

# MAV 08

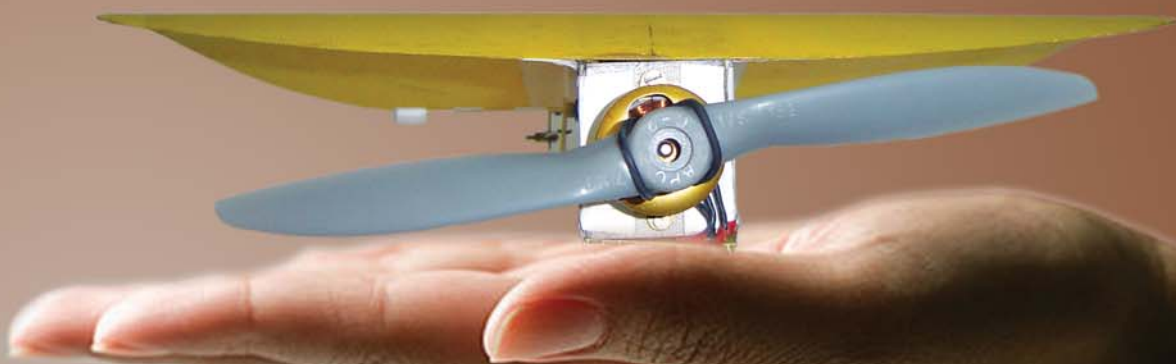
10-15 March 2008  
Agra, India

Organised By  
National Aerospace Laboratories  
Aerial Delivery Research & Development Establishment  
US Army RDECOM(International Technology Center - Pacific)



1<sup>st</sup> US-Asian Demonstration and Assessment of  
Micro Aerial Vehicle (MAV) and  
Unmanned Ground Vehicle (UGV) Technology

Schedule of Events,  
Abstracts and Profiles



## Sponsors

US Department of Defense

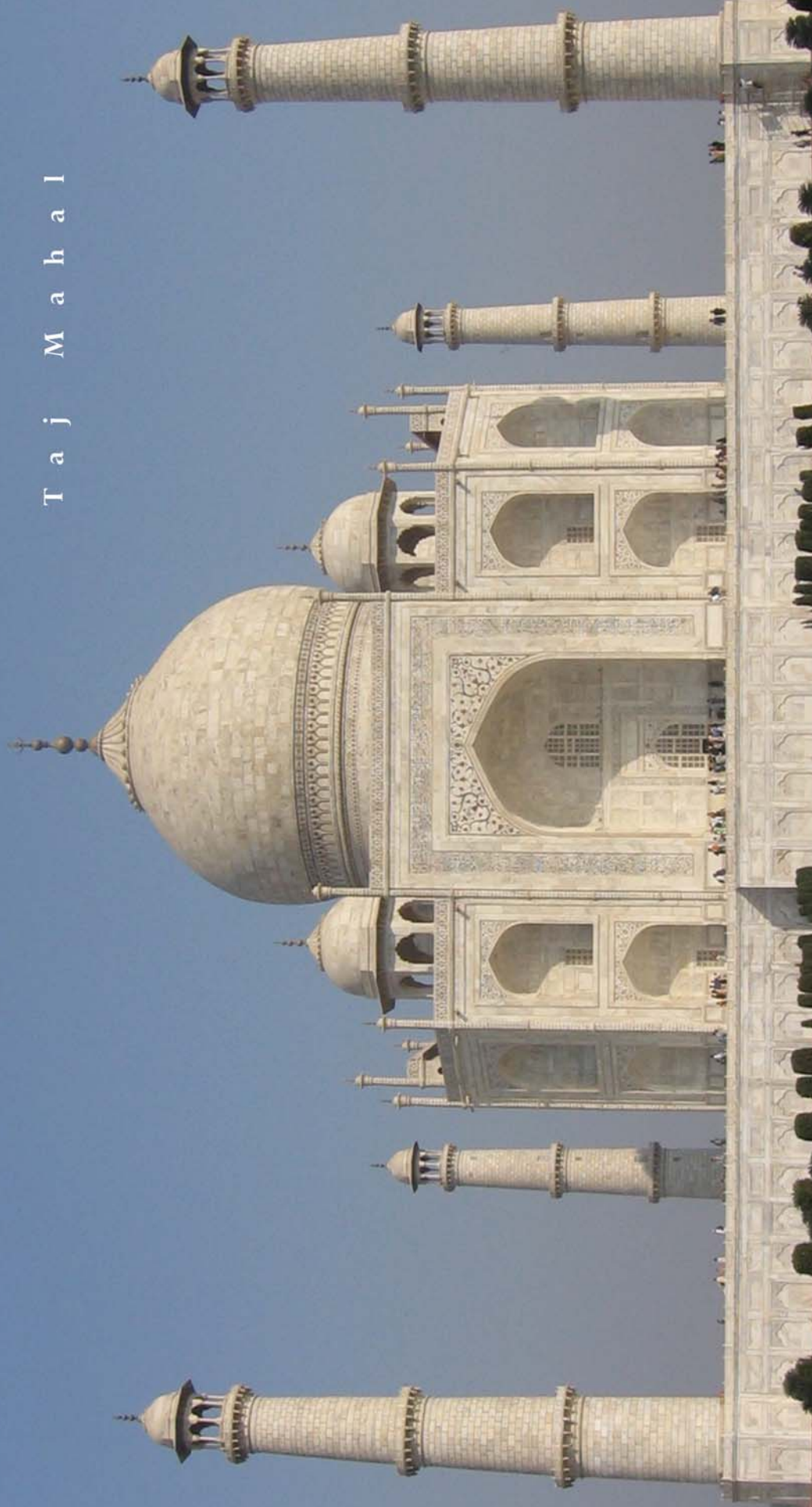
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# T a j M a h a l



# **1<sup>st</sup> US-Asian Demonstration and Assessment of Micro-Aerial Vehicle (MAV) and Unmanned Ground Vehicle (UGV) Technology**

**10-15 March 2008**

**Agra, India**

## **Schedule of Events, Abstracts and Profiles**

*Organised by*

**National Aerospace Laboratories**

**Aerial Delivery Research & Development Establishment**

**US Army RDECOM (International Technology Center - Pacific)**

*Sponsors*

**US Department of Defense**

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**Defence Research and Development Organisation**

**Council of Scientific and Industrial Research**

**Indo-US S&T Forum**







# Contents

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Introduction to the Event	1	Profile of Inaugural Function Speakers	16
MAV 08 Mission Scenario	3	Profile of Seminar Speakers and Abstracts	25
Schedule of Events	5	Profile of Judging Panel Members	41
Schedule of Inaugural Ceremony	6	Profile of Team Members	46
Schedule of Seminar Presentations	7	Profile of International Organising Committee Members	68
Schedule of Concluding Session	8	Profile of Panel Discussion Members	78
Profile of Sponsors	9	About Agra and Spouse Tour	82
Profile of Organisers and Supporting Organisations	10		
National Advisory Committee	15		





# Introduction to the Event

## 1<sup>st</sup> US-Asian Demonstration and Assessment of Micro Aerial Vehicle (MAV) and Unmanned Ground Vehicle (UGV) Technology



### OBJECTIVE

The purpose of the 1<sup>st</sup> US-Asian Demonstration and Assessment of Micro Aerial Vehicle (MAV) and Unmanned Ground Vehicle (UGV) Technology is

- to showcase next-generation, COTS enabled prototype systems of Micro Air Vehicles(MAV) and Unmanned Ground Vehicles(UGV) that are almost ready for end-use, thus hasten their induction into the Forces.
- identify areas for further development of critical technologies.
- evolve ideas and strategies for countermeasures.
- give a fillip to developmental efforts in India by presenting the state-of-the- art in technologies and indicating the future trends in research and development in the area.

The subject is highly relevant as the Defence Services need systems appropriate to Military Operations in Urban Terrain (MOUT), Light-Combat Survivability and Force Protection (FP). Presently such support is being given by a larger class of UAVs, but MAVs definitely enjoy greater advantage. The Systems are also important for civilian applications such as disaster management, urban traffic monitoring, search and rescue operations etc.

It is expected that the event will benefit the MAV community in India and spur speedy developments in this strategically important area.

### BACKGROUND

The motivation for the organization of this event in India came from the Indo-US Workshop on Micro Air Vehicles held at the National Aerospace Laboratories, Bangalore in the year 2005, supported by the Indo-US Science and Technology Forum and the Aeronautical Research and Development Board, DRDO. This workshop was organized jointly by Prof I Chopra of the University

of Maryland, USA and the National Aerospace Laboratories. A number of specialists from USA, Australia and India made presentations in the workshop. The participants included Dr Sam Sampath, Engineering Director, US Army International Technology Center - South East Asia Office, Singapore, who, spurred by the activities in the area in India and the enthusiasm among the Indian scientists, mooted the idea of holding the third event in India.

Previous editions of the event were held in Germany in the years 2003 and 2005. They mainly concentrated on proving platform technology, but mission capability and adaptability is now the major goal. It was the consensus after these events that academia and research communities and small companies can be energized to produce innovative and cheap solutions, and that such low cost units are not attractive for major defence contractors to engage.

### SCOPE

The event is open to all persons and institutions in all countries, with teaming arrangements being rewarded to encourage collaboration to bring out the best. The longest dimension of the MAV is restricted to be less than 300mm.

The program for the event consists of an assessment of design details of the entries followed by the judging of the aerial demonstrations. A seminar will be held in parallel to the demonstrations where experts in various aspects of MAV and UGV will make seminar type presentations.

The rules governing the demonstrations have been tuned to elicit the following capabilities:

Cooperatively and autonomously flying group of MAV; Cooperation between group of MAV and UGV; Collision and obstacle avoidance and de-confliction; Extrication from confined spaces using vision-based navigation; On board storage and processing of information;







# Introduction to the Event (Contd)

Mapping and photographing interiors of buildings; Acoustic sensing; Ability to perch and stare, Chemical sensing etc.

Assessment of the merits of each entry in the demonstration will be performed by a panel of judges comprised of persons with outstanding international reputations. Prototype systems should be able to perform a prescribed mission wherein the systems (MAVs and UGVs) are to assist a group of commandos to rescue hostages being held by an insurgent group in a bank building. There are booby traps (mines and explosives) laid out around the building and armed insurgents are circling the building in a vehicle. The MAVs and UGVs, working together, are to assist in decommissioning the mines, identify the location of explosives and the hostages and identify a path for ingress by commandos.

## ORGANISATION

The National Aerospace Laboratories, Bangalore, India, a constituent of the Council of Scientific and Industrial Research (CSIR) under the Ministry of Science and Technology, Government of India and the Aerial Delivery Research and Development Establishment, Agra, a constituent of the Defense Research and Development Organization (DRDO), Ministry of Defence, Government of India have partnered with the U.S. Army Research, Development and Engineering Command (RDECOM)'s International Technology Center – Pacific in a collaborative effort to host the event.

The event is mainly sponsored by the U. S. Department of Defense, in particular the R&D wings of US Army (RDECOM), US Navy (ONR-G), US Air Force (AOARD) and the Defence Advanced Research Projects Agency (DARPA).

The event has been extended full support by the Indian agencies DRDO, CSIR and the Indo-US Science and Technology Forum (IUSSTF).

An International Organising Committee (IOC) has planned and

coordinated the overall organizational efforts in association with NAL, Bangalore and ADRDE, Agra. The local organizational effort at Agra is being led and coordinated by ADRDE, Agra with full assistance from and active participation of the Air Force Station and the Para Brigade at Agra.

## DATES AND VENUE

The event is being organised in Agra during 10-15 March 2008. The main venue of the meeting is the Jaypee Palace Hotel, Agra. The mission compliance demonstrations will take place at the Drop zone in Agra, which is an Indian Air Force facility.

The details of the event are posted on website <http://www.nal.res.in/MAV08>

## PARTICIPATION AND PROGRAMME

Thirty entrants (about 50% from abroad) announced their intent to compete and a sub-committee of the IOC screened their declared capabilities to evaluate their ability to perform the announced mission. Fifteen among them were selected according to their merit to take part in the competition. Of these twelve have finally confirmed their participation.

The event's main programmes include static judging of the entries on 10<sup>th</sup> and 11<sup>th</sup> of March 2008 and flight demonstrations and evaluation during 12<sup>th</sup> to 14<sup>th</sup> March 2008. The programme will be formally inaugurated on the forenoon of 11<sup>th</sup> March 2008. The three-day specialist's seminar will be held concurrently with the flight demonstrations. On 15<sup>th</sup> March 2008 – the final day of the event - each of the demonstrators will explain their approach to their respective design and asked to provide a retrospective view. This will be followed by a panel discussion by representatives of the potential user community (both from India and abroad) to provide their impressions and feedback to the organizers and contestants. Recognition of the meritorious will bring down the curtain on the event.





# MAV 08 Mission Scenario



The mission scenario of first US - Asian Demonstration and Assessment of Micro Aerial Vehicle (MAV) and Unmanned Ground Vehicle (UGV) Technologies is a mixture of operational and developmental flight test maneuvers and mission tasks that are combined to create a unique and challenging demonstration environment for the prototype MAV systems. The objective of the competition is to demonstrate how combinations of MAV and UGV systems controlled by a team of human operators can effectively conduct a simulated hostage rescue mission.

The concept of the operation is for MAV systems to perform reconnaissance tasks to identify and locate obstacles, mines, hostage location and terrorist guard teams. Additional tasks include stationary hovering, landing on rooftops to perform perch and stare operations, and use of chemical sensors to detect simulated chemical explosive mines. The MAVs develop the rescue teams' situational awareness through a combination of autonomous geo-location and manual imagery analysis. MAVs use digital communication links to direct UGVs to clear an ingress route of mines used by a human commando team to conduct the hostage rescue. UGV tasks include precision navigation, simulated mine disarm, radio relay, and video transmission. The entire operation from first launch to hostage rescue must be completed in 40 minutes or less.

Teams will launch their MAV systems from a launch point approximately one kilometer from the hostage site adjacent to the controlling ground station. The MAVs will fly using a combination of manual and autonomous control along potential ingress routes searching for mines. When mines are detected, the location will be passed to a UGV which moves forward and disarms the mine. This task is repeated until the entire route is cleared. Once in the vicinity of the hostage building, the MAVs will evade detection by patrolling terrorist guards and use a combination of electro-optic and acoustic sensing to determine in which room the hostages are located. During the same time period, the commando team will move along the cleared route

into a covered strike position and wait for the team to decide which room contains the hostages. Once the decision on location has been made, the commando team will conduct the rescue.

Mission success requires a combination of technical capability and tactical skill which will push the limits of both the robotic systems and the human operators. The sensing capabilities of MAVs are limited which makes detection of 15cm mines difficult. The one kilometer distance between the ground station and the hostage building challenges the endurance of vertical takeoff and landing MAVs. The use of perch and stare to conserve power offers an effective tradeoff to offset the range/endurance limitations, but the flight and position control required to perch safely is highly demanding and the limited time available to identify the proper position makes this a difficult task. The chemical sensing method of mine detection pushes the limits of MAV performance, onboard processing capability and power budgets. Lastly, the use of multiple MAVs to complete various aspects of the challenge, creates the need for MAV deconfliction schemes based on flight profile and phase of the mission.

