等からのもの以外にも、インターネット個人HP等からの写真も含まれておりますので、本資料の御取り扱いには十分な注意をお願い申し上げます。
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Blank

International Helicopter Safety Team　—　Overview Briefing（Mark Liptak）

International Helicopter Safety Team

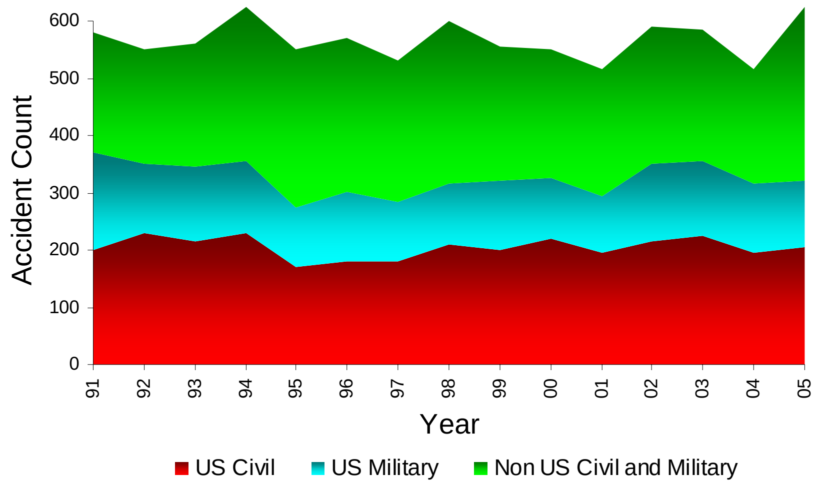
Overview Briefing

Mark Liptak
FAA ASA-100
IHST Program Director

Today's Objectives

- The case for change in helicopter safety
- IHST program status - US and worldwide efforts
- Basics of analysis and implementation processes
- Basics of analysis findings - US fleet accident data set
- Invite stakeholders in Japan to consider working with us

Worldwide Helicopter Accidents per Year



Source - Bell Helicopter

<u>We have a worldwide problem!</u>

Japan Helicopter Society briefing – April 17, 2009

3

<u>September 2005 – Montreal</u>

International Helicopter Safety Symposium (IHSS)

- 300 attendees from the worldwide helicopter community
- Unanimous position reached – unacceptable trends
- International Helicopter Safety Team (IHST) formed

Japan Helicopter Society briefing – April 17, 2009

4

IHST is a volunteer effort

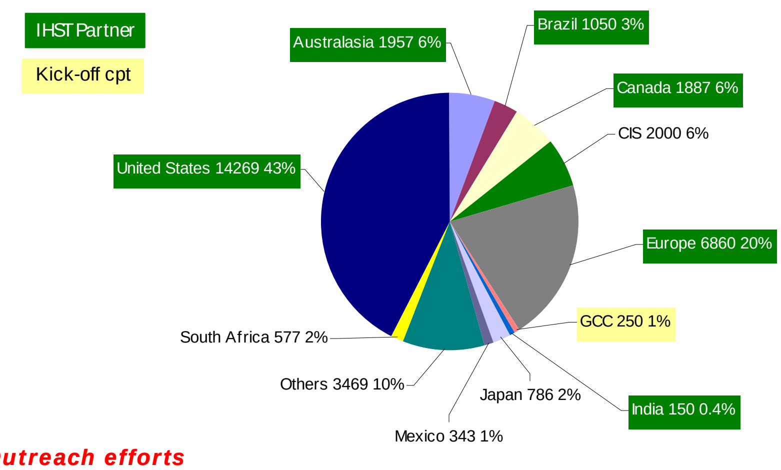
Analysis and implementation processes developed by the IHST, used by international participants

Data sets (accident reports), analysts from industry and government formed and sustained locally

IHST assists with process training and standardization, international coordination

IHST coordinates performance metrics
- ongoing data mining efforts
- seeking regional data sources (flight hours)

Worldwide Helicopter Fleet Distribution
33598 aircraft



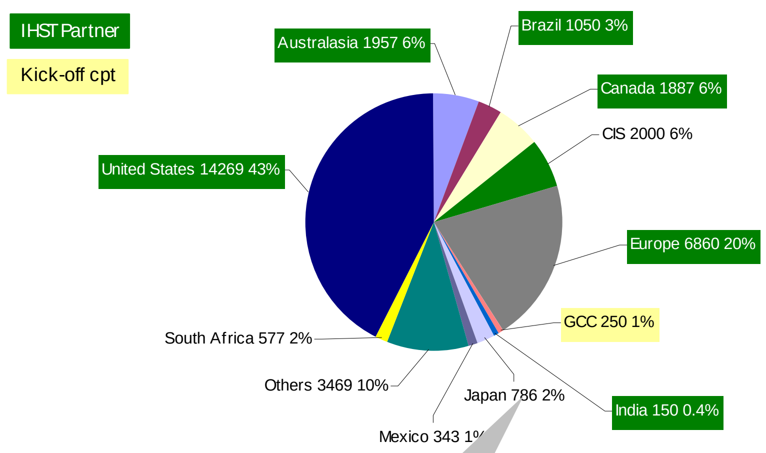
Outreach efforts continue, seeking partnerships in the Mid and Far East, CIS, Mexico and S. Africa

Global outreach key to success

updated Jan '09

Worldwide Helicopter Fleet Distribution

33598 aircraft



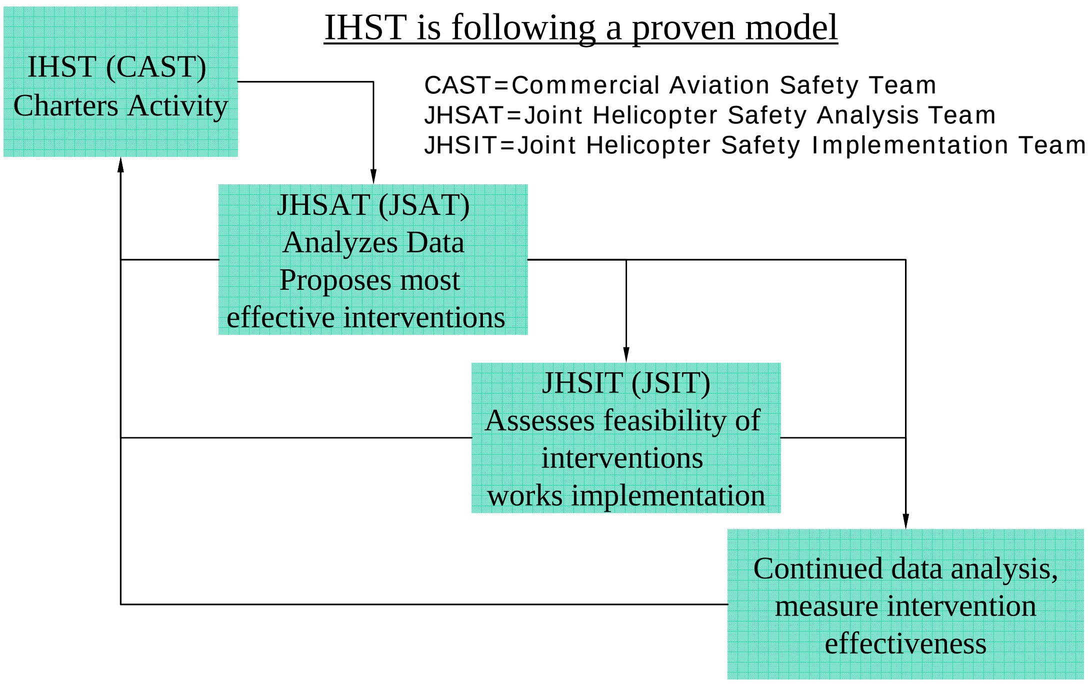
Is this correct?