The MAV 08 event will clearly identify the cutting edge of MAV research in an operational/developmental test environment. The rewards for successful demonstration are funding to advance solutions with promise to the next level in the developmental cycle. The diversity of tasks and complexity of the challenge require that teams attempt higher risk solutions which offers the prospect of a breakthrough rather than incremental change. The organizers and sponsors wish teams success as they compete in this historic demonstration of MAV technology.







# MAV 08 Mission Scenario (Contd)



## Demonstration Zone Sample Layout

Link length  
~ 200m

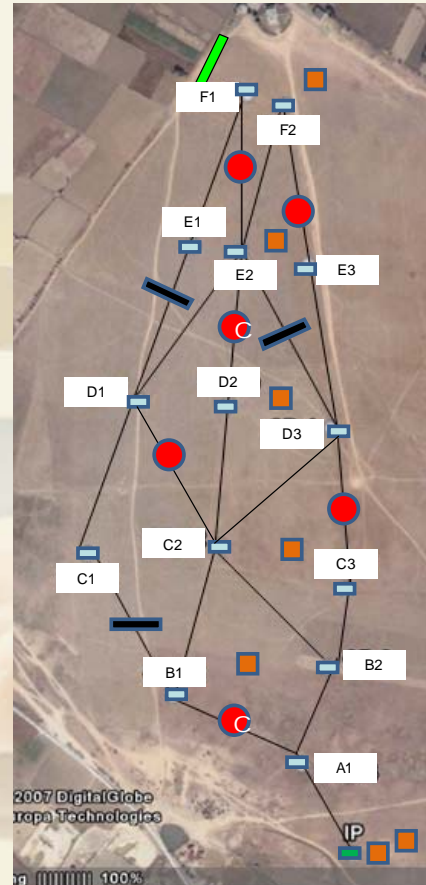
Commando Speed  
100-150 m/min

Red Team Stop Time  
2 minutes out of  
every 3 minutes

UGV Speed  
100-150 m/min

Chemical Mines  
2 out of 6 mines  
when a team uses

- Legend**
- Covered Positions
  - Compacted Earth Route
  - Obstacle
  - Mine
  - Ingress Point (IP)
  - MAV Land Point
  - Chemical Mine
  - Viewing Gallery



## Hostage Building Layout



- Legend**
- Perch Site
  - No Fly Boundary
  - Hostage Building
  - Viewing Gallery

## Launch Point Layout



- Legend**
- Ground Control Station
  - No Fly Boundary
  - MAV Takeoff & Landing Point
  - Ingress Point (IP)
  - Covered Positions



MAV08

# *Schedule of Events*

## **Sunday, 09 March 2008**

1400-1600 : Team Rules Briefing  
(Jaypee Palace Hotel – Agra)

## **Monday, 10 March 2008**

0800-1000 : Teams set-up static displays  
0930-1830 : Static Judging of Team Entries  
1000-1400 : Static displays open to attendees  
2000-2200 : Welcome Reception & Dinner

## **Tuesday, 11 March 2008**

0900- 1030 : MAV 08 Opening Ceremony  
1100-1200 : MAV Orientation Briefing  
1100-1200 : MAV 08 Press Briefing  
1100-1400 : Spouse Tour (Shopping)  
1200-1400 : Static displays open to attendees  
1200-1500 : Static Judging of Team Entries  
1530-1830 : Spouse Tour (Sightseeing)

## **Wednesday, 12 March 2008**

0800-1400 : Aerial Demonstrations  
0800-1700 : Spouse Tour (Safari)  
1430-1800 : MAV Seminar

## **Thursday, 13 March 2008**

0800-1400 : Aerial Demonstrations  
0800-1330 : Spouse Tour to Aerial Demonstrations  
1430-1700 : MAV Seminar  
1730-1930 : Visit to Taj Mahal

## **Friday, 14 March 2008**

0800-1400 : Aerial Demonstrations  
0800-1400 : Spouse Tour (Sightseeing/Shopping)  
1430-1730 : MAV Seminar  
1500-1800 : Spouse Tour(Shopping)  
2000-2200 : IUSSTF-NAL Banquet Dinner

## **Saturday, 15 March 2008**

0830-1030 : Teams Present Approach and Design  
1100-1215 : UAV User Community – Panel Discussion  
1225-1300 : Recognition of the Meritorious  
1300-1310 : Vote of Thanks  
1310 : End of Conference





# Schedule of Inaugural Ceremony

## The Chairmen and Members of the International Organising Committee

cordially invite you to the inaugural ceremony

on Tuesday, 11 March 2008 at 09:00 hrs  
at the Jaypee Palace Hotel, Agra, India

### Mr M Natarajan

Scientific Adviser to Raksha Mantri,  
Secretary, Defence Research & Development and  
Director General, DRDO, GoI, New Delhi

and

### Col(P) Peter N Fuller

Deputy Commander, US Army RDECOM

have kindly consented to deliver  
the Joint Welcome Address

### Lt Gen M L Naidu, PVSM, AVSM, YSM

Vice Chief of the Army Staff,  
Integrated HQ and MoD (Army), GoI, New Delhi

and

### Brig Gen Edwin A Vincent

Mobilization Assistant to  
Director of Strategy & Policy, US Pacific Command

have kindly consented to deliver  
the Joint Keynote Address

## Tuesday 11 March: Inaugural Ceremony

Venue : Jaypee Palace Hotel

### Programme

**Chairmen:** Dr A R Upadhyaya, Director, NAL, Bangalore  
Col James D Bass, US Army ITC Pacific, Japan

- 0830-0900:  
Military Band in Attendance
- 0900-0910:  
Invocation, Introduction of VIPs on the Dais and  
Lighting of the Lamps
- 0910-0920:  
Welcome Address  
*Mr M Natarajan and Col(P) Peter N Fuller*
- 0920-0940:  
Keynote Address  
*Lt Gen M L Naidu and Brig Gen Edwin A Vincent*
- 0940-1000:  
R&D Programs pertaining to MAVs, UGVs in India  
*Lt Gen(Dr) V J Sundaram, PVSM, AVSM, VSM (Retd)*  
Advisor, NDRF and Chairman, SIGMA, AR&DB
- 1000-1015:  
Small Unmanned Aerial Systems (UAS) Programs  
in the US Army  
*Dr William C McCorkle, Director, AMRDEC, USA*
- 1015-1030:  
Development of Unmanned Ground Systems (UGS)  
in the US Army  
*Dr Grace M Bochenek, Director, TARDEC, USA*
- 1030-1035:  
Closing Remarks and Vote of Thanks  
*Mr Balraj Gupta, Director, ADRDE, Agra*



# Schedule of Seminar Presentation

## Wednesday, 12 March 2008

**Chairmen:** Dr. Anthony Finn, DSTO, Australia  
Mr G Elangovan, DRDO, India

- 1430-1500 hours  
*Flight Dynamics in the Hawk Moth Manduca Sexta*  
Professor Thomas Daniel, University of Washington, USA
- 1500-1530 hours  
*Optimizing Robot Chemical Mapping and Localization by Building an Artificial Insect: the Bond between Perception and Action*  
Dr. Paul. Verschure, University of Pompeu Fabra, Spain
- 1530-1600 hours  
*Onboard Information Processing and Data Compression for Micro-Aerial Vehicles*  
Professor Rama. Chellappa, University of Maryland, USA
- 1600-1630 hours : Coffee
- 1630-1700 hours  
*The Human Brain: Biological Networks and Complexity*  
Dr. Vijayalakshmi Ravindranath, NBRC, India
- 1700-1730 hours  
*Vision-based Navigation and Control of MAVs*  
Prof. Mandyam Srinivasan, University of Queensland, Australia
- 1730-1800 hours  
*Novel Methods in Explosives Detection: From Operations to Olfaction*  
Dr. Regina E. Dugan, RedXDefense, USA

## Thursday, 13 March 2008

**Chairmen:** Dr. Clayton Stewart, ONR-G, US Navy  
Prof. S Seetarama Bhat, IISc, India

- 1430-1500 hours  
*Mobile Robotics - A DRDO Perspective*  
Mr. V S Mahalingam, CAIR, DRDO, India

- 1500-1530 hours  
*Deconfliction and Collision Avoidance Algorithms for Unmanned Systems*  
Professor Farshad Khorrami, Brooklyn Poly, USA
- 1530-1600 hours : Coffee
- 1600-1630 hours  
*Coordination of MAVs and UGVs for Information - Theoretic Urban Search and Rescue*  
Dr. Tomonari Furukawa, University of New South Wales, Australia
- 1630-1700 hours  
*Human Factors Considerations for MAV*  
COL. James McGhee, USAARL, USA

## Friday, 14 March 2008

**Chairmen:** Dr. R. Szczepanik, Poland  
Prof C Venkatesan, IIT-Kanpur, India

- 1430-1500 hours  
*Rotor Based Micro Air Vehicles: Challenges and Opportunities*  
Prof. Inderjit Chopra, University of Maryland, USA
- 1500-1530 hours  
*Hovering Capability of Fixed-Wing Micro-Aerial Vehicles*  
Prof. Jean-Marc Moschetta, University de Toulouse, France and  
Dr. Sergey V. Shkarayev, University of Arizona, USA
- 1530-1600 hours  
*Autonomy in Robots*  
Professor Kenzo Nonami, Chiba University, Japan
- 1600-1630 hours : Coffee
- 1630-1700 hours  
*Morphing Wings: From Concept to Reality*  
Dr. Jayanth Kudva, NextGen Aeronautics, Inc, USA
- 1700-1730 hours:  
*MAV System Design and integration Issues*  
Dr. Robert Michelson, Georgia Tech, USA





# Schedule of Concluding Session

**Saturday, 15 March 2008**

- 0830-1030 hours :  
Teams Present Approach and Design
- 1100-1215 hours:  
User Community - Panel Discussion

**Chairmen: Mr Jason Denno, Director, Battle Command  
Battle Lab (TRADOC), US Army**

**Dr D Banerjee, CC R&D(AMS), DRDO, India**

## **Panelist**

- Representative from Indian Army
- Representative from Indian Ministry of Defence
- *COL Stephen Kinloch*, Acting Director-General, Land Development, Australian Army
- *Mr Makoto Ono*, Director, Systems Division, Japanese Ministry of Defense
- *Dr Charles Kimzey*, Science Advisor to the Pacific Command, US Army.
- 1225-1300 hours :  
Recognition of the Meritorious by  
*Dr Barbara Machak*, Associate Technical Director  
U S Army, ARDEC.
- Vote of Thanks by  
*Col James D Bass*  
*Dr A R Upadhya*  
*Mr Balraj Gupta*



# Profile of Sponsors

## US Department of Defense

With its military units tracing their roots to pre-Revolutionary times, one might say that it is America's oldest company. And if one looks at it in business terms, one would say it is not only America's largest company, but its busiest and most successful.

### How US DoD Evolved:

- The Army, Navy, and Marine Corps were established in 1775, in concurrence with the American Revolution. The War Department was established in 1789, and was the precursor to what is now the Department of Defense.
- The Department of the Navy, was founded in 1798.
- The Coast Guard (part of Homeland Security in peacetime), can trace it's history back to 1790.
- Congress, in 1947, established a civilian, Cabinet-level Secretary of Defense to oversee an also newly created National Military Establishment.
- The U.S. Air Force was also created, along with a new Department of the Air Force. The War Department was converted to the Department of the Army.
- Finally, the three services, Army, Navy, and Air Force, were placed under the direct control of the new Secretary of Defense.
- In 1949, an amendment to the Act consolidated further the national defense structure, creating what we now know as the Department of Defense, and withdrawing cabinet-level status for the three Service secretaries.

### 5 Million Strong

With over 1.3 million men and women on active duty, and 669,281 civilian personnel, it is the nation's largest employer. Another 1.1 million serve in the National Guard and Reserve forces. About 2 million military retirees and their family members receive benefits.



US Army Research, Development and Engineering Command (RDECOM)



The Defense Advanced Research Projects Agency (DARPA)



Office of Naval Research – Global (ONR-G)



US Army Research Laboratory (ARL)



US Army Aviation & Missile Research Development & Engineering Center (AMRDEC)



US Army Armament Research Development & Engineering Center (ARDEC)



US Army Communications & Electronics Development & Engineering Center (CERDEC)



US Army Tank Automotive Research, Development and Engineering Center (TARDEC)



US Air Force Research Laboratory (AFRL)







# *Profile of Organisers and Supporting Organisations*

**Post Bag No. 1779  
Airport Road  
Bangalore 560 017, India**

**Website: [www.nal.res.in](http://www.nal.res.in)**

## **NATIONAL AEROSPACE LABORATORIES**

National Aerospace Laboratories (NAL), a constituent of Council of Scientific and Industrial Research (CSIR), is India's eminent civil R&D establishment in aeronautics and allied disciplines. NAL was set up at Delhi in 1959 and moved to Bangalore in 1960.

NAL's primary objective is the "development of aerospace technologies with a science content and their practical application to the design and construction of flight vehicles". NAL is also required "to use its aerospace technology base for general industrial applications".

NAL's core competence spans practically the whole aerospace spectrum. Over the years, NAL has made very significant contributions to all Indian aerospace programmes, often even setting the national agenda for such programmes. During the last decade NAL has spearheaded the effort to design and develop small and medium-sized aircraft for the civil sector.

NAL's real strength lies in its vast reservoir of expertise and facilities created over the years. With this imposing infrastructure, NAL has been very successful in obtaining a large number of R&D contracts for testing and subsystem development for various national programmes as well as industries all over India and abroad.

NAL is well-equipped with modern and sophisticated facilities which include national facilities like the Nilakantan Wind Tunnel Centre and the computerised fullscale fatigue test facility. The various facilities and multi-disciplinary expertise, developed primarily for the aerospace sector, are also utilised in other sectors involving advanced technology. NAL is recognised as a centre for failure analysis and extends its support in investigating failures and accidents both for aerospace applications and other general

facilities. Other major facilities at NAL include: the acoustic test facility, turbomachinery and combustion research facilities, Composite Structures Laboratory, black box readout systems and the FRP fabrication facility.

It is thus in a unique position to offer R&D support, expertise and services to both aerospace and non-aerospace industry sectors. Some major recent contracts include: development of carbon fibre composite wings for India's Light Combat Aircraft (LCA) programme, design, development and fabrication of a fully-automated autoclave for Hindustan Aeronautics Limited (HAL), development of co-cured fin and rudder for LCA and a shake test facility for HAL's Advanced Light Helicopter (ALH).

Latest addition to NAL's multi-pronged activities in the design and development of small civil aircraft. It has successfully developed India's first all composite trainer aircraft HANSA and the 14-seat light transport aircraft SARAS. This is expected to lead to a robust civil aviation industry in the country.

Spin-off technologies from aerospace R&D activities have significantly contributed to the non-aerospace sector everywhere in the world. Conscious of this aspect, NAL has made special efforts to identify those developments which could result as off-shoots from the main R&D programmes.

NAL's models for business development activities include inhouse projects leading to commercialisation, sponsored projects, industry-lab linkages, multi-agency collaborative projects and international contracts.

NAL's current staff strength is 1250 of this about 350 are scientists.





# *Profile of Organisers and Supporting Organisations*

**Post Box No. 51  
Station Road  
Agra Cantt. 282 001, India**

## **AERIAL DELIVERY RESEARCH & DEVELOPMENT ESTABLISHMENT**

Aerial Delivery Research & Development Establishment (ADRDE) based at Agra, is a pioneer R&D Organization where various capabilities related to the design and development of parachutes, aerial delivery systems, aircraft arrester barrier systems, recovery systems and floatation systems for both military and civil applications have been mastered over the years.

The technological competence acquired in the fields of Aeronautical, Textiles, Mechanical, Electronics and Electrical engineering has imparted the ADRDE, a unique combination of capabilities to evolve new solutions in these fields with an emphasis on quality assurance.

### **Historical Background**

Aerial Delivery Research & Development Establishment at Agra was started in Kanpur during the latter part of the 1950s consisting of two Aerial Delivery Sections, namely - Chief Inspectorate of Textiles & Clothing (CIT & C) and Chief Inspectorate of General Stores (CIGS) under the control of Director General of Inspection (DGI). Primarily, these two sections are responsible for the indigenisation of parachutes and related equipment for the paratropping of men and materials. Subsequently, these sections moved to Agra during 1965 and were transformed into a full-fledged establishment referred to as the Chief Inspectorate of Aerial Delivery Equipment (CIADE). This DGI establishment came under the fold of DRDO in May 1968 and ADRDE was born in January 1969. The charter of duties of the establishment was also revised, which includes Heavy Dropping System, Brake Parachute Systems, Recovery Parachutes and Aircraft Arrester Barrier Systems.







# *Profile of Organisers and Supporting Organisations*

**Ministry of Defence  
Government of India  
New Delhi**

**Website: [www.drdo.org](http://www.drdo.org)**

## **DEFENCE RESEARCH & DEVELOPMENT ORGANISATION**

Defence Research & Development Organisation (DRDO) works under Department of Defence Research and Development of Ministry of Defence. DRDO dedicatedly working towards enhancing self-reliance in Defence Systems and undertakes design & development leading to production of world class weapon systems and equipment in accordance with the expressed needs and the qualitative requirements laid down by the three services. DRDO is working in various areas of military technology which include aeronautics, armaments, combat vehicles, electronics, instrumentation engineering systems, missiles, materials, naval systems, advanced computing, simulation and life sciences.

DRDO was formed in 1958 from the amalgamation of the then already functioning Technical Development Establishment (TDEs) of the Indian Army and the Directorate of Technical Development & Production (DTDP) with the Defence Science Organisation (DSO). DRDO was then a small organisation with 10 establishments or laboratories. Over the years, it has grown multi-directionally in terms of the variety of subject disciplines, number of laboratories, achievements and stature.

Today, DRDO is a network of more than 50 laboratories which are deeply engaged in developing defence technologies covering various disciplines, like aeronautics, armaments, electronics, combat vehicles, engineering systems, instrumentation, missiles, advanced computing and simulation, special materials, naval systems, life sciences, training, information systems and agriculture. Presently, the Organisation is backed by over 5000 scientists and about 25,000 other scientific, technical and supporting personnel. Several major projects for the development of missiles, armaments, light combat aircrafts, radars, electronic warfare systems etc are on hand and significant achievements have already been made in several such technologies

### **Vision**

Make India prosperous by establishing world class science and technology base and provide our Defence Services decisive edge by equipping them with internationally competitive systems and solutions.

### **Mission**

- Design, develop and lead to production state-of-the-art sensors, weapon systems, platforms and allied equipment for our Defence Services.
- Provide technological solutions to the Services to optimise combat effectiveness and to promote well-being of the troops.
- Develop infrastructure and committed quality manpower and build strong indigenous technology base

DRDO has a network of more than 50 laboratories which are deeply engaged in developing defence technologies covering various disciplines, like aeronautics, armaments, electronic and computer sciences, human resource development, life sciences, materials, missiles, combat vehicles development and naval research and development. The organisation includes more than 5000 scientists and about 25,000 other scientific, technical and supporting personnel.





# *Profile of Organisers and Supporting Organisations*

**Anusandhan Bhawan  
2, Rafi Marg  
New Delhi 110 001, India**

**Website: [www.csir.res.in](http://www.csir.res.in)**

## **COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH**

The Council of Scientific & Industrial Research (CSIR) —the premier industrial R&D organization in India was constituted in 1942 by a resolution of the then Central Legislative Assembly. It is an autonomous body registered under the Registration of Societies Act of 1860. CSIR aims to provide industrial competitiveness, social welfare, strong S&T base for strategic sectors and advancement of fundamental knowledge.

The Strategic Road Map designed for CSIR as it stepped into the new Millennium envisaged:

- Re-engineering the organisational structure;
- Linking research to marketplace;
- Mobilising and Optimising the resource base;
- Creating an enabling infrastructure; and
- Investing in high quality science that will be the harbinger of future technologies.

Interestingly, the Government of India has also announced a new Science and Technology Policy 2003 in the early years of the new century. It presents Science and Technology with a human face and emphasizes realities such as facing open, global competition; need for examining social, economic and environmental consequences of S&T; and, aggressive international benchmarking and innovation. It advocates strong support for basic research. It emphasizes manpower build-up and retention as important challenges. It advocates dynamism in S&T governance, through the participation of scientists and technologies.

Today CSIR is recognised as one of the world's largest publicly funded R&D organisations having linkages to academia, R&D

organisations and industry. CSIR's 38 laboratories not only knit India into a giant network that impacts and add quality to the life of each and every Indian but CSIR is also party to the prestigious Global Research Alliance with the objective of applying global knowledge pool for global good through global funding. CSIR's R&D portfolio embraces areas as diverse as Aerospace, Biotechnology, Chemicals...indeed, almost the ABC-Z of Indian Science!







# *Profile of Organisers and Supporting Organisations*

**Fulbright House  
12 Hailey Road  
New Delhi 110 001, India**

**Website: [www.indousstf.org](http://www.indousstf.org)**

## **INDO-US SCIENCE AND TECHNOLOGY FORUM**

The Indo-U.S. Science and Technology Forum (IUSSTF) was established in 2000 under an agreement between the Governments of India and United States of America with a mandate to promote, catalyze and seed bilateral collaboration in science, technology, engineering and biomedical research through substantive interaction amongst government, academia and industry.

As its mandate, IUSSTF provides an enabling platform to the scientific enterprises of the two nations by supporting an S&T program portfolio that is expected to foster sustainable interactions with a potential to forge long term collaborations. IUSSTF program manifests are largely catalytic in nature, helping to create awareness through the exchange and dissemination of information and opportunities which promoting bilateral scientific and technological cooperation.

IUSSTF has an evolving program portfolio that is planned by scientific communities of both the countries, with support for symposia, workshops, conferences on topical and thematic areas of interest, visiting professorships and exchange programs, travel grants, fellowships, advanced training schools, public-private networked centres and knowledge R & D networked centres. IUSSTF also works towards nurturing contacts between young and mid career scientists by convening stimulating flagship events like the Frontiers of Science and Frontiers of Engineering symposium through the U.S. National Academies model. At the same time, it reaches out to industries by partnering with business associations to generate high quality events on technology opportunities for business development and to foster elements of innovation and enterprise through networking between academia and industry.

IUSSTF maintains a close working relationship with federal agencies, laboratories, government institutions, and the academia in U.S. and India, cutting across all disciplines. As an autonomous, not-for-profit society, IUSSTF has the ability, agility and flexibility to engage and involve industry, private R&D labs, and non governmental entities in its evolving activity manifold. This operational uniqueness allows the IUSSTF to receive grants and contributions from independent sources both in India and USA, besides the assured core funding from the two governments.

IUSSTF solicits proposals for its activities thrice a year (January, May and September) and awards are made on the basis of peer reviews both in India and USA.

IUSSTF values interactions and looks forward to work with the S&T community of both countries to implement new ideas that endeavor to promote cutting edge Indo-U.S. Science and Technology collaborations.



# *National Advisory Committee*

**Mr M Natarajan**

Scientific Adviser to Raksha Mantri and  
Director General, DRDO  
Government of India  
New Delhi.

**Dr R A Mashelkar**

Former Director General, CSIR and  
CSIR Bhatnagar Fellow  
National Chemical Laboratory  
Pashan Road  
Pune.

**Prof Roddam Narasimha**

Chairman  
Engineering Mechanics Unit  
Jawaharlal Nehru Centre for Advanced Scientific  
Research Jakkur P O  
Bangalore 560 064

**Air Marshal NAK Browne AVSM VM**

Deputy Chief of Air Staff  
Air Headquarters  
Vayu Bhawan  
New Delhi.

**Dr T Ramasami**

Secretary  
Department of Science & Technology  
Technology Bhavan  
New Mehrauli Road  
New Delhi.

**Air Marshal A V Vaidya VM**

Deputy Chief of Integrated Defence Staff  
HQ Integrated Defence Staff  
Ministry of Defence  
Kashmir House, Rajaji Marg  
New Delhi.

**Dr V K Aatre**

Former Scientific Adviser to Raksha Mantri  
No. 139, 7th Cross  
3rd Main, RMV 2nd Phase, Block I  
Bangalore.

**Prof S K Brahmachari**

Director General  
Council of Scientific & Industrial Research and  
Secretary, DSIR  
Anusandhan Bhawan  
2, Rafi Marg, New Delhi.





# Profile of Inaugural Function Speakers



## **Mr M Natarajan**

Scientific Adviser to Raksha Mantri  
Secretary, Department of Defence Research  
and Development and  
Director General, DRDO, Gol, New Delhi

Mr M Natarajan has a B.Tech Degree in Mechanical Engineering from IIT, Chennai and M.Tech Degree in Mechanical Engineering specializing in Engineering Design from IIT, Mumbai. He joined the Defence Research & Development Organisation in 1970. He additionally holds a Master of Science Degree in Military Vehicle Technology obtained from the RMCS, UK in 1975.

Mr M Natarajan has worked for over 30 years on several important project assignments relating to the design and development of tracked vehicles. He has been associated with the MBT - Arjun programme since its inception. He took over the overall responsibility of development of the MBT Arjun in the capacity of Programme Director in 1987. He assumed charge as Director of the CVRDE on 01 December 1989. The continued hard work and innovative design approach and dedication of the highest order exhibited by Mr Natarajan and his team for over two decades resulted in India's having an indigenous state-of-the-art Main Battle Tank Arjun and a self propelled gun system BHIM.

Mr Natarajan received the Best Scientist Award for the year 1994 for his personal contributions to the success of MBT Arjun. His laboratory was selected as the Best Systems Engineering laboratory for the year 1995, for which he received the Rolling Silicon Award in 1996, for outstanding professional excellence by the Institution of Engineers (India). He was made a Distinguished Scientist in DRDO in 1999.

He has served in the capacity of CCR&D (ACE) at DRDO HQ

looking after Armaments, Combat Vehicles and Engineering equipment since July 2000. During this period, he ensured the acceptance of Pinaka MBRLS, developed by ARDE, by the Army through exhaustive field tests.

He became a Fellow of Indian National Academy of Engineering with effect from December 2001.

He received the award of Padma Shri from the Honourable President of India in 2003 for his contributions to the design and development of Combat Vehicles.

He was awarded Technology Leadership Award for 2003 by DRDO for his contributions to the design and development of Combat vehicles and Mechanical Systems for LCA.

He has also been made Distinguished Alumni of IIT, Madras w.e.f. December 2003.

Mr M Natarajan took over as Scientific Adviser to Raksha Mantri in August 2004.



# Profile of Inaugural Function Speakers



**Colonel Peter Nelson Fuller**  
**Deputy Commander**

Colonel Peter Nelson Fuller is the Deputy Commander of the US Army Research, Development and Engineering Command. A native of Andover, MA, Colonel Fuller was commissioned and a second lieutenant in 1980 after graduating from the University of Vermont with a Bachelor of Arts degree in History and Political Science. He also holds: a Master of Science in Public Administration, Shippensburg University, Shippensburg, PA; a Master of Science in Military Arts and Sciences, US Army Command and General Staff College, Fort Leavenworth, KS; and a Master of Science in Resourcing of the National Security Strategy from the Industrial College of the Armed Forces, Fort McNair, Washington, DC.

His military education includes the Armor Officer Basic and Advanced Courses, Fort Knox, KY; the US Army Airborne School, Fort Benning, GA, the Materiel Acquisition Management Course, Fort Lee, VA, the US Army Command and General Staff College at Fort Leavenworth, KS; the Joint Intelligence and Space School, Colorado Springs, CO, the Defense Systems Management College, Program Manager's Course, Fort Belvoir, VA; and the Industrial College of the Armed Forces, Fort McNair, Washington, DC.

Colonel Fuller's assignments include various positions like Assistant Professor of Military Science at Shippensburg University, Test and Evaluation Officer, Assistant Director for Acquisition, Ballistic Missile Defense Organization, Washington, DC, Systems Coordinator, US Army Staff for Anti-Armor Missiles,

the Product Manager for Single Channel Ground and Airborne Radio System (SINCGARS), Faculty member, Industrial College of the Armed Forces, Washington, DC, Task Force Leader for Rapid Acquisition of BFT, C2 On the Move and BCT Integration, and Project Manager Stryker Brigade Combat Team.

Colonel Fuller's awards include the Legion of Merit, Defense Meritorious Service Medal, Army Meritorious Service Medal, Army Commendation Medal (with two oak leaf clusters); Operation Desert Storm Medal with star, Army Achievement Medal (with two oak leaf clusters), National Defense Service Ribbon, Army Service Ribbon, Army Parachutist Badge, Office of the Secretary of Defense Identification Badge, Army Staff Identification Badge, and the Overseas Ribbon.





# Profile of Inaugural Function Speakers



**Lt. Gen. Milan Naidu, PVSM, AVSM, YSM**  
Vice Chief of the Army Staff  
Integrated HQ and MoD (Army)  
Government of India  
New Delhi.

Lieutenant General Milan Naidu is currently The Vice Chief of the Army Staff from Oct 2007. Early in his school days only he had decided to continue his family tradition to join the Army. An alumni of the National Defence Academy, Khadakvasla, where he excelled in marksmanship and was awarded a "Blue". His expertise was acknowledged when he formed part of the Services team in the National Skeet Shooting Championship in 1968. Selected to attend the Defence Services Staff College Course in Canada, he has also attended the Higher Command Course at the Army War College and acquired the M.Sc in Defence Studies and has a Post Graduate degree in Environmental and Ecological Sciences.

Commissioned in the Rajput Regiment in Dec 1967, he has had a long and chequered career having served in all sectors and terrain in India and abroad. As Commanding Officer of 5 Rajput he participated in Op PAWAN in Sri Lanka and in recognition of the excellent performance of his Battalion he was awarded the Yudh Seva Medal. He has the experience of Commanding a Brigade in the semi desert terrain, a Division in the Plains of Punjab during Op PARAKRAM, a Corps in the High Altitude and Glaciated area and as the General Officer Commanding-in-Chief of Army Training Command.

The General's forte has been in the field of instruction. Having trained cadets and young officers at the Indian Military Academy and the Infantry School, he has also had the distinction of being the Commandant of Indian Army's premier officers' training establishment for combat – The Army War College.