Outreach efforts continue, seeking partnerships in the Mid and Far East, CIS, Mexico and S. Africa

updated Jan '09

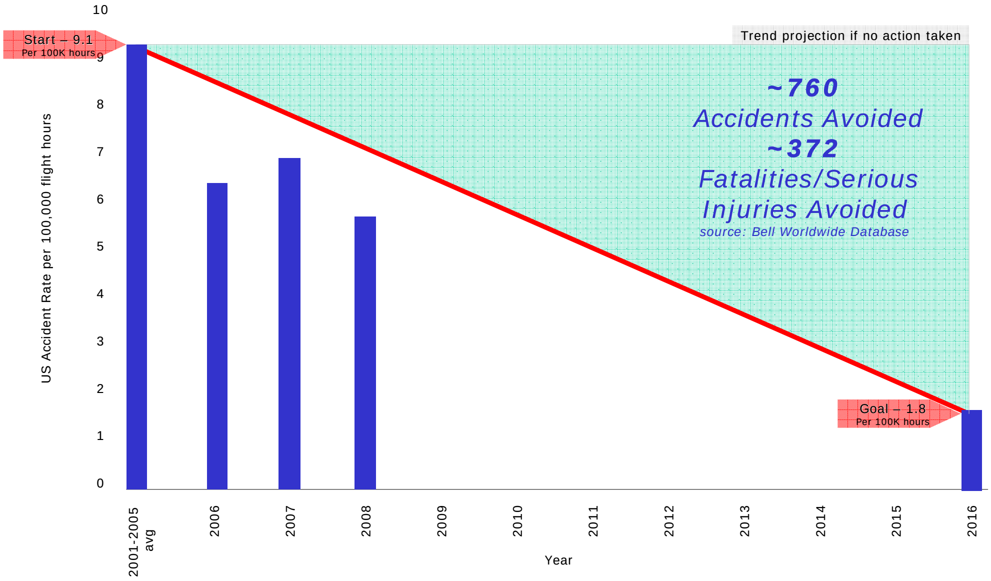
IHST is following a proven model

CAST=Commercial Aviation Safety Team
JHSAT=Joint Helicopter Safety Analysis Team
JHSIT=Joint Helicopter Safety Implementation Team



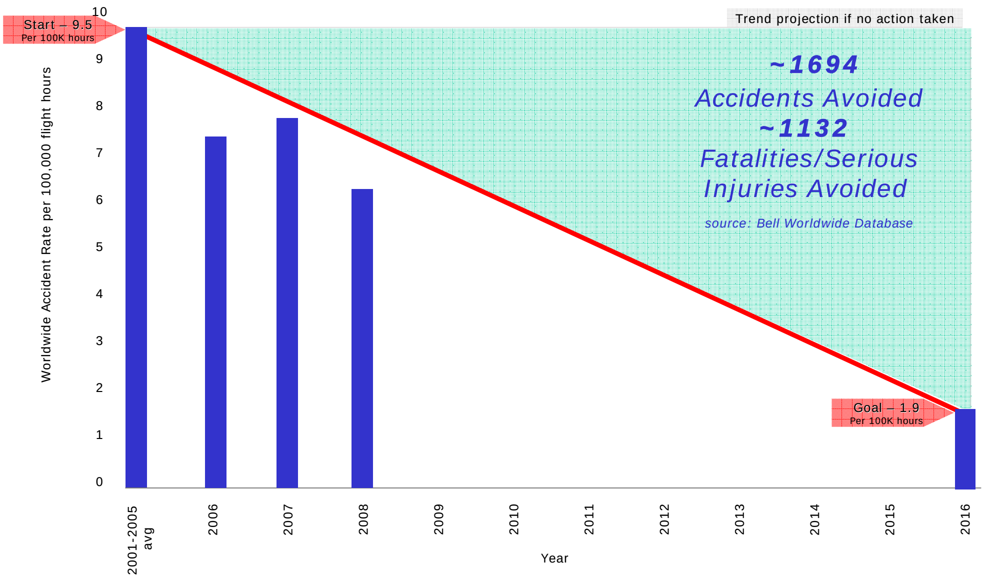
Progressing Toward the 80% Goal

US Fleet Data



Progressing Toward the 80% Goal

Worldwide Fleet Data



This is a worldwide effort

All IHST participants using a process adapted from CAST.

Key attributes:

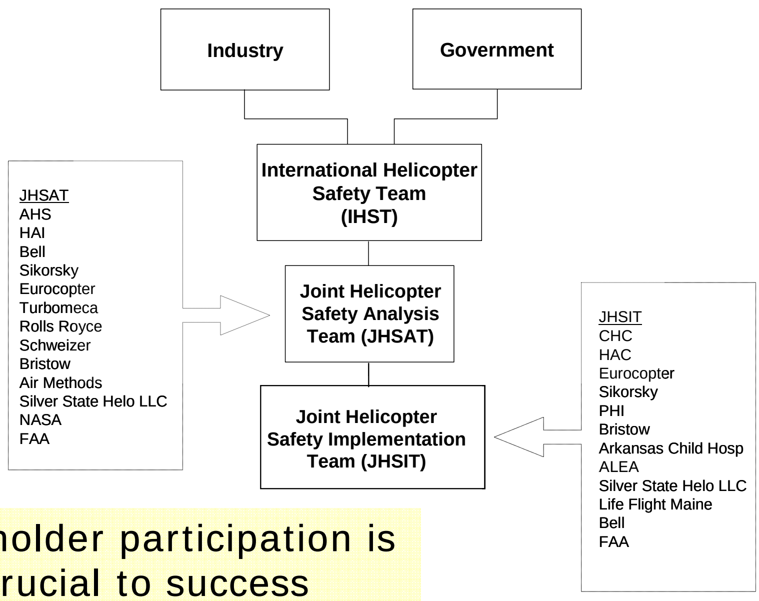
All recommendations directly rooted in accident data.

Regional ownership –

- Data is owned and analyzed by those most familiar with it.
- Safety recommendations are implemented by teams most familiar with local needs and challenges.

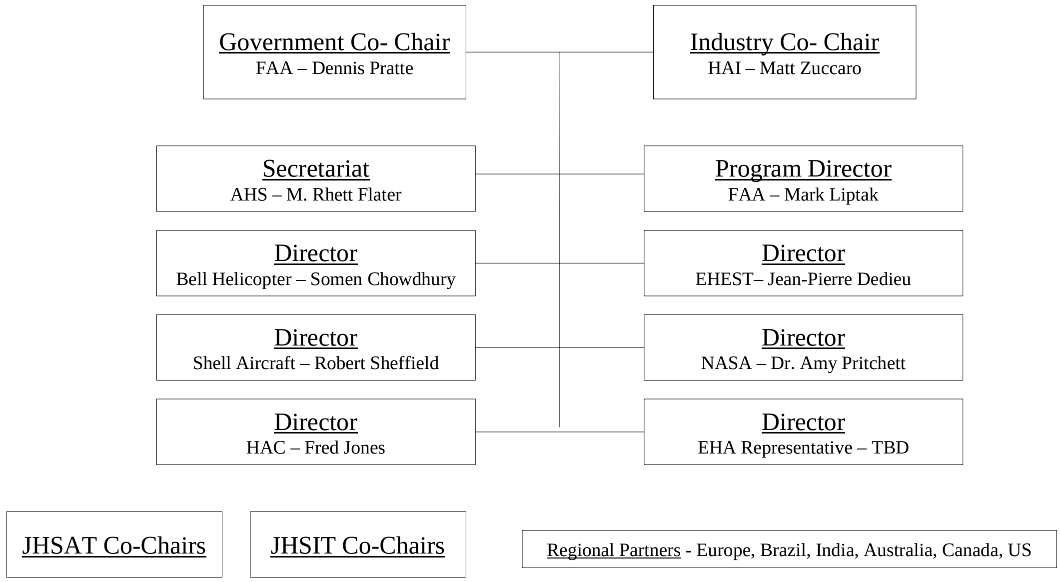
JHSAT and JHSIT lead teams responsible for training/coaching regional teams, measuring the results of the safety recommendations and implementation effectiveness.