The General has had varied operational and staff experience at all levels including a stint at the Military Operations Directorate at Army HQs. He has had the privilege of being our Defence Attaché in Germany.



# Profile of Inaugural Function Speakers



**Brigadier General Edwin A. Vincent**  
National Guard Bureau  
Departments of the Army and the Air Force  
General Officer Management Office  
Arlington, VA

Brigadier General Edwin A. Vincent has graduated as a Bachelor of Business Administration from University of Hawaii and also Air War College (Seminar). He now holds the position of Mobilization Assistant to Director of Strategy and Policy, U.S. Pacific Command (in 2007). He has a key role in the Pacific Command's effort for regional security through the development of diplomatic, economic, and military policies. This includes building and maintaining military-to military and political-military relationships among the 43 nations within the Pacific region, covering over 51% of the globe. Activities include disaster management, humanitarian assistance, homeland defense, appropriate overseeing of reserve component matters, and as a senior leader within the directorate, the overseeing of strategy and policy issues that influence the Pacific region.

Brig Gen Vincent enlisted in the Hawaii Army National Guard in 1973 and received his commission as a Second Lieutenant through the U.S. Army Officer Candidate School at Fort Benning, Georgia in 1976. He then traded in his Army National Guard commission for an Air Guard commission in 1982. After attending undergraduate navigator training, he began his flying career as an F-4 Weapons System Officer in the Hawaii ANG.

During his National Guard career, Brig Gen Vincent has held a variety of command and staff positions at the unit, state, and air staff levels. He also served on several national committees, including a period as Chairman of the ANG Mission Support Group Commander's Field Advisory Council and President, National Guard Association - Hawaii Chapter. He has

commanded at the company, squadron, and group levels, as well as commanded in combat during the Balkan conflict and most recently in the Middle East. He has more than 2000 flight hours to his credit. Prior to his current assignment, Brig Gen Vincent served as the Assistant Adjutant General - Air, Hawaii National Guard.

He has many awards to his credit and to name a few ; Legion of Merit & Meritorious Service Medal with Oak Leaf Cluster, Air Force Commendation and achievement Medals, Joint Service Commendation Medal, National Defense Service Medal & Armed Forces Expeditionary Medal with 2 Bronze Star Devices, Kosovo Campaign Medal, Global War on Terror Expeditionary & Terror service Medal, Humanitarian Service Medal, Air Force Expeditionary Ribbon with Gold Border, Armed Forces Reserve Medal with "M" device & silver hourglass.





# Profile of Inaugural Function Speakers



**Lt. Gen. (Dr) V J Sundaram**  
**PVSM, AVSM, VSM (Retd.)**

Advisor - Micro and Nano Systems –  
National Design and Research Forum  
No.7, Cornwell Road  
Langford Garden  
(Off. Richmond Road)  
Bangalore 560 025

Lt. Gen. (Dr.) V.J.Sundaram, obtained his B.Sc and BE (Mechanical) degrees from Mysore University followed by ME (Aero) and Ph.D from the Indian Institute of Science.

He joined the Indian Army in 1957 and worked on border roads at high altitudes in Jammu & Kashmir (Poonch Sector) as well as the North East (Sela-Tawang Sector), followed by tenures in infantry divisions and training centers.

After completing courses in telecommunication engineering and guided missiles he was at DRDL from 1968 to 1997. Concerning technology, he worked in the areas of propulsion, structures, environmental testing and missile assembly. He was Head, Structures and later Director, Propulsion.

He led the Flight Vehicles design team for PRITHVI in 1982-83 and was its first Project Director (1983-89), guiding its induction into the Army with 95% indigenous content. From 1992 to 1997 he was Director of both DRDL and RCI with overall responsibility for all Indian Missile Projects. During this period he was also a Director on the board of Bharat Dynamics Limited. He has participated in design reviews and failure analysis of AGNI, ASLV and PSLV. He has strongly promoted the development of miniaturized flight instrumentation systems for missiles.

He was awarded the VSM in 1980 for his work on the Devil Surface to Air missile, the AVSM in 1989 for the PRITHVI, and

PVSM in 1994 for overall contribution to the Indian Missile Program.

He was an advisor to Aeronautical Development Agency on critical technologies denied to Light Combat Aircraft from 1997 to 2001. During this period he also chaired failure analysis linked with MIG aircraft ejection seat and Indian AWACS. As Chairman of the Board of Governors of the National Design and Research Forum from 2000 to 2004, he promoted MEMS, Nano, Bio Sensor and Micro Air Vehicle Technologies across India in various institutions.

A crusader for quality, he was the Chairman of Hyderabad Chapter of the Indian Society of Non-destructive testing (1995-97), President of Aeronautical Society of India (1997) and since 2001 he has been the President of Association for Machines and Mechanisms (India).

His current activities are Micro Air Vehicles, Micro-Nano-Bio Systems as well as the interfacing of biology and engineering.

He is the recipient of : National Aeronautics Prize, Aeronautical Society of India – 1988, Aryabhata Award, Astronautical Society of India – 1998 & Instrument Society of India Award - 2002

He received the Lifetime Achievement Award of DRDO in 2005 from Dr. Manmohan Singh, Prime Minister of India. Still active, he has been the Mission Director for more than 35 Prithvi Flights including the Dhanush Mission for the Navy on 30 March 2007. He was also the Mission Director of the Prithvi Targets for the exoatmospheric and endoatmospheric Ballistic Missile interceptor missions in November 2006 and December 2007 respectively.



# Profile of Inaugural Function Speakers



**Dr. William C. McCorkle, Jr.**  
Director  
Aviation and Missile Research, Development,  
and Engineering Center (AMRDEC)

**Dr. William C. McCorkle, Jr.** has a Ph.D. in Physics from University of Tennessee; 1956. Currently Dr. McCorkle serves as the Director of the Aviation and Missile Research, Development, and Engineering Center (AMRDEC). As Director of the AMRDEC, he is responsible for providing major research, development, production, field engineering, software engineering, and product assurance support to more than twenty-five Aviation and Missile Command (AMCOM) project and product-managed systems. In addition, he is responsible for planning and executing AMRDEC's programs in research, exploratory, and advanced development of aviation, missile and unmanned system technology.

Dr. McCorkle came to Redstone Arsenal in 1957 from a position at Tulane University and has since served in a number of increasingly responsible scientific and engineering positions, including an 18-month rotational assignment in the Department of Army Staff as Science Advisor to the Director of Weapons Systems. In November 1980, Dr. McCorkle was selected for the dual role of Technical Director of the Missile Command and Director of the U.S. Army Missile Laboratory (now AMCOM and AMRDEC). In 1999, he was selected to be the first Director of AMRDEC.

Dr. McCorkle has worked on missile-related research and development problems and projects associated with virtually every Army missile and rocket system. His contributions include numerous papers and patents in guidance and control, such as the complete guidance system used in the LANCE missile and

major improvements to the HAWK missile system, including the most recent improvement permitting multiple simultaneous engagements. He has achieved national recognition for initiating and guiding the Center's highly successful pioneering work in fiber optic guidance links for missiles, providing a revolutionary new countermeasure-resistant capability for finding and engaging both rotary wing and armored targets out of the gunner's line of sight. Dr. McCorkle has long effectively championed the use of simulation techniques for missile design and analysis and initiated the effort which led to AMRDEC's Advanced Simulation Center, a major national facility and key to a number of successful missile development and improvement programs.

He has many awards to his credit. The most coveted of them are Army R&D Achievement Award, The American Institute of Aeronautics and Astronautics' Holger N. Toftoy Award for Technical Management (1972) & Hermann Oberth Award (1982), Presidential Distinguished (1987) and Meritorious (2000 and 1990) Executive Rank in the Senior Executive Service, The American Defense Preparedness Association Leslie E. Simon Award (1986) & Tennessee Valley Chapter's General John B. Medaris Award (1991), Doctor of Science (Honoris Causa) University of Alabama (1991), Doctor of Science (Honoris Causa) Southeastern Institute of Technology (1990), Presidential Rank Award (2000), The AIAA Missile Systems Management Award (2000) and National Space Club Astronautical Engineer of the Year (1992).





# Profile of Inaugural Function Speakers



**Grace M. Bochenek, Ph.D.**  
Director, Tank Automotive Research,  
Development and Engineering Center  
Warren, Michigan  
USA.

Dr. Grace Bochenek, a native of Michigan, has a bachelor's degree in electrical engineering from Wayne State University, a master's degree in engineering from the University of Michigan, and a Ph.D. from the University of Central Florida. She is a member of the Society of Automotive Engineers, the Army Acquisition Corps and an active participant in several defense-related associations. She was appointed the Director for the U.S. Army's Research, Development, and Engineering Command's (RDECOM) Tank Automotive Research, Development and Engineering Center (TARDEC) in September 2006. Dr. Bochenek brings over twenty years of scientific, technical and managerial experience to this prominent Army institution.

Dr. Bochenek has served in various capacities earlier as Deputy Program Executive Officer (DPEO) for Combat Support and Combat Service Support (CS&CSS). She was involved in programs in five geographically distributed sites supporting the Army's tactical wheeled vehicle fleet and force projection commodities.

Earlier she was appointed to the Senior Executive Service in 2003 as the Executive Director of Research and Technical Director for RDECOM-TARDEC where she led programs to align all ground-based systems science and technology research objectives to meet the Army's future war fighting and logistics needs; including vehicle survivability, robotics, vehicle electronics, hybrid electric, alternative power and energy, and software engineering.

Dr. Bochenek's career includes experience in simulation, virtual reality, system design and acquisition, virtual prototyping, engineering research and development, program management and joint international programs. Dr. Bochenek is a nationally recognized expert in 3-D visualization, immersive virtual technology and real-time simulation and integration design processes. In 2002, ACE's contribution to the Army's Stryker program was honored with an Army Simulation and Modeling for Acquisition, Requirements and Training Award.

Dr. Bochenek is an active member of the community. She is the U.S. voting member of the North Atlantic Treaty Organization (NATO) Applied Vehicle Technology Panel. She co-chaired the 2003 Army Simulation and Modeling for Acquisition, Requirements and Training Conference. She was the President of the College of Industrial Engineering and Management Systems Advisory Board at the University of Central Florida and currently serves on the Industrial Advisory Board at Michigan Technological University's College of Engineering. She is also an Adjunct Professor at Wayne State University and in 2004 was inducted into the Wayne State University, College of Engineering Hall of Fame for her accomplishments and commendable career achievements.



# Profile of Inaugural Function Speakers



**COL Bass, James D.**  
Uniformed Scientist (51S)  
Commander, US Army ITC-Pacific

**COL Bass, James D** has a Doctoral degree from Drexel University (1997). In the service he has many courses to his credit viz., Adjutant General Advanced Course, Material Acquisition Management, Command and general Staff and US Army War College (Fellowship, Univ. of TX at Austin). He is currently the Commander of the US Army International Technology Center – Pacific. COL Bass is Responsible for the identification assessment and potential acquisition of foreign technology in the Asian, Oceania region. He is responsible for field offices in Australia and Singapore with his headquarters located in Tokyo Japan.

He has won many awards like Defense Superior Service Medal, Meritorious Service Medal (3), Army Commendation Medal (4), Army Achievement Medal (3), Army Superior Unit Award, Secretary of Defense Service Badge, National Defense Medal (2), GWOTSM, Korea Service, OSR, ASR etc.

Recently he held many important positions like Product Manager, Movement Tracking System, PEO-EIS, Ft Lee, VA; Program Manager, DARPA, Office of Information Awareness and Technology, Alexandria, VA; Project Officer, Army Research Laboratory, Information Systems Branch, Adelphi, MD; Information Systems Analyst, Integration and Analysis Center, ODISC4, Falls Church, VA; Systems Engineer, CECOM RDEC – Center for C3 Systems, Ft Monmouth, NJ

He is an Amateur Radio Operator (W5FCN), and holds a patent on sectorized-omni HF and VHF antennas. Pending design patent on limited domain noise robust automatic speech recognition system developed at DARPA.



**Dr A R Upadhyaya**  
Director  
National Aerospace Laboratories  
PB No.1779, Airport Road  
Bangalore 560 017, India  
director@css.nal.res.in

Dr Upadhyaya received his B Tech and M E degrees in aeronautical engineering from IIT, Kharagpur and IISc, Bangalore respectively. He obtained his Ph D from the Cranfield Institute of Technology, Cranfield, UK in 1980 on a Commonwealth Fellowship from the Government of UK. He was a scientist at the National Aerospace Laboratories, Bangalore from 1974 to 1986. From 1986 to 2004, he was at the Aeronautical Development Agency, Bangalore, initially as Group Director and then as Project Director for Structural Technologies and subsequently as Associate Program Director (LCA Navy). During this period, he was closely associated with India's prestigious Light Combat Aircraft Program in the technical areas of loads, dynamics, aeroelasticity and structure-control interactions and also as a senior executive in the management of the programme.

Dr Upadhyaya was also the Program Director from 2000 to 2004, for India's National Program on Smart Materials, aimed at the development of smart sensors, actuators and MEMS based devices and the associated technologies for material processing, packaging and applications.

Dr Upadhyaya returned to the National Aerospace Laboratories as its Director in Dec.2004.

Dr Upadhyaya is associated with various scientific and Professional Bodies. He is a Member of AIAA, Fellow, Aeronautical Society of India, Life Member and past President, Indian Society for Advancement of Materials and Process





# Profile of Inaugural Function Speakers

Engineering, Life Member and President, Institute of Smart Structures and Systems, Member, Semiconductor Society of India, Life Member, Society for Aerospace Quality and Reliability, Member, Academic Senate Visvesvaraya Technical University, Indian Member, World Federation of Engineering Organisations, Member, Board of Governors, Engineering Council of India & Convenor, Technical Committee AR&DB.

He has many awards to his credit and to name a few ; Distinguished Alumnus Award of Department of Aerospace Engineering, Indian Institute of Science, Bangalore in the year 2003, Distinguished Alumnus Award of Indian Institute of Technology (IIT), Kharagpur in July 2006 & Elected Corresponding Member, Section 4 (social Sciences) of the International Academy of Astronautics, in September 2007.



**Mr Balraj Gupta**

Director

Aerial Delivery Research and  
Development Establishment

PB No. 51, Station Road  
Agra Cantt- 282001, India  
directoradrde@dataone.in

Mr Balraj Gupta graduated in Bachelor of Science (Aeronautics) from Punjab Engineering College, Chandigarh during the year 1974 and did his Master's in Technology (System Engineering & Management) from DEI, Agra during the year 1994. He joined DRDO in 1975 at ADE, Bangalore. He joined ADRDE, Agra in the year 1984. Mr Balraj Gupta is a specialist in Parachute Technology. He has worked on number of projects pertaining to parachutes for Paratroopers, Ejection seats, Heavy Drop Systems, UAVs, Weapons, Spin recovery, Brake, Missile and Space application. He has 36 Journal publications and is proud recipient of number of awards including the Commendation by the Chief of Army Staff.

In 2004, Mr Balraj Gupta was appointed as the Scientific Advisor to Chief of Army Staff. During this tenure, he has successfully completed number of projects including establishing Parachute Repair Wing at Agra for the Army, the Modification of Sarvatra Bridge, repairing of Milan Missile Cooling Bottle, the trial of Multi mode grenades and user trials of CFF parachutes.