US JHSAT and JHSIT Stakeholders



Stakeholder participation is crucial to success

IHST Organization Chart
Executive Committee



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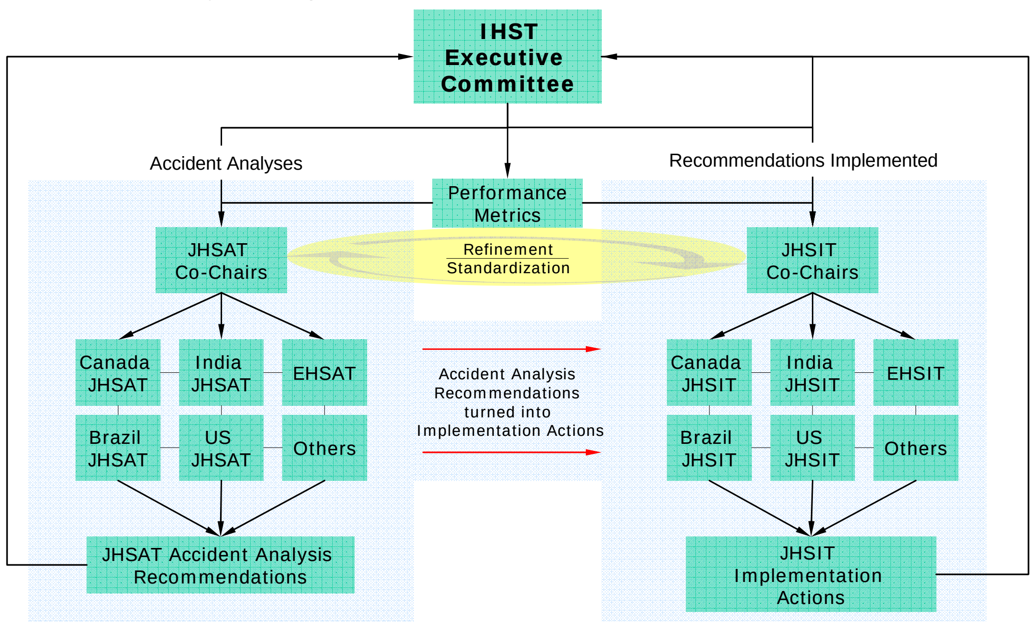
IHST Safety Initiative
Analysis, Implementation and Metrics Functional Structure



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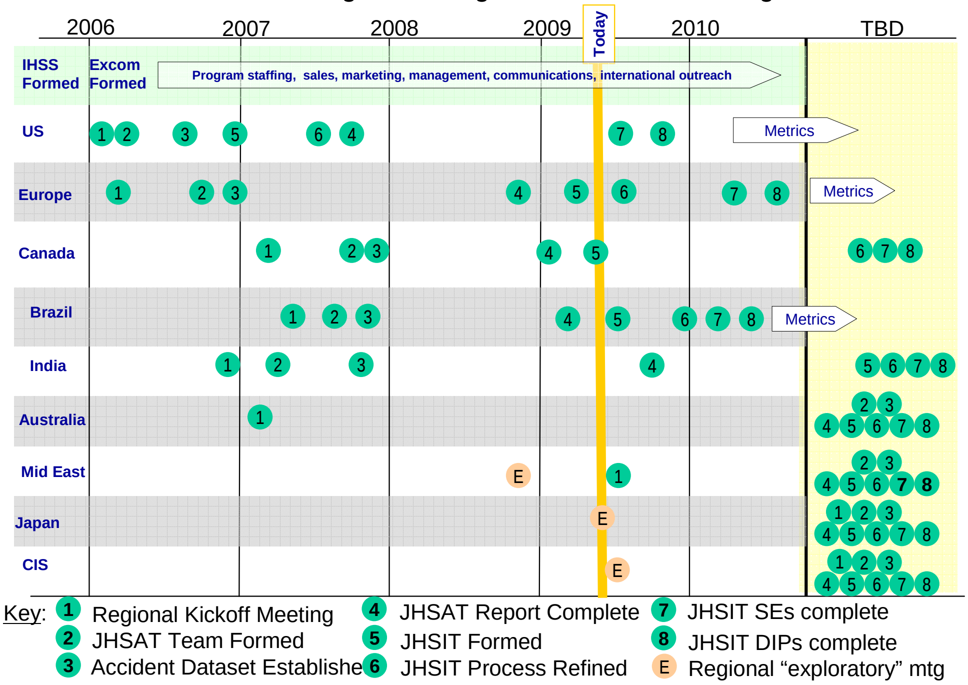
IHST Program - Regional Process Tracking



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A look at some of the IHST's work in the US

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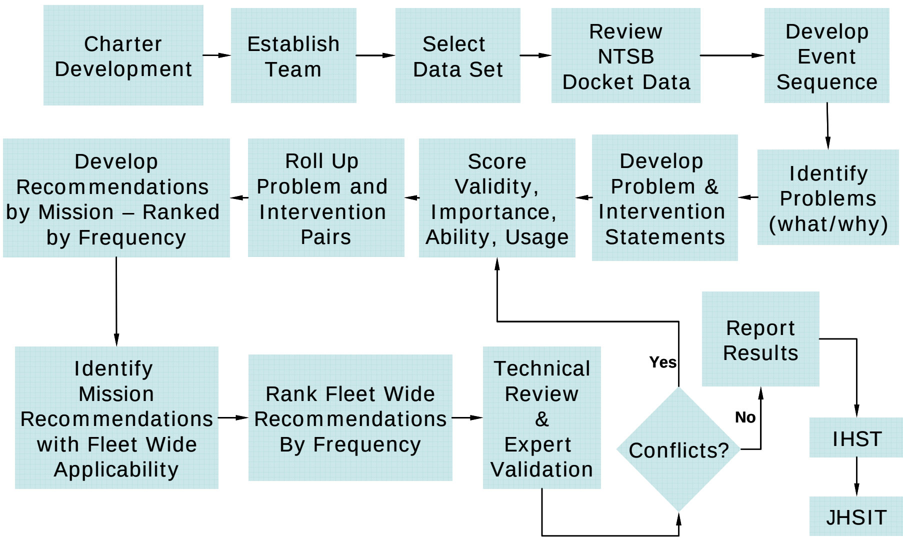
US JHSAT Process Overview



US Accident Analysis Overview:

197 accidents analyzed; covered a wide spectrum of helicopter operations – 15 basic mission types identified.