Mr Balraj Gupta is presently The Director, ADRDE, Agra. He is also the Chairman of the Agra Chapter of Aeronautical Society of India.



# Profile of Seminar Speakers and Abstracts



## **Prof. Inderjit Chopra**

Alfred Gessow Prof. of Rotorcraft Engineering  
Director, Alfred Gessow Rotorcraft Center  
Department of Aerospace Engineering,  
University of Maryland  
College Park MD 20742  
Tel: 301-405-192;  
[chopra@eng.umd.edu](mailto:chopra@eng.umd.edu)

Dr. Inderjit Chopra is the Alfred Gessow Professor in Aerospace Engineering and Director of Rotorcraft Center at the University of Maryland. He received his M.E. (Aero) from Indian Institute of Science, Bangalore in 1968 and his Sc.D. (Aero & Astro) from MIT in 1977. He worked at the National Aerospace Labs, Bangalore from 1966 to 1974. His research there included wind tunnel testing of scaled aeroelastic models of airplanes and launch vehicles. In 1977, he joined NASA Ames/Stanford University Joint Institute of Aeronautics & Acoustics, where he worked on the aeroelastic analysis and testing of advanced helicopter rotor systems. He has been working on fundamental problems associated with aeromechanics of helicopters, smart structures and micro air vehicles. His graduate advising resulted in 38 Ph.D. and 70 M.S. degrees. An author of over 165 archival papers and 270 conference papers, Dr. Chopra has been an associate editor of *Journal of the American Helicopter Society* (1987-91), *Journal of Aircraft* (1987-cont.) and *Journal of Intelligent Materials and Systems* (1997-cont.). Also, he has been a member of the editorial advisory board of various journals. He was the recipient of 1992 UM's Distinguished Research Professorship, 1995 UM's Presidential Award for Outstanding Service to the Schools, 2001 ASME Adaptive Structures and Material Systems Prize, 2002 AIAA Structures, Structural Dynamics and Materials Award, 2002 AHS Grover Bell Award, 2002 A. J. Clark School of Engineering Faculty Outstanding Research Award, and 2004 SPIE Smart Structures & Materials Lifetime Achievement Award. He has been a member of the *Army Science Board* (1997-2002) and *NASA Aeronautics and Space*

*Engineering Board* (2007-cont.). He is a Fellow of AIAA, *American Helicopter Society*, *ASME*, *Aeronautical Society of India* and *National Institute of Aerospace*.

## **Rotor Based Micro Air Vehicles: Challenges and Opportunities**

A Micro air vehicle (MAV) is envisaged to be a small-scale autonomous flying vehicle (with no dimension larger than 15 cm) intended for reconnaissance over land, in buildings and tunnels, and in other confined spaces. While some progress has been made in this field, no vehicle has been able to achieve long-loiter time (over 60 minutes) and hover at weights less than 100 grams with a payload of about 20 grams. Several factors contributed to this poor performance including lack of understanding of aerodynamic, structural and propulsion physics at the micro-scale. Also, none of these configurations can carry avionics packages that would permit robust navigation in complex urban environments. In contrast, nature has evolved thousands of miniature flying machines (insects and small birds) that perform far more difficult missions. While details underlying the operational success of biological fliers remain an ongoing research endeavor, a general picture is emerging that indicates that the overwhelming superiority of biological fliers over existing MAVs stems from two fundamental factors: ability to generate lift more efficiently than existing technologies and ability to store and release energy efficiently.

Two efficient hovering configurations can be used to generate sufficient thrust to sustain weight; rotary-wings and flapping-wings. The rotary-wing approach has proved successful in the high Reynolds number regime ( $>10^6$ ), where inertial forces dominate flow characteristics. However, in the low Reynolds number regime that scales MAV flight physics, it is not clear which solution is more efficient. Hence, both hovering concepts are being examined at this time. To develop such vehicles, challenges include: low Reynolds number flow regime ( $\sim 10^4$ ),





# Profile of Seminar Speakers and Abstracts

low altitude environment (gusts and obstacles), size and weight constraints, compact power generation and storage, micro actuators, strong aeroelastic couplings, and stringent navigational and guidance requirements. Among hovering air platforms, rotor-based platforms appear more advanced at this time than flapping-wing-based vehicles. The objective of this presentation is to cover the state-of-the-art design concepts and aeromechanics of rotor-based MAVs, and identify key barriers for future research. Covered configurations will include: single main rotor with turning vanes, coaxial rotor, shrouded rotor, flapping rotor, and cycloidal rotor systems.

Because of dominant viscous effects at low Reynolds numbers, hover figure of merit of current MAVs ranges from 0.4 to 0.65, a number far below the full-scale value of about 0.8. Cambered plates with maximum camber (6.75%) ahead of mid-chord, and a sharp leading edge exhibited the best hover performance. Detailed flow visualization of a single rotor using laser sheet showed evidence of highly non-ideal inflow wake distribution and a significant blocked flow in the center. At a given disk loading, there is a specific combination of rotor speed and collective pitch at which the power loading becomes optimum. It is possible to counteract the torque of the main rotor by installing active turning vanes in the downwash of the main rotor. Incorporation of duct around a rotor resulted in an increase of total thrust by 25% for a given electric power. A coaxial rotor configuration is compact, but can be less efficient in hover because of aerodynamic interference between rotors. Providing a shroud around a single rotor would not only improve hover performance of the system, but would also serve as a safety feature. However in forward flight, the shrouded rotor resulted in more drag and pitching moment compared to the free rotor. In a cycloidal rotor, it is envisaged to have a superior aerodynamic efficiency than a conventional rotor. Three-bladed cycloidal rotor was found to be more efficient than a six-bladed rotor. To improve rotor performance of a single rotor especially at high thrust levels, it may be possible to exploit the unsteady aerodynamic effects using a flapping rotor.



## **Prof. Farshad Khorrami**

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Farshad Khorrami received his Bachelor's degrees in Mathematics and Electrical Engineering in 1982 and 1984 respectively from The Ohio State University. He also received his Master's degree in Mathematics and Ph.D. in Electrical Engineering in 1984 and 1988 from The Ohio State University. Dr. Khorrami is currently a professor of Electrical & Computer Engineering Department at Polytechnic University where he joined as an assistant professor in Sept. 1988. His research interests include *control systems with emphasis on nonlinear systems, robotics and automation, unmanned vehicles (fixed-wing and rotary wing aircrafts as well as underwater vehicles and surface ships), smart structures, large-scale systems and decentralized control, adaptive control, and microprocessor based control and instrumentation.*

Prof. Khorrami has published more than 180 refereed journal and conference papers in these areas. Springer Verlag published his book on "modelling and adaptive nonlinear control of electric motors" in 2003. He also has twelve U.S. patents on novel smart micro-positioners and actuators, control systems, and wireless sensors and actuators. He has developed the Control/Robotics Research Laboratory at Polytechnic University. The Army Research Office, National Science Foundation, Sandia National Laboratory, Office of Naval Research, Army Research Laboratory, NASA Langley Research Center and several industrial organizations, has supported his research. Prof. Khorrami has served as chairman and program committee member of several international conferences.



# *Profile of Seminar Speakers and Abstracts*

## **Deconfliction and Collision Avoidance Algorithms for Unmanned Systems**

Unmanned vehicles for land, sea, air, and space have numerous military and civilian applications including surveillance, communication relays, rescue, traffic monitoring, border patrol, weather monitoring, transmission line and pipeline monitoring and inspection to name a few. The successful deployment of autonomous vehicles and their effective use in a variety of missions requires several key technologies including reliable obstacle detection sensors, algorithms for path planning and obstacle avoidance sensors, and robust inner-loop dynamic controllers. An important challenge in the development of these key technologies is the tight constraint on payloads (in terms of size, weight, power requirement, etc.) especially on micro aerial vehicles (MAVs). Meeting the payload constraints requires small low-power sensors and algorithms with low computational complexity and memory requirements.

This presentation will first provide a broad overview of the challenges and current state-of-the-art MAV obstacle avoidance technologies, both in terms of sensor hardware (cameras, RADAR, LIDAR, etc.) and obstacle detection and avoidance algorithms (optical flow, potential fields, graph theoretic algorithms, etc.). The talk will then focus on a general-purpose path planning and obstacle avoidance technology that we have developed in recent years. This technology utilizes a hierarchical architecture comprising of a Wide-Area Planner (WAP) based on the well-known A\* graph-search algorithm and a Local-Area Planner (LAP) based on our low-resource reactive obstacle avoidance algorithm called GODZILA (Game-Theoretic Optimal Deformable Zone with Inertia and Local Approach). The WAP and LAP address the far-field (or global) and the near-field (or local) aspects of path planning and obstacle avoidance. The WAP utilizes an environment map with large range but low resolution while the LAP uses a finer resolution to focus on local obstacles. The LAP may be utilized alone if payload constraints are extreme.

The distinctive feature of the GODZILA algorithm is that no prior knowledge of the environment is required and a map of the environment does not need to be built during navigation. GODZILA follows a purely local approach using current sensor measurements. This minimizes the memory and computational requirements for implementation of the algorithm, a feature that is especially attractive for small autonomous vehicles (specifically MAVs). GODZILA is highly flexible and can operate in dynamic environments (in both two-dimensional and three-dimensional spaces) with moving obstacles or with obstacles with changing sizes. Due to its low computational complexity, GODZILA can be operated at high sampling rates even on small embedded platforms (e.g., around 5Hz is attainable with a Rabbit microprocessor) resulting in a low latency navigation solution capable of reacting quickly to changes in the environment. GODZILA can also be used as the low-level path planner and obstacle avoidance solution for collaborative missions involving multiple agents.





# *Profile of Seminar Speakers and Abstracts*



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Dr. Kudva received his BS in Aeronautical Engineering from the Indian Institute of Technology in 1973, and his MS and PhD degrees in Aerospace Engineering from Virginia Tech in 1976 and 1979, respectively. From 1979 to 1980 he was a member of the Aerospace Engineering Faculty at Rensselaer Polytechnic Institute in Troy NY. He worked at Northrop Grumman Corporation from 1980 to 2002, where he managed a structures R&D group and led the divisional activities on smart materials and adaptive aircraft. In 2003, he founded NextGen Aeronautics with the explicit purpose of developing revolutionary technologies and designs for the next century of flight. He is an Associate Fellow of AIAA.

## **Morphing Wings: From Concept to Reality**

Morphing aircraft wings are defined as wings that undergo very large changes in geometry (span, area, chord, sweep, etc.) such that the wing configuration is optimized for widely varying flight conditions (e.g., loiter, dash and high-speed manoeuvres). They represent the next step in aircraft wing design, and will lead to multi-role, multi-function aircraft.

Under a three-year program from DARPA, NextGen has designed and developed a revolutionary morphing aircraft wing and successfully tested it in a wind tunnel at transonic Mach numbers and operational load conditions. NextGen also designed, developed, and demonstrated in-flight wing morphing on a 100-lb Jet powered RC model, named the MFX-1, in August 2006. A larger 300-lb MFX-2 UAV, with two morphing degrees of freedom, was successfully flight tested in September 2007.

This talk will present a background of morphing wing concepts and outline the design, and development work performed under the program, as well as discusses the future of morphing aircraft technologies. Also the challenges of starting and running an aerospace R&D company will be briefly addressed.



# Profile of Seminar Speakers and Abstracts



**Prof Thomas Daniel**

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Thomas Daniel is the Chair and Joan and Richard Komen Professor of Biology at the University of Washington. He received his Bachelor's and Master's Degrees from the University of Wisconsin where he worked on drag reduction mechanisms in fish. He later received a Ph.D. from Duke University where his research focused on unsteady aspects of aquatic locomotion. He had postdoctoral training at the California Institute of Technology, where he studied unsteady flexing foil fluid dynamics. He was appointed to the faculty at the University of Washington in 1984 and currently is chair of Biology. He has received awards from the University for teaching, graduate mentorship and from MacArthur foundation. His current research focuses on the dynamics and control of flight in insects and on the molecular basis of force generation in muscle.

## **Flight Dynamics in the Hawk Moth *Manduca sexta***

Hawk moths fly under low light conditions, capable of hovering while feeding from moving flowers. They process both visual and mechano-sensory information to control a variety of actuators (wings and abdominal motions) that affect the flight path. This talk will review the diverse elements of flight control in the hawk moth, highlighting recent advances in our understanding of the aerodynamics of flight and its control. We focus on two themes: (1) sensory-motor integration of flight control which shows that abdominal motions are coupled to both visual and mechano-sensory input and (2) the emergent dynamics of highly compliant wings.

In our analysis of the role of abdominal motions, we show that significant shifts in the center of gravity can lead to changes in the flight path. These shifts correlations are shown for freely flying individuals and those subjected to direct stimulation of the abdominal musculature. Moreover, both visual and mechano-sensory information drive abdominal motions in both the pitch and yaw planes, though with vastly different time constants (~80 ms delays for visual systems; ~10 ms delay for mechano-sensory systems). The ability to drive abdominal shifts via electrical stimulation allows us to test hypothesis about the role of the abdomen in flight control.

While abdominal motions present an intriguing part of the flight control system, wings (particularly highly compliant ones) are clearly the most significant contributors to path control. While significant strides have been made in aerodynamic and kinematic studies of Dipteran (fly) wings, relatively less is known about wings that deform significantly during flight. As a second theme in this talk, we address the consequences of wing deformation to the flight control system. We show that hawk moth wings deform significantly during flight, manifest as large amplitude bending waves propagating chordwise along the wing. Moreover, using particle image velocimetry, we show that there are significant changes in the flux of momentum that are correlated with wing deformations.





# Profile of Seminar Speakers and Abstracts



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Srinivasan holds an undergraduate degree in Electrical Engineering from Bangalore University, a Master's degree in Electronics from the Indian Institute of Science, a Ph.D. in Engineering and Applied Science from Yale University, a D.Sc. in Neuroethology from the Australian National University, and an Honorary Doctorate from the University of Zurich. He is presently Professor of Visual Neuroscience at the Queensland Brain Institute of the University of Queensland. Among his awards are Fellowships of the Australian Academy of Science, of the Royal Society of London, and of the Academy of Sciences for the Developing World, and the 2008 Rank Prize for Optoelectronics. Srinivasan's research focuses on the principles of visual processing, perception and cognition in simple natural systems, and on the application of these principles to machine vision and robotics.

## **Vision-based Navigation and Control of MAVs**

Investigation of the principles of visually guided flight in insects is offering novel, computationally elegant solutions to challenges in machine vision and robot navigation.

Insects, in general, and honeybees, in particular, perform remarkably well at seeing and perceiving the world and navigating effectively in it, despite possessing a brain that weighs less than a milligram and carries fewer than 0.01% of the neurons in a human brain. Although most insects lack stereo vision, they use a number of ingenious strategies for perceiving their world in

three dimensions and navigating successfully in it. For example, distances to objects are gauged in terms of the apparent speeds of motion of the object's images, rather than by using complex stereo mechanisms. Objects are distinguished from backgrounds by sensing the apparent relative motion at the boundary. Narrow gaps are negotiated by balancing the apparent speeds of the images in the two eyes. The speed of flight is regulated by holding constant the average image velocity as seen by both eyes. This ensures that flight speed is automatically lowered in cluttered environments, and that thrust is appropriately adjusted to compensate for headwinds and tail winds. Visual cues are also used to compensate for crosswinds. Bees landing on a horizontal surface hold constant the image velocity of the surface as they approach it, thus automatically ensuring that flight speed is close to zero at touchdown. Bees approaching a vertical surface hold the rate of expansion of the image of the surface constant during the approach, again ensuring smooth docking. Foraging bees gauge distance flown by integrating optic flow: they possess a visually-driven "odometer" that is robust to variations in wind, body weight, energy expenditure, and the properties of the visual environment.