1200+ scored problem statements/intervention findings developed

US JHSAT refined the problem statement/intervention findings into:

7 foundational recommendation areas for the US fleet

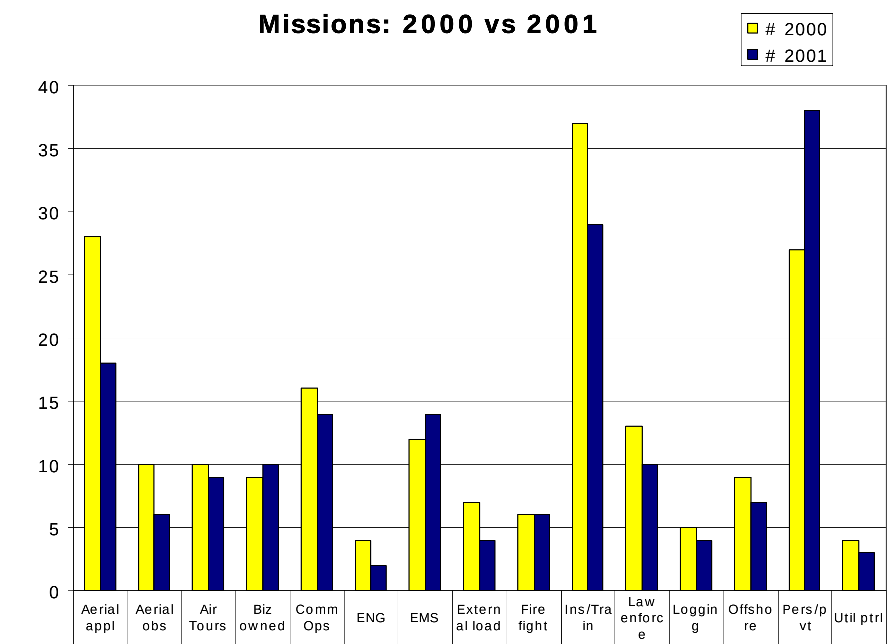
125 specific recommendations for 15 mission types

2001 analysis almost complete, 174 additional accidents

Ranked US Fleet-wide Recommendations

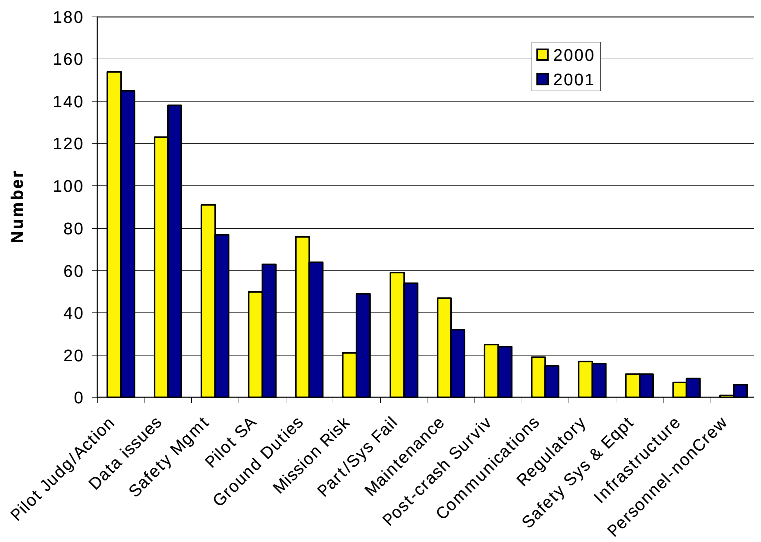
1. Safety Management
2. Training
3. Systems and Equipment
4. Information
5. Maintenance
6. Regulatory Recommendations
7. Infrastructure

Detailed problem/solution info for 15 missions also developed

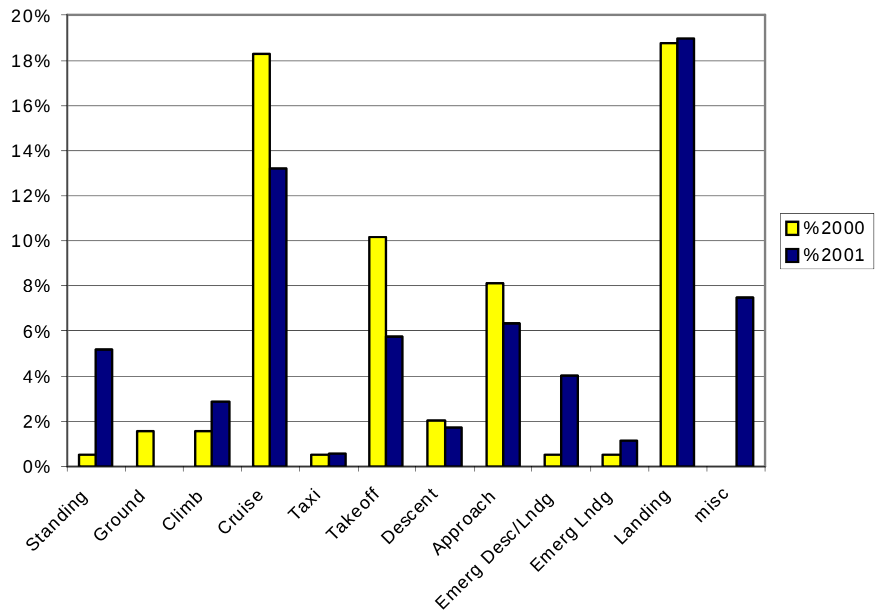


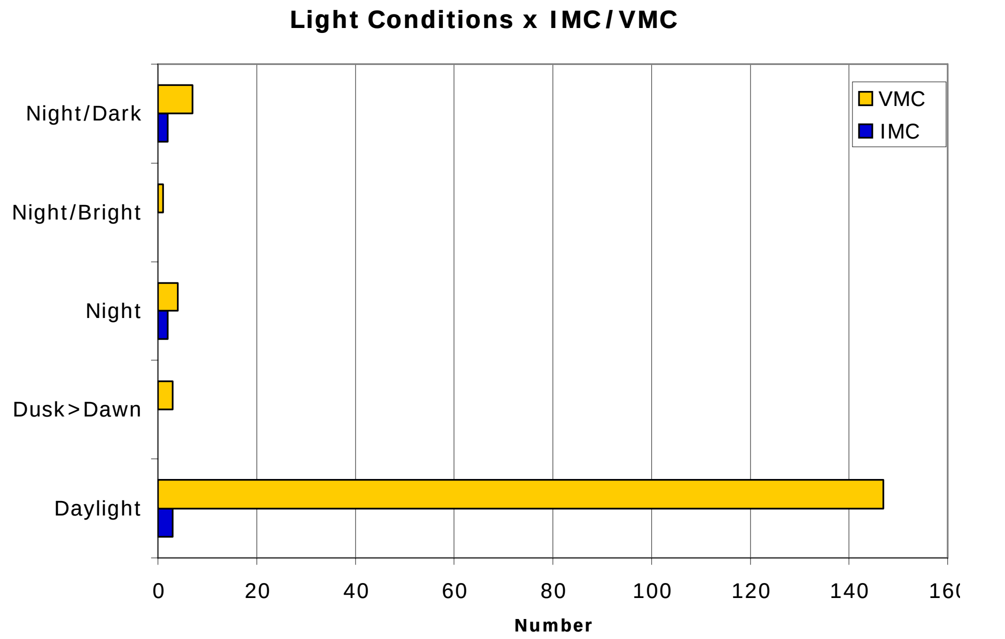
	Aerial appl	Aerial obs	Air Tours	Biz owned	Comm Ops	ENG	EMS	External load	Fire fight	Ins/Train	Law enforce	Logging	Offshore	Pers/pvt	Util ptrl
# 2000	28	10	10	9	16	4	12	7	6	37	13	5	9	27	4
# 2001	18	6	9	10	14	2	14	4	6	29	10	4	7	38	3