We have been using some of the insect-based strategies described above to design, implement and test biologically-inspired algorithms for the guidance of autonomous terrestrial and aerial vehicles.



# Profile of Seminar Speakers and Abstracts



## **Professor Rama Chellappa**

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Rama Chellappa received the B.E. (Hons.) degree from the University of Madras, India, in 1975 and the M.E. (Distinction) degree from the Indian Institute of Science, Bangalore, in 1977. He received the M.S.E.E. and Ph.D. Degrees in electrical engineering from Purdue University, West Lafayette, IN, in 1978 and 1981 respectively.

Since 1991, he has been a Professor of electrical engineering and an affiliate Professor of computer science at the University of Maryland, College Park. He is also affiliated to the Center for Automation Research (Director) and the Institute for Advanced Computer Studies (Permanent member). Recently, he was named a Minta Martin Professor of Engineering. Prior to joining the University of Maryland, he held various positions at the University of Southern California, Los Angeles. Over the last 26 years, he has published numerous book chapters and peer-reviewed journal and conference papers in image and video processing, analysis and recognition. He has also co-edited/co-authored six books on neural networks, Markov random fields, face/gait-based human identification and activity modeling. His current research interests are face and gait analysis, 3D modeling from video, automatic target recognition from stationary and moving platforms, surveillance and monitoring, hyper spectral processing, image understanding, and commercial applications of image processing and understanding.

Dr. Chellappa has served in various capacities like member, an associate editor, Co-Editor in chief, Editor in chief of several IEEE Transactions. He was the Vice President of Awards and Membership of IEEE signal processing Society Board. He has

received several awards, including an NSF Presidential Young Investigator Award in 1985, three IBM Faculty Development Awards, the 1990 Excellence in Teaching Award from the School of Engineering at USC, the 1992 Best Industry Related Paper Award (with Q. Zheng), the 2006 Best Student Authored Paper in the Computer Vision Track (with A. Sundaresan) from the International Association of Pattern Recognition, and the 2000 Technical Achievement Award from IEEE Signal Processing Society. He was elected as a Distinguished Faculty Research Fellow (1996-1998) and as a Distinguished Scholar-Teacher (2003) at the University of Maryland. He is a co-recipient (with A. Sundaresan) of the 2007 Outstanding Innovator Award from the Office of Technology Commercialization and received the A. J. Clark School of Engineering 2007 Faculty Outstanding Research Award. He is a Fellow of IEEE and the International Association for Pattern Recognition. He has served as a General and Technical Program Chair for several IEEE international and national conferences and workshops. He is a Golden Core Member of IEEE Computer Society and also received a Meritorious Service Award from the IEEE Computer Society in 2004.

## **Onboard Information Processing and Data Compression for Micro-Aerial Vehicles**

Due to power and bandwidth constraints, onboard information processing of video sequences collected by a micro air vehicle needs an integrated approach towards algorithm design and implementation. In this talk, methods for onboard stabilization and compression of video sequences and detection and tracking of moving objects, and building 3D models of objects will be presented. Onboard mechanisms for detection tracking failures using time-reversibility constraints will be discussed. Robust implementations using onboard imaging and inertial sensors for some of these tasks will be outlined. Designs of optimized algorithms and architecture will also be presented, for a general class of video trackers.





# Profile of Seminar Speakers and Abstracts



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Dr. Dugan has PhD in mechanical engineering from the California Institute of Technology and her master's and bachelor's degrees from Virginia Tech. She is an experienced professional in defense against explosive threats and counterterrorism. On these topics, she has interacted with the highest authorities in Defense and Government. She is field experienced, having participated in active mine clearance efforts in Mozambique and field tested equipment in both Africa and Bosnia. She was also a special advisor directly to the Vice Chief of Staff of the Army (2001 -03) and continues to serve on senior advisory panels.

In 1999, she was named DARPA Program Manager of the year and in 2000 she was awarded the Bronze deFleury medal, the most prestigious award of the Army Engineer Regiment. In 2001, Dr. Dugan co-founded Dugan Ventures, a niche investment firm, where she has served as President & CEO. Widely recognized for her leadership in technology development and an experienced public speaker, she has appeared on the *Discovery Channel*, *National Public Radio*, and *The AAAS Science Report*. She is the coauthor of *Engineering Thermodynamics*, 1996. She has many patents to her credit.

## **Novel Methods in Explosives Detection: From Operations to Olfaction**

This presentation focuses on a new conceptual framework as it relates to the IED threat and recent areas of research in new

detection technologies ranging from quadrupole resonance to systems that mimic the mammalian olfactory system.

The new conceptual framework consists of an order of magnitude (factor of ten) analysis of the terrorist or insurgency problem. It provides a straightforward organizing principle against which to test possible technological, organizational, or tactical solutions as well as a means for assessing their effectiveness in execution. The "bookends" principle illustrates the difficulty of achieving success using current approaches and challenges existing investment strategies for both the military and homeland security problem. The author suggests that current approaches and investments are overly focused on finding the bomb after deployment despite recognition that such solutions are unlikely to change the basic nature of the fight. The "bookends" principle shows that in the matching between the types of weapons/means of delivery and the possible target set, there exists a problem of order 100 to the 100<sup>th</sup> power (a combinatorial explosion). We will *always* lose if we fight here.

The analysis does not suggest that we do nothing to stop certain weapons or protect key targets; it does, however, suggest that such activities be tailored to effect outcomes at the terrorist or insurgency organizational levels. The "bookends" theory highlights what most commanders and security officers know intuitively. It turns this intuitive understanding into an actionable organizing principle against which various solutions may be weighed. This conceptual framework serves as a backdrop for reviewing historical efforts in combating IEDs that have ranged from detection methods to armored vehicles. The author concludes by discussing and challenging the way forward.



# Profile of Seminar Speakers and Abstracts



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## Hovering Capabilities of Fixed-Wing Micro-Aerial Vehicles

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Fixed-wing micro air vehicles (MAV) are very attractive for outdoor surveillance missions since they generally offer better payload and endurance capabilities than rotorcraft or flapping-wing vehicles of equal size. They are generally less challenging to control than rotorcraft in outdoor environment and allow for a dash capability to escape enemy attention. On the other hand, they usually fail miserably to perform vertical take-off and landing (VTOL) and sustain stable hover flight which proves to be crucial for urban surveillance missions including building intrusion. The present paper investigates the possibility to improve the aerodynamic performance of fixed-wing MAV concepts so as to allow for true hovering capabilities and still maintain high cruise speed for covertness.

Several combinations of rotors and fixed-lifting surfaces were tested, analyzed and compared. First, a tandem-rotor biplane MAV configuration was designed and tested as a result of different biplane powered configurations. A low-speed

autonomous fixed-wing MAV was fabricated and flight tested to perform multi-tasking outdoor surveillance missions. Secondly a side-by-side comparison of a tilt-wing and a tilt-body powered configuration with a pair of counter-rotating motors in tractor configuration with MAV configurations were carried out. The tilt-body configuration was shown to be more suitable for MAV applications with higher hovering performances. Second, a coaxial tilt-body concept based on coaxial motors and contra-rotating propellers inspired from the *Convair* XFY1 "Pogo" experimental aircraft was designed and tested. A wind tunnel test was carried out to fully characterize the aerodynamic performances of the coaxial tail-sitter configuration, named *Vertigo*. An autonomous version was developed in order to autonomously perform transitions between horizontal and vertical flight. A smaller 300-mm span version, called *mini-Vertigo*, was designed and fabricated based on a series of wind tunnel tests using miniaturized coaxial-rotor propulsion set. Autonomous altitude hold and attitude stability augmentation were then achieved using specific control laws adapted for the *Paparazzi* autopilot system. Thirdly, a new no-through-shaft coaxial-rotor configuration has been proposed in order to enhance the prototype ruggedness through an embedded spherical structure made of carbon rods. It is believed that such a crash-proof VTOL MAV, called *Cyclope*, can be very attractive for the use of MAV systems in real operations and allows for further size reduction such as for Nano Air Vehicles applications. Current prospects include both further wind tunnel tests using new high-precision micro sting-balances on coaxial-rotor tail-sitter MAVs and the development of control laws to autonomously perform transition flights.

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# Profile of Seminar Speakers and Abstracts



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Paul received both his MA and PhD in psychology. His scientific aim is to find a unified theory of mind, brain and body through the use of synthetic methods and to apply such a theory to the development of novel cognitive technologies.

Paul has pursued his research at different institutes in the US (Neurosciences Institute and The Salk Institute, both in San Diego) and Europe (University of Amsterdam, University of Zurich and the Swiss Federal Institute of Technology-ETH and University Pompeu Fabra in Barcelona).

Paul works on biologically constrained models of perception, learning, behavior and problem solving that are applied to wheeled and flying robots, interactive spaces and "avatars". The results of these projects have been published in leading scientific journals including Nature, Science, PLoS and PNAS. In addition to his basic research, he applies concepts and methods from the study of natural perception, cognition and behavior to the development of interactive creative installations and intelligent immersive spaces. Since 1998, he has, together with his collaborators, generated a series of 17 public exhibits of which the most ambitious was the exhibit "Ada: Intelligent space" for the Swiss national exhibition Expo.02, that was visited by 560000 people.

Verschure leads a multidisciplinary group of 10 doctoral and post-doctoral researchers including physicists, psychologists, biologists, engineers and computer scientists.

## **Optimizing Robot Chemical Mapping and Localization by Building an Artificial Insect: the Bond between Perception and Action**

The brain of an average insect is more advanced in processing complex sensory states than our most sophisticated technologies. For instance, male moths display changes in heart rate concentrations of pheromones as low as 10-18g based on a sensitivity of 10-7g at their sensor periphery. Obviously we have been missing out on something. It will be shown that one reason for missing the boat of artificial perception is due to insistence on hierarchical Perception-like methods. The second reason is that the importance of behavior itself has been neglected. It will be shown that natural perception depends only partially on hierarchically structured filter systems by discussing a novel and brain based method for rapid sensor processing and classification that we have been developing over the last few years the so called temporal population code -TPC. TPC shows how densely coupled neuronal structures can be seen to transform static spatial stimulus features into a dynamic temporal representation. It will be shown that this concept is well supported by our study of olfactory encoding by the insect antennal lobe system. Subsequently the issue of behavior and active sensor sampling itself will be addressed. It will be proved that the Perception and behavior are tightly coupled processes. As an example the case of chemical searching will be analysed. It will be demonstrated by using an analysis of the behavior of the male moth in search of a mate as well as a robot negotiating a windtunnel, that the exquisite capabilities of insects for the localization and mapping of chemical cues emerged from the intricate relationship between their sensing capabilities and their specific sampling strategies. These results combined with our previous work will be used on the opto-motor system to present a prototype of a neuromorphic control system for an artificial insect that can be applied to an autonomous unmanned aerial vehicle.



# Profile of Seminar Speakers and Abstracts



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Shri VS Mahalingam joined DRDO after obtaining his Bachelor's degree in Engineering in the year 1973 from the College of Engineering, Guindy, affiliated to Madras University. He had advanced training in Software Engineering at Indus Tech, Pittsburgh, USA, and obtained his master degree from Indian Institute of Technology, Kanpur. He has made outstanding contributions in the development of equipments like Multiplexer for Adaptive Delta Modulation (ADM) coded signals, FDM signal encryptor (named Broad Band Caddis), Radio Regenerator Unit, Digital Trunk Unit, Shelterised Command Post for PINAKA Weapon system, C3I system - Artillery Combat Command and Control System and Command Information Decision support System that have found widespread usage amongst services. He has published more than 12 papers in various International and National forum. He is one of the members of team which received the Agni Award for Excellence in Self Reliance in the year 2003. He received the Scientist of the Year Award in 2003.

## **Mobile Robotics - A DRDO Perspective**

Mobile Robots are set to play a very major role in the realization of future battlefield platforms including unmanned /autonomous air / ground /under water vehicles. A classical application of unmanned ground vehicles has been the disposal of hazardous explosives. In the military context, the new generation of fast, agile mobile robots is expected to perform such hazardous tasks as well as surveillance, reconnaissance, logistics support and even enemy attack.

These modern new generation robots are required to be built with sophisticated on board "intelligence" to efficiently perform the above tasks. The intelligence component comprises of an integrated GPS, Image /video processing, Laser ranging etc and advanced algorithms embedded into an onboard computer.

A number of DRDO labs are working on different classes of tracked, wheeled under water and unmanned/autonomous vehicles.





# Profile of Seminar Speakers and Abstracts



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Dr. Vijayalakshmi Ravindranath is the Founder Director of the National Brain Research Centre, a Deemed University, which has been recently established by the Government of India as a centre of excellence to co-ordinate and network neuroscience research groups in the country. After completing her Master's degree, she obtained her Ph.D in Biochemistry from Mysore University in India and carried out post-doctoral research at the National Institutes of Health, USA. Prior to taking over the current position at NBRC, she was a Professor of Neurochemistry at National Institute of Mental Health and Neurosciences, Bangalore where her research centered on identifying the factors involved in differential drug responses often seen in patients with mental illnesses. She has also been studying the molecular mechanisms underlying the pathogenesis of neurodegenerative disorders such as Parkinson's disease and motor neuron disease. She has spear-headed the establishing of the NBRC and networked over 45 institutions involved in neuroscience research and helped to develop multi-institutional and multi-disciplinary collaborations while making available the facilities at NBRC to neuroscientists from other centers.

She has won many awards like Shanti Swarup Bhatnagar Award for Medical Sciences, 1996, Omprakash Bhasin Award for Science and Technology, 2001 & K.P. Bhargava Medal of INSA (2001). She is the fellow of The National Academy of Sciences, India, 1998, Indian Academy of Science, 2001, Third World Academy of Sciences, 2002 and Indian National Science Academy, 2004. She is also member of Governing Council of International Brain Research Organisations, Council of Federation of Asian and Oceanian Neuroscience Societies, International Neurotoxicology Association & International Society for Neurochemistry, American Association for Advancement in

Science to name a few. She is member of various editorial boards like Progress in Neurobiology, International Journal Neurotoxicity Research, Neuroscience research and Current Science.