Accidents in which Problem Category was Cited at least Once



NTSB Phase of Flight-2000 vs 2001





2001 accident data

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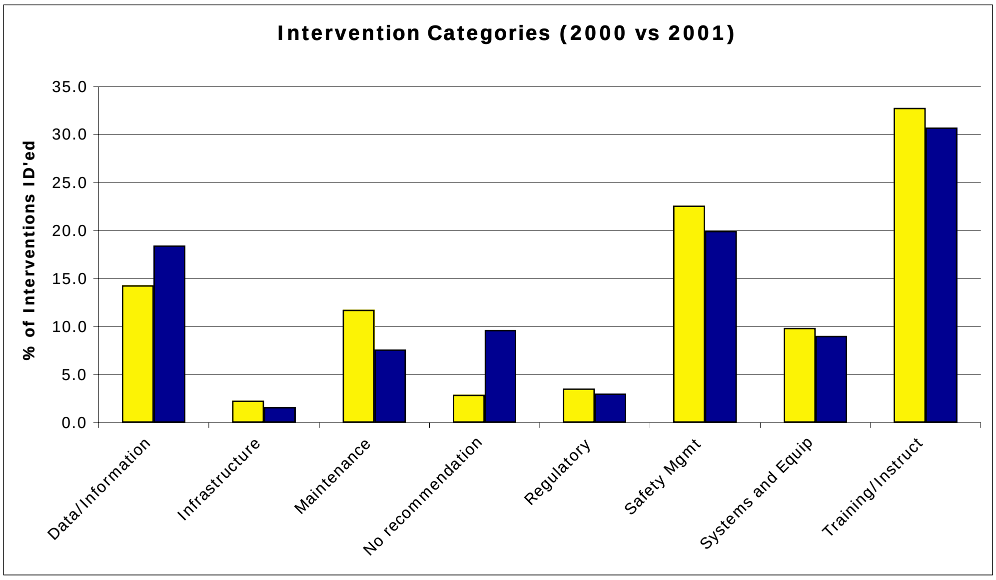

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Moving from analysis to implementation

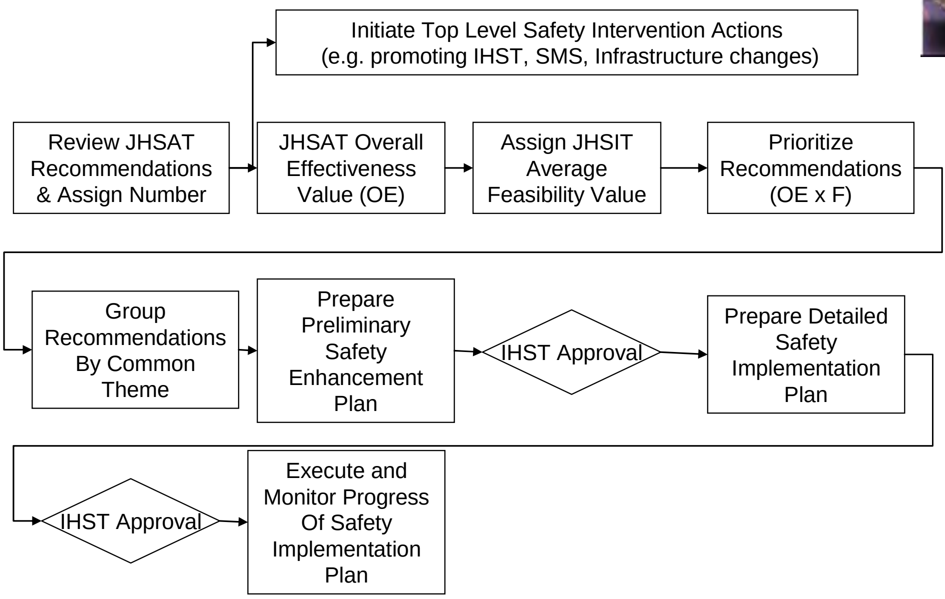
Analysis team results passed to an implementation team

Joint Helicopter Safety Analysis Team (JHSAT)
Joint Helicopter Safety Implementation Team (JHSIT)

JHSAT ⇒ JHSIT

The JHSIT is responsible for receiving the recommendations, ranking them against specific criteria and developing detailed implementation plans

U.S. JHSIT PROCESS FLOW



US Implementation Challenges

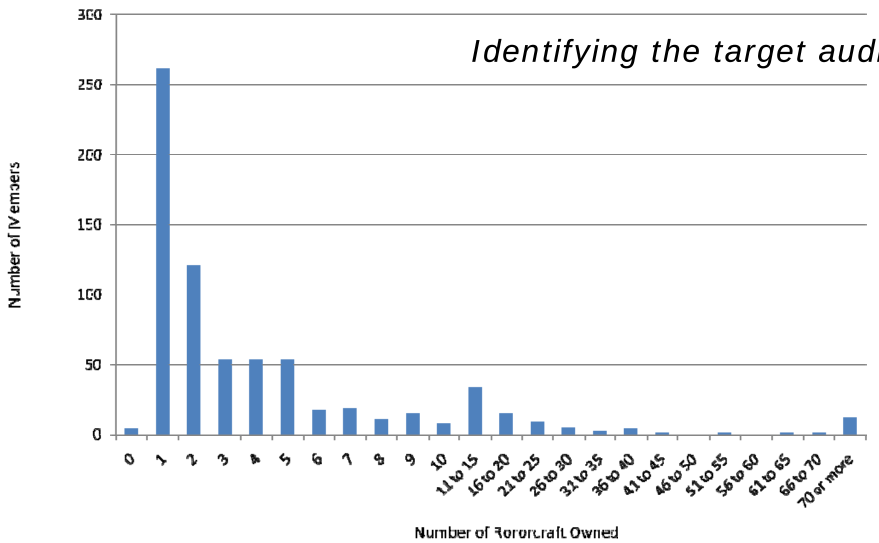
Target audience is the 1 to 5 ship operators

IHST/JHSIT not staffed to interact with 1000+ operators

Need to leverage system and infrastructure channels to influence change

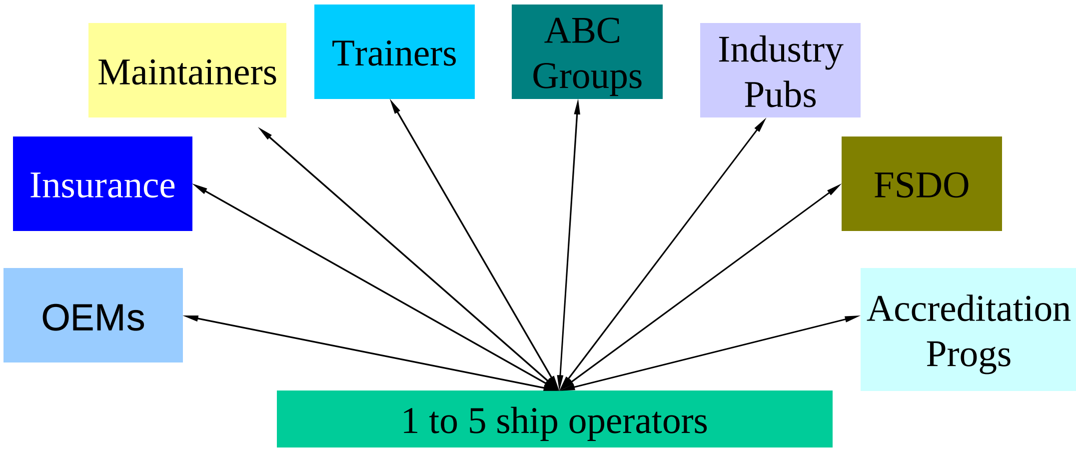
HAI Survey Data

Identifying the target audience



The IHST challenge – reaching small and medium sized operators

Pathways to Influence Change in the US



We need to find high leverage means to influence the small ops community

Conclusions:

We have a problem – Unanimity in the worldwide helicopter community; long term accident trends are unacceptable.

We know how to fix it – Using a data driven, stakeholder consensus process we've identified the drivers behind helicopter accidents. Implementation of SMS, training, information and maintenance enhancements are the top priority targets. Demonstrated benefits in OGP, EMS, ALEA and other well funded and managed operations. Effectiveness measures will be used.

We can't do it alone – Any entity with accident data willing to use the IHST analysis and implementation process is a viable candidate to join this worldwide initiative.

Request:

IHST seeks to engage helicopter industry stakeholders in Japan

- Manufacturers
- Operators
- Regulators
- Researchers

Next considerations:

- Identify responsible leaders
- Identify an accident dataset
- Learn the IHST analysis process

Program resources, timing, implementation actions come under local (Japanese) ownership, day to day work not managed by IHST

However, the basic analysis and implementation process developed by the IHST should be used to develop outputs compatible with the overall IHST effort

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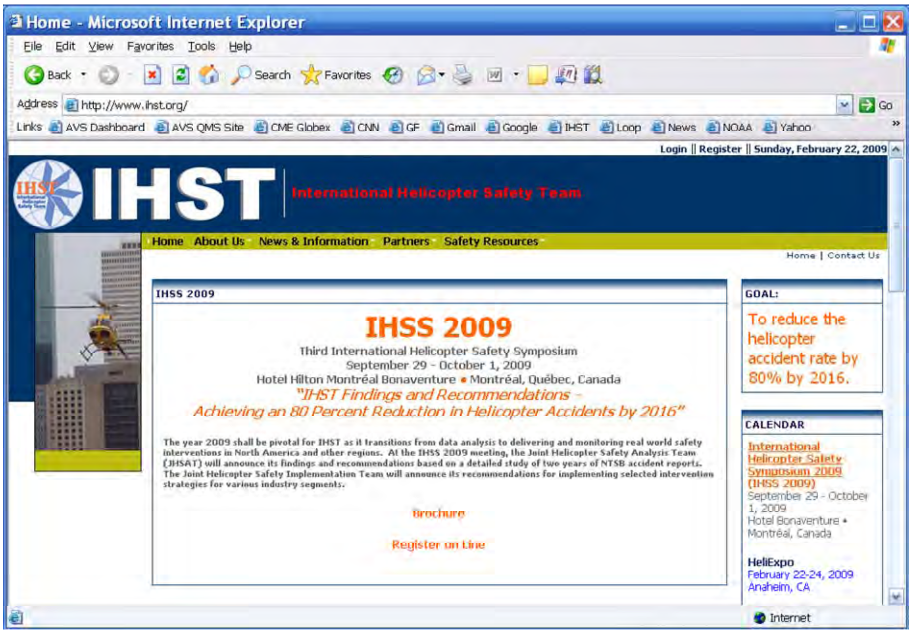

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日本ヘリコプタ協会規約(案)

施行　平成元年 12 月 15 日
改正　平成 10 年 7 月　6 日
改正　平成 12 年 6 月 22 日
改正　平成 15 年 7 月　3 日
改正　平成 18 年 4 月 28 日
改正　平成 21 年 8 月 4 日（暫定施行）

第1章　総　則

(名 称)

第 1 条　本組織は『日本ヘリコプタ協会（Japan Helicopter Society)』(以下「本協会」という）と呼称する。

(目 的)

第2条　本協会は、広くヘリコプタ及び垂直離着陸飛行の発展に寄与するため、AHSI（American Helicopter Society International）の日本支部（Japan Chapter of the AHSI）として、ヘリコプタ並びに垂直離着陸飛行に関する基礎研究、試験、開発、製造、維持、運航並びに広報等、全ての分野にわたる活動の活性化、情報収集の効率化、会員相互の親睦・共生、国際交流の実をあげることを目的とする。

(管理機構)

第 3 条　本協会の管理運営機構は理事会及び幹事会とする。

理事会は AHSI の基本目的、本規約、並びに本協会全体の運営方針に関わる事項を統括する。各担当常任理事は、担当範囲の年間事業計画を策定し執行する。各担当幹事は、担当常任理事の事業執行を補佐する。

本協会の事務局は、会長が指名する機関内におく。

第2章　会　員

(会員の資格)

第 4 条　本協会は、日本在住の AHSI の正会員、学生会員、法人会員、教育法人会員、並びに本協会の賛助会員他をもって構成する。

(会員の分類)

第 5 条　本協会の個人会員は、正会員、学生会員、賛助会員、及び名誉会員、法人会員は一般法人会員、教育法人会員、及び賛助法人会員からなる。

① 正会員は、AHSI 会員の資格を有するものおよび本協会に入会申込書を提出し理事会で承認をえたもの。

② 学生会員は、AHSI 会員の資格を有するものおよび本協会に入会申込書を提出し理事会で学生会員として認められたもの。

③ 一般及び教育法人会員は、AHSI 会員の資格を有するものおよび本協会に入会申込書を提出し理事会で夫々一般及び教育法人会員として認められた法人。

④ 賛助会員並びに賛助法人会員は、本協会の目的に賛同し本協会の活動を賛助する個人並びに法人。

⑤ 名誉会員は、所定の審査の結果、本協会の目的達成及び推進に特に顕著な功績があって、名誉会員として遇するに相応しいと認められたもの。

(加入及び脱会)

第６条　前条の各号に該当し、入会を希望するものは所定の申込書を、会長に提出し、理事会の承認を得なければならない、また、脱会を希望するものは所定の脱会届けを、会長に提出しなければならない。

(除名)

第７条　本協会は、会員が本協会の目的に反するような行為があったと認められる場合、理事会で審議のうえこれを除名することができる。

(会員の権利)

第８条　会員は、会のすべての事項に参画する権利及び均等の取扱いをうける権利を持つ。

(会員の義務)

第９条　会員は、次の義務を負う。

① 当規約及び総会、理事会で定められた事項に従うこと。

第３章　役 員

(役員)

第 10 条　本協会には、次の役員をおく。

会長	(PRESIDENT)	１名
副会長	(VICE PRESEDENT)	２名
常任理事	(MANAGEING DIRECTOR)	若干名
理事	(DIRECTOR)	若干名
監査役	(AUDITOR)	若干名
幹事長	(PROGRAM CHAIRMAN)	１名
幹事	(MANAGER)	若干名
メンバーシップ担当	(MENBERSHIP /CHAIRMAN)	１名
リエゾン担当	(LIAISON MANAGER)	若干名

尚、名誉顧問(ADVISER EMERITUS) 、顧問(ADVISER)をおくことができる。

（選任）

第 11 条　常任理事及び理事、監査役は、前期役員が候補者を推薦し、会員の選挙又は総会の承認を得てこれを決定する。

会長、副会長は、常任理事および理事の互選による。

幹事長、メンバーシップ担当並びにリエゾン担当の委嘱は会長が行う。

幹事は理事会が推薦し会長が任命する。

名誉顧問および顧問は、会長、副会長経験者から構成される。名誉顧問はまた顧問は、理事会での決定をもってこれを承認する。また、会長、副会長経験者でない場合、特別に会長の推薦があった場合にはこれを認める。