## The Human Brain: Biological Networks and Complexity

The human brain is a complex structure endowed with properties ranging from learning and memory, to perception, cognition and consciousness. Understanding how such properties emerge as a result of the molecular and biochemical machinery remains a fundamental conceptual challenge confronting science today. This complexity arises through synergistic interactions across multiple levels of organization, with each level of organization emerging from a lower level. For example, in order to understand a neuron, it is necessary to understand the molecular and biochemical machinery that makes up the cell; the interaction of neurons in turn, through electrical signals generated from the interaction of ion channels, gives rise to local neural networks that are capable of processing simple information; the interaction of these neural networks across different brain areas in turn helps the processing of more complex information. Thus, from the integration of information across different networks, such as those that process sensory and motor information, emerge higher order functions like decision-making and cognition. Complete understanding of brain functions in health and disease is an interdisciplinary effort spanning molecular and cellular systems and cognitive levels of organization. New insights have been gained into the molecular under-pinning of human cognitive processes and the biological basis of behaviour and cognition has been irrevocably established. Further, discoveries in the last decade have demonstrated the capacity of the brain to change during one's life span and during injury. This plasticity is seen to the utmost during development although it is evident all through life. Although more has been learnt of the human brain in the last decade than in the previous hundred years, we are cognizant of the enormity of what is yet to be understood, which will come about through an interdisciplinary approach involving molecular biology, physiology, psychology and computational science.



# *Profile of Seminar Speakers and Abstracts*



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Colonel McGhee received his commission after graduating from the Medical College of Virginia in 1981. He is board certified in both Family Medicine and Aerospace Medicine, and is a Fellow of both the American Academy of Family Practice and of the Aerospace Medical Association. Additionally, Colonel McGhee earned a Master of Science degree in Environmental Engineering from the Virginia Polytechnic Institute and State University, and a Master of Public Health degree from Johns Hopkins University.

During his career, Colonel McGhee has commanded several medical treatment facilities in the US and internationally, and has two tours in the Pentagon. Prior to his assignment at the US Army Aeromedical Research Laboratory, he was the Dean of the US Army School of Aviation Medicine (USASAM). While serving as the Dean of USASAM, he was appointed as the Army Surgeon General's Consultant for Aerospace Medicine.

His military awards include the Master Flight Surgeon Badge, the Defense Meritorious Service Medal, the Meritorious Service Medal (with 4 oak leaf clusters) and the Army Commendation Medal (with 3 oak leaf clusters) and the Legion of Merit. He holds the US Army special skill identifier designation for space activities. He has been inducted into both the Order of Military Medical Merit and the Order of St. Michael. Most recently he was awarded the Order of Aeromedical Merit for lifetime achievement in Army Aviation and the Army Surgeon General's "A" designation for excellence in the field of aerospace medicine.

Colonel McGhee has lectured extensively on the subject of the human factor aspects of unmanned aerial systems. He serves as consultant for aerial robotics and telemedicine to the Technology and Telemedicine Research Center of the Medical Research and Materiel Command, Ft. Detrick., MD which is developing an unmanned medical evacuation capability for the US Army. He is presently the Commander of the US Army Aeromedical Research Lab, Ft. Rucker, Alabama.

## **Human Factor Considerations for MAV**





# Profile of Seminar Speakers and Abstracts



**Prof Tomonari Furukawa**  
School of Mechanical and Manufacturing  
University of New South Wales  
Sydney 2052, New South Wales, Australia  
t.furukawa@unsw.edu.au

Tomonari Furukawa is a Senior Lecturer at University of New South Wales (UNSW), Sydney, Australia. He received the B.Eng. in Mechanical Engineering from Waseda University, Japan, in 1990, the M.Eng. (Research) in Mechatronic Engineering from University of Sydney, Australia, in 1993 and Ph.D in Quantum Engineering and Systems Science from University of Tokyo, Japan, in 1996. He was an Assistant Professor (1995-1997) and Lecturer (1997-2000) at the University of Tokyo, and Research Fellow (2000-2002) at the University of Sydney before joining UNSW. His research work focuses on inverse analysis and optimisation methods in computational mechanics and robotics. He has published over 160 technical papers and won various early career research awards and paper awards including the most prestigious computational mechanics young investigator award from International Association for Computational Mechanics.

## **Coordination of MAVs and UGVs for Information-theoretic Urban Search and Rescue**

This talk presents an information-theoretic control (ITC) technique that coordinates Micro Aerial Vehicles (MAVs) and Unmanned Ground Vehicles (UGVs) for Urban Search and Rescue (USAR). USAR missions are concerned with the state estimation of various static and dynamic targets such as (i) victims to search

for & rescue and (ii) enemies to capture or escape where their information is often partially available. The technique, unlike the traditional area coverage and tracking techniques, can utilize any available information including prior knowledge and empirical knowledge. ITC technique effectively estimates the target states in the form of probability density function (PDF). The use of a nonlinear recursive Bayesian estimator further enables the estimation of a non-Gaussian PDF of a nonlinear system. Thus the search, results in a highly non-Gaussian PDF due to the use of the negative observation likelihood, as well as the tracking. The independent nodewise computation in the nonlinear recursive Bayesian estimation (RBE) also allows its implementation into a parallel computer including the graphical processing unit, making the real-time RBE possible irrespective of the number of vehicles to coordinate.

The preliminary numerical investigations show successful implementation through validation and verification as well as real-time performance even when the number of nodes used for RBE exceeds one million. The proposed technique was further used for the RBE by a team of rotary-wing MAV and UGVs each equipped with a GPS and a compass to identify its global state, a camera to detect a target and a wireless module to communicate with the ground station. Although the ground to search for a target was vast and thus made the number of nodes considerably large, the proposed technique could execute real-time RBE while the MAVs and UGVs were cooperatively observing the ground.



# Profile of Seminar Speakers and Abstracts



**Prof. Kenzo Nonami**

Department of Mechanical Engineering  
Division of Artificial Systems Science  
Graduate School, Chiba University  
1-33 Yayoi-cho, Inage-ku  
Chiba 263-8522, JAPAN  
nonami@faculty.chiba-u.jp

Dr. Kenzo Nonami has a Doctorate degree (1979) in Mechanical Engineering from Tokyo Metropolitan University. He worked as an Associate Professor at Chiba University from 1988 to 1994 and as full professor in the Department of Mechanical Engineering and Electronics from 2004. He won the NRC research fellowship at NASA (USA) in 1985 and did research on various fields like robots, unmanned small scale helicopter, Micro Air Vehicle to name a few. He is a member of Japan Society of Mechanical Engineers, Robotics Society of Japan, IEEE, ASME, etc. He has published more than 300 journal papers and seven textbooks. He has guided 36 Ph.D students. He will be taking over as Vice-President of Chiba University in April 2008. He has many awards to his credit from Japan and American Society of Mechanical Engineers.

## Autonomy in Robots

There is a widespread & rapid development of unmanned aircraft (UAV & MAV) equipped with autonomous control systems, called "robotic aircraft" in recent years. Although they can be used for both civil and military applications, remarkable development has taken place for applications in military use. However, by exploiting the outstanding characteristics of these devices, there are infinite possibilities of making use of them for civilian use even though applications are not obvious. In the light of the present scenario, we present here the recent research & development of these autonomous uninhabited aircraft for civilian use.

Chiba University UAV group started research on autonomous control from 1998, continued advanced joint research with Hirobo, Ltd. from 2001 and realized in a small-scale hobby helicopter fully autonomous control. We describe here the power line monitoring application of UAV called **SKYSURVEYOR**. The helicopter with a gross weight of 48kgs, payload of 20kgs and with various cameras mounted on them, with cruising time of one hour, catches power line, regardless of the shake of the helicopter. We have also developed another autonomous controlled hobby helicopter SST-eagle2-EX with a gross weight of 5kg - 7kg, payload of 1kg and cruising time of 20 minutes. This is a cheap, simple system, which can be flown by a single person and can be used for spraying chemicals to fields, gardens, to orchards etc. It can also be used for aerial photographing, for surveillance and for disaster prevention rescues. This system automated the hobby commercial radio control helicopter.

Chiba University and GH Craft are continuing research and development of autonomous control of the four rotor-tilt-wing aircraft. This QTW (Quad Tilt Wing) UAV is about 30kg in gross load, take-off and landing is made in helicopter mode and the high-speed cruising flight is carried out in airplane mode. Although Bell company in the US were the first to make this system and the first flight of the QTR(Quad Tilt Rotor)-UAV was carried out in January, 2006, QTW-UAV is not existing in the world now. Scientific observation flights in South pole –the Antarctica Exploration using the above system is being done at a fast pace and there has been considerable development.

Chiba University and Seiko Epson have jointly tackled the autonomous control of micro flying robot of the smallest size in the world, weighing 12.3g. This offers an opportunity as a light weight MAV with autonomous control in the interior of a room for image processing using a camera. Chiba University with Hirobo, Ltd. has also succeeded in the development of a similar robot, though heavier by 170g.





# *Profile of Seminar Speakers and Abstracts*

The configuration of the autonomous control system in the power line monitoring helicopter has been successfully demonstrated in this presentation. Generally, the autonomous UAV used for civilian purpose consists of a power line monitoring helicopter SKYSURVEYOR as indicated earlier. The various systems which are carried on a Civil used UAV are (i) sensors for autonomous control such as GPS receiver, an attitude sensor and a compass (ii) on- board computer and (iii) a powerline monitoring device. These will be dealt in detail in the presentation. The flight of the compound inertial navigation of GPS/INS or 3D stereo vision base is also possible if needed. From the ground station operator assisted flight is also possible. In addition, although a power line surveillance image is recorded on the video camera of UAV loading in automatic capture mode and it is simultaneously transmitted to a ground station, an operator can also perform posture control of a power line monitoring camera and zooming by interruption at any time. Also, the autonomy ground robot like a hexapod robot, a dual manipulator robots, and the autonomy marine robot like a robotic boat are briefly introduced in this presentation.



# Profile of Judging Panel Members



**Nils Holme**  
Hurdalsgt. 5  
No. 2003 Lillestrom  
Norway

Mr. Holme, received his degree as a graduate engineer (applied physics) from the Norwegian University of Technology in 1961. After his university, Mr Holme joined Norwegian Defence Research Establishment (FFI) at Kjeller, Division for Systems Analysis, where he assessed the performance of maritime aircraft, and tactics for their operations in surveillance of the Northern Waters. He joined SHAPE Technical Center in The Hague as a scientist in 1964, working on computer applications for NATO Air Defence Ground Environment (NADGE). Returning to FFI in 1967, he became project manager for development of a new weapons control system for the KOBLEN class submarines. In 1971 he became the Assistant Director of *Informasjonskontroll A/S*, directing a study for NATO Industrial Advisory Group (NIAG) of alternative concepts for microwave landing systems (MLS). In 1973 he joined Norconsult in Saudi Arabia, as a field engineer on a project to install a telecommunication cable system joining the major cities in the country. Returning to FFI in 1976 he became manager for development of the weapons control system for the German-Norwegian Submarine Project. In 1977 he became Director of Research, and from 1981 Chief, Division for Electronics. A major effort in this period was the development of a new concept for a digital, tactical radio system. In 1988 Mr. Holme joined Ministry of Foreign Affairs as a special advisor on strategic export control. In 1990 he became the Chief-of-Staff of FFI, and in 1993 he was appointed Director General of FFI, a position he held until 2001. He is presently Senior Advisor to The Norwegian Atlantic Committee.

Mr Holme has served for many years on various NATO groups, including Tri-Service Group on Telecommunications and Electronic Engineering (TSGTEE), AGARD National Delegate Board, and NATO Research and Technology Board (RTB) from 1997 to 2001. He was Study Director for Aerospace 2020 (AGARD 1995). He was a member of the National Defence Council and the National Defence Research Policy Board (1993-2001). Mr Holme was elected member of The Norwegian Academy of Technical Sciences in 1993, and was Chairman of The Polytechnical Society (1997-99). He was Chairman of NATO RTB (2000-2003) and received the von Karman Medal in 1998.

Mr Holme has published number of articles on defense related issues and on aspects of government.





# Profile of Judging Panel Members



## Prof Roddam Narasimha

Chairman, Engineering Mechanics Unit  
Jawaharlal Nehru Centre for Advanced  
Scientific Research  
Jakkur P O, Bangalore 560 064  
Ph: 91 80 2208 2789/2293 2505 Fax: 91 80  
2360 0865  
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Prof Roddam Narasimha was Educated at University College of Engineering, Bangalore, for his BE degree in 1953. He got his A.I.I.Sc & D.I.I.Sc from Indian Institute of Science, Bangalore in 1955 & 57. He took his Ph.D from California Institute of Technology, USA, in Aeronautics and Physics in the year 1961.

He is currently holding the position of Chairman, Engineering Mechanics Unit at Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore. Prior to this he had very distinguished career holding various important positions like Chief Project Coordinator, Hindustan Aeronautics Ltd., (1977-79), Professor and Chairman, Aerospace Engineering, Dean Engineering Faculty, Founder-Chairman, Centre for Atmospheric Sciences, at Indian Institute of Science (1962-89), Director of the National Aerospace Laboratories (1984-1993), INSA Golden Jubilee Research Professor (1990-1994), ISRO K R Ramanathan Distinguished Professor at IISc/JNC ( 1994 -1999) and Director, National Institute of Advanced Studies (1997-2004).

His research interests are in the field of Transition, flow control, relaminarization, hydrodynamic stability, Shock waves, Temperature distributions near the ground, Fluid dynamics of clouds, convection, Aerospace engineering development at both technical and policy-making levels and Science and technology policy studies, history of science.

He has many awards to his credit like

Fellow of the Royal Society, 1992  
Foreign Associate of both the US National Academy of Engineering (1989) and the US National Academy of Sciences. (2000)  
Foreign Honorary Member of the American Academy of Arts and Sciences, 1999  
Fellow, American Institute of Astronautics and Aeronautics, 1993  
Bhatnagar Prize, 1976  
Gujarmal Modi Award, 1990  
Padma Bhushan, 1987; Karnataka Rajyotsava Award, 1986  
Fellow of all the Indian national academies of science and engineering, Distinguished Fellow, Astronautical Society of India, 2003  
Fluid Dynamics Award of the American Institute of Aeronautics and Astronautics, 2000  
Distinguished Alumnus of both Caltech (1986) and IISc (1988)  
Bhatnagar Medal, INSA 1985; Srinivasa Ramanujan Medal, Indian Science Congress 1988; National Design Award, Institution of Engineers 1996  
American Institute of Aeronautics and Astronautics Fluid Dynamics Award 2000  
Fellow, The World Innovation Foundation, UK 2000  
Life Time Contribution Award in Engineering 2003, Indian National Academy of Engineering  
Aryabhata Award, Astronautical Society of India, 2004

Prof Marasimha has edited 15 books and has published nearly 250 papers on numerous technical subjects and policy matters. He is the Member of Editorial Board of *Experiments in Fluids* (Springer), *Fluid Dynamics Research* (North Holland), *Sadhana* (Indian Acad. Sci.), *Journal of Aerospace Engineering* (I. Mech. E. London), *Current Science* (Bangalore), *Journal of Theoretical and Computational Fluid Dynamics*.



# Profile of Judging Panel Members



**Vice Admiral Raman Puri (Retd.)**  
S429, Greater Kailash, Part 1  
New Delhi 110 048

Vice Admiral Raman Puri (Retd) was commissioned in the Executive Branch of the Indian Navy in January 1966. He is a gunnery and missile specialist and holds a Masters degree in Defence Studies from the Defence Services Staff College, Wellington.