なお、任期中に役員に欠員が生じた場合の後任者の選任は、その都度、理事会の合議によって決定し、常任理事の場合には総会で承認する。

（任期）

第 12 条　役員の任期は、2 ヵ年とする。なお、副会長に関しては 2 名のうち 1 名を 1 年毎に交互に選出される。

但し、前条、後任役員の任期は前任者の残りの期間とする。

（職務）

第 13 条　役員は下記の職務を遂行する。

① 会長は、本協会を代表して、会務を統括し、会の運営に対する一切の責任を負う。

会長は総会、理事会の議長となる。

② 副会長は、会長を補佐し、会長事故あるときは、その職務を代行する。なお、2 名のうちどちらかの副会長がメンバーシップ担当を受け持つ。また、副会長は次期会長の候補となる。

常任理事、理事は、理事会を構成し、本協会の運営に関わる基本的事項を決定する。

④ 常任理事には、次の担当を設ける。

- 総務担当
- 企画担当
- 編集担当
- 広報担当
- 国際担当
- 行事担当

⑤ 各担当常任理事は別途定める担当ごとの職務を担当幹事と共に遂行し、本協会の運営につき、会長並びに理事会を補佐する。

⑥ メンバーシップ担当(副会長)は、会員の増加に関する基本施策を立案遂行すると共に、会員名簿を維持管理する。

⑦ リエゾン担当は、国内における外部関係機関との情報交換、協力関係の強化に努める。

⑧ 幹事長は、総務担当常任理事を補佐し、本協会の運営に関して、担当理事の決定した基本事項を具体化し遂行する。また、幹事会を主催し、各担当常任理事との調整を行う。

⑨ 幹事は、幹事長より指示された業務を行う。

⑩ 監査役は本協会の会計が適正に行なわれていることを監査する。

⑪ 名誉顧問および顧問は、会の運営に関して意見を具申する。

（理事会）

第 14 条　理事会は、必要に応じて、会長がこれを招集する。顧問、名誉顧問は、理事会に出席し意見を述べることができる。理事会は、全常任理事・理事の過半数を持って成立し、議決については、参加者の過半数をもって成立する。

（幹事会）

第 15 条　幹事会は、必要に応じ、幹事長がこれを招集する。

（内規）

第 16 条　本協会の運営に内規を必要とする場合は理事会の決議によりこれを定める。

第４章　総会及び行事

（総会）

第 17 条　総会は、本協会の最高決議機関であり、会員全員をもって構成し、原則として新年度に入って３ヶ月以内に会長が招集し、次の事項を協議するものである。ただし、理事会が必要を認めたとき、また会員の総数 3 分の１以上のものが、議題を明示して請求したときは、会長は臨時に総会を招集しなければならない。

① 役員の選出並びに解任

② 規約の改廃

③ 予算及び決算

④ その他役員が発案し、理事会で必要と認めた事項

⑤ 会員からの提案事項

総会は、会員の過半数の出席又は委任状がなければ成立しない。

総会の決議は出席した会員の多数決による。議長は、賛否同数の場合のみ決議に加わることができる。

（行事）

第 18 条　本協会は、理事会の承認を得て、研究会・講演会を開催するほか、本協会の目的に沿った各種の行事を行うことができる。

第５章　会 計

（会の経費）

第 19 条　本協会の経費は、賛助会費、臨時会費及び寄付金他をもってあてる。

（会費）

第 20 条　会費の徴収は、次により行う。

① 賛助会費は、年額１口 10,000 円以上の賛助会費を納入する。原則として新年度に入って３ヶ月

以内にこれを徴収する。

② 臨時会費は、理事会の決議により、必要に応じ適宜徴収する。

（会計年度）

第21条　本協会の会計年度は毎年４月１日から翌年３月３１日までの１ヵ年とする。

（会計）

第22条　本協会の会計は、総務担当常任理事／幹事が担当して行う。

会計は監査役の監査を経た上で、定期総会に会計報告を行い、承認を得るものとする。

第６章　附則

（効力）

第23条　当規約の効力は、平成元年１２月１５日から発足するものとする。

以上

表　担当常任理事における職務

担　　当	職　　務
総務担当	• 総会、理事会、定例研究会、特別講演会及び臨時委員会等の開催の事前通知ないし、これらの会議についての議事録を作成し保存する。 • 本協会の会計記録を保存し、資産の安全保管の責任を負う。 • 本規約が、明示又は暗示に規定するその他の職務、或は会長又理事会から付託された業務を遂行する。 • 表彰を取り扱う。 • その他
企画担当	• 年間の行事を立案する。 • 協会のホームページの作成を助言する。 • 各種イベントを企画（臨時組織、特別広報企画等）する。 • 各種情報発信を企画する。(アーカイブス、臨時委員会、広報活動等) • その他
編集担当	• HP を作成に協力する。 • 年 1 回会報を製作する。 • 発信情報（アーカイブス）を作成する。 • 年間の発表論文を" e-Library" 化する。 • その他
広報担当	• HP の作成し運営する。 • 対外的な関係を構築する。 • 広告を募集する。 • 寄付を募る。 • 国内における教育機関との関係を構築する。 • その他
国際担当	• AHSI 対応 • 海外対応 • その他
行事担当	• HeliJapan 国際会議 • IHST 参加 • その他

個人情報に付き【賛助会員名簿（法人賛助会員)】(１６８頁～１６９頁）は削除いたしました。

日本ヘリコプタ協会 2009年度役員

会　　長	平本　　隆	富士重工業(株) 航空宇宙カンパニー 技術開発センター 航空機設計部　主管 (ヘリコプター技術統括)
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副 会 長 （兼）AHS本部技術委員 （兼）HeliJapan2010委員会	齊藤　　茂	宇宙航空研究開発機構 航空プログラムグループ 運航・安全技術チーム　ヘリコプタ技術セクションリーダ
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理事	望月　清光	朝日航洋㈱　安全推進室長
理事	富塚　昌孝	タクトワン（株）　代表取締役
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幹事	田上　啓介	防衛省 海上自衛隊　第５１航空隊 訓練指導隊　課程教育班長
幹事	岡本　拓也	富士重工㈱　航空宇宙カンパニー　航空機設計部 ヘリコプター設計課　担当
幹事	奥野　善則	宇宙航空研究開発機構　航空プログラムグループ 運航・安全技術チーム　ヘリコプタ技術セクションリーダ
幹事	砂田　　茂	大阪府立大学　工学部　宇宙航空工学科　准教授

リエゾン担当

全日本航空事業連合会 ヘリコプタ部会	望月　清光	朝日航洋㈱　安全推進室長
日本航空医療学会	西川　　渉	日本航空医療学会理事 NPO法人救急ヘリ病院ネットワーク（HEM-Net）理事
日本航空宇宙学会	青山　剛史	宇宙航空研究開発機構　研究開発部 数値解析グループ　非定常流・振動セクションリーダ
経産省（SJAC） (ﾍﾘｺﾌﾟﾀ活用懇談会)	上村　　誠	㈱ナスカ　取締役
国交省（IHST）	町田　　茂	宇宙航空研究開発機構　航空プログラムグループ 運航・安全技術チーム　構造　セクションリーダ
国交省（IFR研究会）	奥野　善則	宇宙航空研究開発機構　航空プログラムグループ 運航・安全技術チーム　防災・運航管理技術セクションリーダ
厚生労働省 （ドクターヘリ）	長尾　　牧	朝日航洋㈱　運航統括部　統括部長
文科省 （航空科学委員会）	齊藤　　茂	宇宙航空研究開発機構　航空プログラムグループ 運航・安全技術チーム　ヘリコプタ技術セクションリーダ
防衛省 （防衛技術協会）	長島　知有	防衛大学校　名誉教授
総務省（消防庁） （防災ヘリ）		
日本操縦士協会		
ヘリポート研究会		
日本女性航空協会		
日本航空協会		

顧問

名誉顧問	東　　　昭	東京大学 名誉教授
名誉顧問	義若　　基	初代会長：AHS日本支部
顧問(総務担当)	牧野　　健	第2代会長：AHS日本支部
顧問(企画担当)	佐藤　　晃	第3代会長：中菱エンジニアリング㈱　（特別）顧問
顧問(編集担当)	長島　知有	第4代会長：防衛大学校　名誉教授
顧問(広報担当)	西川　　渉	第5代会長：日本航空医療学会理事 NPO法人救急ヘリ病院ネットワーク（HEM-Net）理事
顧問(広報担当)	上村　　誠	第6代会長：㈱ナスカ　取締役
顧問(広報担当)	山野　　豊	ユーロコプター　理事、アドバイザー 航空医療学会　理事、評議員 NPO法人救急ヘリ病院ネットワーク（HEM-Net）理事
顧問(国際担当)	古澤　正人	セントラルヘリコプターサービス㈱　常務取締役
顧問	高木　淳二	第7代会長：宇都宮大学工学部附属ものづくり創成工学センター講師
顧問	小林　　孝	第8代会長：三菱重工業㈱　名古屋誘導システム製作所　所長
顧問(国際担当)	河内　啓二	第9代会長：東京大学　工学系研究科　航空宇宙工学専攻　教授
顧問	大林　秀彦	AHS日本支部

日本ヘリコプタ技術協会　略年表

年度	会報	会長 (所属先,当時)	総会／講演会	定例研究会、( )内は通算回数		特別講演会等	AHS年次総会
1989	-	義若　基 (川崎重工)	設立総会 12.15 航空会館	3.16 第6回ヘリコプタ研究会，東大先端研		3.13 川崎重工岐阜 - Prouty氏	義若氏：AHS Fellow Award
1990	-		ー	7.18 三菱重工(1)	2.16 第2回国際航空宇宙シンポジウム ヘリコプタセッション，幕張メッセ	10.5 帝国ホテル - Buckley氏(Sikorsky社長/ AHS会長)	
1991	1		5.29 川崎重工岐阜	7.19 富士重工(2)	2.7 防大(3)	10.24-25 東大山上会館 - Schrage教授(Georgia Tech)	
1992	2	牧野　健 (富士重工→輸送機工業)	6.23 川崎重工	9.18 三菱重工(4)	2.5 山上会館(5)	12.4, 航空宇宙技術研究所 - Carlson氏(米陸軍ATCOM)	
1993	3		6.18 富士重工	9.10 川崎重工(6)	2.15 山上会館(7)	7.6 健保会館 – フランスヘリ技術 11.18 防大- Ham教授(MIT)	
1994	4	佐藤　晃 (三菱重工)	6.3 富士重工	7.22 陸自霞ヶ浦(8)	2.24 航技研(9)	11.8, 三菱重工横浜- Gessow教授(Maryland大) 11.11 交通・物流から見た将来ヘリ技術 総評会館	Japanese Session開催
1995	5		6.19 三菱重工	9.29 川崎重工(10)	2.23 防衛庁３研(11)	11.2, 三井物産 – Gaffey氏(Bell副社長)	
1996	6	長島　知有 (防衛大学校)	5.17 三菱重工	10.4 富士重工(12)	2.14 川崎重工(13)	1.20 三菱重工本社 - Crawford氏(Georgia Tech)	
1997	7		6.6 住友重機追浜	10.24 三菱電機(14)	1.23 陸自木更津(15)		
1998	8	西川　渉 (地域航空総合研究所)	7.6 ソニー	10.2 富士重工(16)	2.19 東京ヘリポート(17)	4.21-23 Heli Japan 98 岐阜長良川国際会議場 12.22, 日大- Wang氏(Sikrosky)	OH-X設計チーム ：Howard Hughes Award
1999	9		6.16 パイオニア	10.26 陸自明野(18)	3.23 TA2000(19) 東京ビッグサイト	4.16 日大 - Rozhdestvensky氏(Mil)	東名誉教授：AHS Fellow Award 義若氏：Honorary Fellowships S-92開発チーム：Robert Pinckney Award
2000	10	上村　誠 (川崎重工→日本航空宇宙工業会)	6.22 川崎重工	11.28 陸自立川(20)	2.23 八尾空港(21)	1.23 川崎重工本社 - Schmitz教授(Maryland大)	牧野氏：AHS Fellow Award S-92開発チーム：Agusta International Fellowship Award
2001	11		7.4 航技研	11.29 ヤマハ(22)	2.28 東京ヘリポート(23)	1.28 三菱重工本社 - Johnston氏(米陸軍)	大林氏：AHS Fellow Award
2002	12	高木　淳二 (富士重工→宇都宮大学)	ヘリ事始め50年記念 6.28 航空会館	3.13 宇都宮大学(24)		11.11-13 Heli Japan 2002 栃木県総合文化センター	定岡氏：International Chairman's Award
2003	13		7.3 富士重工	10.31 電子航法研究所(25)	3.19 海上保安学校宮城分校(26)		佐藤氏：Honorary Fellowships
2004	14	小林　孝 (三菱重工)	7.1 三菱重工本社	12.17 防衛庁３研(27)	2.25 ヘリ防災シンポ(28) 名古屋国際会議場	10.7 JA2004ヘリセミナー パシフィコ横浜	長島名誉教授：Honorary Fellowships
2005	15	井口　敦雄 (三菱重工)	7.19 グランドヒル市ヶ谷	12.16 三菱重工小牧(29)		8.31 三菱重工本社 - Friedmann教授(Michigan大)	
2006	16	河内　啓二 （東京大学）	4.28 三菱重工横浜ビル	10.3 JAXA (30)	3.15 山上会館 (31)	11.15-17 Heli Japan 2006 名古屋国際会議場 11.13 JAXA 航空宇宙技術研究センター Philippe氏（元ONERA） 2.7 東大 本郷キャンパス工学部 Xia氏(南京航空航天大)	
2007	17		7.17 東京大学 先端科学技術研究センター	11.20 防衛大学校（32）			

年度	会報	会長 (所属先,当時)	総会／講演会	定例研究会、( )内は通算回数	特別講演会等	AHS年次総会
2008	18	平本　隆 （富士重工）	7.1 東京大学　山上会館		7.23　JAXA　航空宇宙技術研究センター Dr. Hongyi Xu（ｶﾅﾀﾞ航空宇宙研究所） 10.3　航空会館 Dr. James M.Wang（ｱｸﾞｽﾀ・ｳｪｽﾄﾗﾝﾄﾞ）	

AHSインターナショナル本部への入会申込用紙 （JAPAN CHAPTER）

この用紙に書き込んでFAXで送付すれば入会できます。また、AHSインターナショナルのホームページ（http://www.vtol.org/）からオンラインでの申込みもできます。
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日本ヘリコプタ協会　賛助会員　申込書

年　　月　　日

区　　分 （該当する方に○）	法　人　・　個　人 新　規　・　継　続
団体（会社）名	
（代表者）氏名 役職	
（代表者）連絡先 住　所 電　話 ＦＡＸ	〒
入会口数	口（　　　万円／注：１口＝１万円）
備　　　考 （連絡事項等）	

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