The Admiral has held a number of important Command and Staff appointments during his distinguished career. These include command of 5 frontline warships of the Indian Navy including the Aircraft Carrier INS Vikrant. His onshore appointments include founder Director of the College of Naval Warfare, Flag Officer Offshore Defence Advisory Group, Flag Officer Commanding Maharashtra Naval Area, Fortress Commander Andaman and Nicobar Islands, the Deputy Chief of the Naval Staff, New Delhi and the Flag Officer Commanding in Chief Eastern Naval Command. Prior to his retirement the Admiral was the Chief of the Integrated Staff as well as the Chairman of the Chief of Staff Committee (CISC).

Vice Admiral Raman Puri (Retd) is a renowned expert on Higher Defence Management. During his tenure as the CISC, a number of bold initiatives were implemented to strengthen the Higher Defence Management of Armed Forces. These included a new approach towards Perspective Planning and Force Development in accordance with the National Security Strategy, Defence Strategy and Net Assessments; streamlining of the acquisition process, Development of Industry-Academia-DRDO and Armed Forces partnership for formulating indigenous solutions to the

needs of the Armed Forces, Development of the Defence Space Vision for the Armed Forces etc. As the CISC, the Admiral was also the Chairman of the Defence Crisis Management Group and guided the relief effort for a number of disasters including the Tsunami that devastated the A&N islands and parts of coastal peninsular India in 2004.

Vice Admiral Raman Puri (Retd) has also been the Chairman of the Executive Council of the USI for over 2 years. A Centre for Strategic Studies and Simulation was established at USI during his Chairmanship. The Admiral was also a key member of the Kelkar Committee established by the Govt. to examine changes in the acquisition process and enable greater participation by the private sector in defence production.

The Admiral retired from the Indian Navy in February 2007. He is presently working as an Adviser to the BEL Management and is also representing the MoD on the board of HAL.

Vice Admiral Puri is a great supporter of the idea of indigenisation. He firmly believes that self reliance is the only way of maintaining independence in strategic areas. He has great faith in the ability of Indian scientists and technologists to be able to deliver goods. Notwithstanding the constraints under which we operate, he has been propagating the idea of self reliance through his speeches and writing. Even when he was in service in the armed forces he initiated several projects for the Navy's needs etc.





# Profile of Judging Panel Members



**Dr. Daniel P Schrage**  
Professor and Director  
CERT and CASE  
School of Aerospace Engineering  
Georgia Institute of Technology  
USA

Dr Daniel P Schrage graduated with a B.S. in General Engineering from the United States Military Academy in 1967, an M.S. in Aerospace Engineering from the Georgia Institute of Technology in 1974, an M.A. in Business Administration in 1975 from Webster University, and a D.Sc. in Mechanical Engineering from Washington University in St. Louis in 1978. He was also an Army aviator and commander with combat experience in Southeast Asia (South Vietnam and Cambodia) in 1969-1970, and was a nuclear weapons field artillery battery commander in Europe in 1968.

Dr. Schrage is currently professor in the School of Aerospace Engineering at Georgia Institute of Technology (GIT) and also the Director of the US Army Center of Excellence in Rotorcraft Technology (CERT) and the Georgia Tech Center for Aerospace Systems Engineering (CASE). He teaches graduate and undergraduate courses and supervises research in Integrated Product/Process Development, Systems Engineering, Aerospace Systems Design (specifically with respect to rotorcraft design), as well as other aerospace engineering disciplines. He has numerous published articles (>100) and several book chapters in these areas. In addition, Dr. Schrage initiated the Georgia Tech Unmanned Aerial Vehicle (UAV) program in the early 1990s and helped establish the International Aerial Robotics Competition. Dr. Schrage also served as the Co-PI for the highly successful DARPA Software Enabled Control (SEC) for Intelligent UAVs from 1998 to 2004.

He has served as a government senior executive involved in the design and development of Army Aviation Systems, He was also

the chief of vibrations and dynamics engineering and Structures and Materials Division for the U.S. Army Aviation Systems Command (AVSCOM) from 1974 – 1984. He served as the Technical Area Chief for the Army Helicopter Improvement Program (AHIP) culminating in production of the OH-58D Kiow Warrior helicopter. From 1983-84 he was leading the Concept Exploration effort developing RAH-66 Comanche helicopter. As the AVSCOM Director for Advanced Systems from 1982-1984 he guided the Army Aviation Science and Technology (S&T) program. During his tenure the Army Aviation S&T program grew to be the largest in the Army and included several major technology demonstrator programs, such as ACAP, ADOCS, ATD Engine, and ARTI.

Dr. Schrage is an AHS Fellow and has served as the AHS Chapter President in St. Louis and Atlanta; as the Midwest and Southern Regional Vice Presidents, and as the AHS Associate Technical Director for Vehicle Integrity, as well as the AHS Associate Technical Director for Vehicle Design.

Dr. Schrage has served as a consultant to a broad cross-section of the aerospace industry. He has served on several National Research Council (NRC) studies in the late 1990s and early 2000s, such as the Alternative Futures for the Army Research Laboratory, High Speed Research Program, and Advanced Engineering Environments. He is also an AIAA Fellow and has served on several AIAA Technical Committees such as Aircraft Design, V/STOL Aircraft and MDO, and national advisory boards, such as the Army Science Board, Air Force Studies Board, and NASA's Aeronautics Research and Technology Subcommittees, Goals Sub-committee and Aviation Safety Program Executive Committee. During 2001-2003, Dr. Schrage served on the FAA Oversight Board for the Commercial Transport Certification Process Study and the Implementation Plan. Dr. Schrage was a member of the MIT team addressing Lean Aircraft Initiatives for the US Air Force and Aerospace industry and is deeply involved in new initiatives addressing Product Life Cycle Management through the Georgia Tech – Dassault Systemes/IBM Strategic Alliance in this area.



# Profile of Judging Panel Members



**Dr D (Nanda) Nandagopal**  
Deputy Chief Defence Scientist  
(Policy & Programs)  
Defence Science and Technology Organisation  
Australia

Dr D. Nandagopal (Nanda), is Deputy Chief Defence Scientist (Policy & Programs) at the Defence Science and Technology Organisation (DSTO). He is responsible for DSTO's strategic policy development, client program planning and reporting across the organisation. He is also DSTO's Chief Systems Integration Officer, responsible for the overall planning, policies and frameworks for the integration of systems and technologies across the whole of DSTO, and the ARC Research Network on Information Systems, Sensor Networks and Information Processing. He has the lead for DSTO's major S&T initiative in Military Experimentation.

Dr Nandagoal holds a B.E., M.S., and Ph.D. degrees in Electrical and Electronic Engineering and has held academic positions at the University of Adelaide, McMaster University, Canada and the University of Melbourne. He has held an Adjunct Associate Professor position at the University of Adelaide and he has also been appointed Adjunct Fellow of the Australian National University (ANU).



**Dr. Avi Weinreb**  
Head, Aeronautical Division  
DDR&D, IMOD  
Israel  
DOB: 13 March 1950.  
Married, 2 children.

**Dr. Avi Weinreb** has Ph.D. in Electrical Engineering, from Stanford University, Stanford, Ca., US, in 1984. He did his M.Sc. in Electrical Engineering, from Technion, Haifa, Israel, in 1979 and graduated in Electrical Engineering, from Technion, in 1972,

Since 2003 Dr. Weinreb is holding the position of Head of the Aeronautical Division, Directorate of Defense Research & Development (DDR&D), IMOD. Prior to that he held various important positions at Ultraguide, InSightec, High Intensity Focused Ultrasound Business, ELBIT & Rafael. He specializes in missiles and other defense systems. He holds a patent (as a member of the development team) for Mechanical Positioner for MRI Guided Ultrasound Therapy System.





# Profile of Team Members

**Team: Delft University of Technology & Wageningen University and Research Centre**



*Stan\_Kosman (Team Leader)*



*Rene Lindeboom*



*Marijn van de Ruit*



*Tjibbe van der Veen*

## **Bio-Sketch**

RoboSwift, the micro airplane project was started as a Bachelor's Level Design Exercise for Aerospace Engineering studies. The team consists of Stan Kosman (Team Leader), Jan Wouter Kruyt (Logistics), Rene Lindeboom (Visuals), Marijn van de Ruit (Pilot), Abishek Sahai (Builder), Tjibbe van der Veen (Builder) and Stef Wesselings (Public Relations).

## **Equipment Details**

- Transmitter, receiver, motor, Lipo batteries, a VR headset, laptop, cameras, servos, controller and antennae.
- Materials used: carbon, aramid, balsa wood, epoxy and glue.
- Tools used: hammer, screwdrivers, pincers, a soldering iron, etc.

## **Technical Write-Up**

Inspired by the common swift, one of Nature's most efficient flyers, the micro airplane RoboSwift was designed with movable wings. Its special feature is that the wing geometry as well as

the wing surface area can be adjusted continuously, making RoboSwift more maneuverable and efficient. It can fly undetected and can also be used for surveying vehicles and people on the ground by using three micro cameras mounted on it.

RoboSwift has a span of 50 cm and is 80 grams in weight. It can follow a group of swifts for 20 minutes and can perform ground surveillance for one hour. The lithium-polymer batteries are used for powering the electromotor which in turn drives the propeller. The propeller folds back during gliding to minimize air drag. The common swift's unique feature is its morphing wings which can be swept back in flight by folding feathers over each other, thus changing the wing shape and reducing the wing surface area. RoboSwift steers itself using this unique morphing wing design. This enables the micro airplane to perform optimally and fly efficiently with high maneuverability at both high and low speeds.



## Team: Drone Aerospace Systems Pvt. Ltd., India



Krishna Venkatesh



Krishna Kishore J



Uttam Chandrashekhar



K Gopalakrishnan

# Profile of Team Members

### Bio-Sketch

**Krishna Venkatesh** has a Ph.D in Mechanical Engineering and is an alumnus of the Indian Institute of Science, Bangalore, India. He has worked with various research bodies such as NAL, BEML, IISc and ADA for the last 16 years. He has also initiated various Industry- Academic collaborations with Honeywell, FESTO, IBM, Bosch, Diamant and others in the fields of Avionics, Automation, CNE, MEMS, Tribology and so on. He has started his own company M/s Drone Aerospace that primarily deals with the development of autonomous and intelligent systems. He has published a number of papers in peer reviewed international journals and received various awards. His interest in MAV started in 2002 when along with his student Kishore he built an ornithopter. Subsequently he and his group also built a couple of mini RC planes with semi APS for Honeywell under the Industry-Academic Initiative in 2004. In keeping with his vision and punch line "classroom to boardroom" he started Drone Aerospace in Aug 2007 along with five of his former students.

**Krishna Kishore J** is a Mechanical Engineering graduate and has been working with Honeywell since the last couple of years. Having a flair for development with his "out of the box" thinking attitude, he has been one of the key members of Dr. Venkatesh's team both at the University and at Drone. He currently works with Drone and is interested in embedded systems development.

A pioneering promoter of open source, his interests include RC modeling and flying, system design and home automation products.

**Uttam** is an avid aeromodeller with a passion for small, micro electric model airplanes. He has been building and flying small electric Radio controlled planes since 6 years. He holds a master's degree in Computer applications from MAHE. He has experience in building and flying a variety of Micro air vehicle platforms, such as Flying wings and the Zimmermann platforms, using the latest lightweight high-strength materials. His strengths include experience with Lithium polymer cells and brushless motors and building airframes that are light and strong.

**K Gopalakrishnan** has a Ph.D in Mechanical Engineering from Anna University, India with over 24 years' experience in teaching, research and industrial consultancy. He has numerous publications to his credit and is a member of many professional bodies. He is currently a Member, Board of Governors, NDRF. He also holds the adjunct position of Executive Director, DIAS, Bangalore. His research interests include Design and Analysis of Integrated Management Systems, Quality Control, Optimization and SQP Trilogy. He is also the Editor-in-Chief, Manufacturing Technology and Management, Quarterly Journal of IIPE.





# Profile of Team Members

**Team: Drone Aerospace Systems Pvt. Ltd., India**

## Equipment Details

- Radio Controller (MAV/Ornithopter) - Futaba, 35 and 72 MHz
- Airframe (MAV/Ornithopter) - Foam/Balsa/Carbon Fibre
- Power Source – Li-Poly cells
- Electric Motor- Brushless DC Motors (DC Enterprises)
- UGV – Electric powered with RC - 27MHz
- Cameras – Pin Hole(Wireless) - 1.2, 2.4 GHz
- Radio Modems – Maxstream - 900 MHz(> 10 Kms range), 2.4 GHz(2 Kms range)

## Technical Write-Up

MAVs, with one or more fixed wings fitted within a sphere of 300 mm, are capable of autonomous flight and navigation. They can patrol any area and relay vital information about conditions on the ground to the base station. A UGV guided by information from the fixed wing MAV can be used to determine a safe path free from obstacles, for the eventual commando rescue mission. A small flapping wing/ rotary wing vehicle can be launched from the UGV to gather audiovisual information about activity in the vicinity of the captivity location.

**Detailed Design Features: MAV/UGV design specifications and number of micro-aerial and unmanned ground vehicles in the system**

- **System - MAV**
  - Type – Fixed wing, < 300 mm sphere
  - Platform – Inverse Zimmerman / Delta
  - Powerplant – Brushless DC motor
  - Range – 3 Km
  - Mode – Autonomous with on board autopilot

- Payload – Camera with wireless telemetry
- Endurance – 40 minutes
- Power Source – Li-Poly cells
- Quantity - 2

- **System – UGV**

- Type – Wheeled / Tracked
- Powerplant – Electric Motor
- Range – 3 Km
- Mode – Autonomous ground navigation controlled by the base station
- Payload – LASER range finder, Pan-tilt capable camera, Micro mine detectors, Flapper / Rotary Wing flyer, Relay station for relaying information from the flapper / rotary wing vehicle.
- Endurance – 60 minutes
- Power Source – Batteries
- Quantity – 2

- **System – Ornithopter / Helicopter**

- Type – Flapping / Rotary
- Powerplant - Brushless DC motor / Ducted fan
- Payload – Camera
- Mode – Tele-controlled using vision guidance
- Endurance – 10 Minutes
- Quantity - 1

## **Planned Operating Frequencies**

72, 151.3, 900MHz, 1.2, 2.4 GHz.



# Profile of Team Members

## Team: University of Arizona, USA



*Sergey V. Shkarayev*



*Gavin Kumar Ananda Krishnan*



*Roman Krashanitsa*



*David Addai*

### Bio-Sketch

**Dr. Sergey Shkarayev** is an Associate Professor (since August 2005) in the Department of Aerospace and Mechanical Engineering at the University of Arizona, which he joined in 1995. Dr. Shkarayev held a faculty position at the Aircraft Construction Department of Kharkov Aviation Institute, Ukraine till 1995. He also worked as a Vice Chief-Designer for Buria Aircraft Inc. He is an expert in the areas of the aerodynamic design of micro air vehicles and applied fracture mechanics. Along with his students, Dr. Shkarayev has participated in several international micro air vehicle competitions and won the first place at the 1st US-European Micro-Aerial Vehicle Technology Demonstration and Assessment in 2005. He has more than 50 journal papers, 30 conference papers and several books and patents to his credit.

**Gavin Kumar Ananda Krishnan** is a senior student at the University of Arizona, majoring in both Mechanical and Aerospace Engineering. He received the Highest Academic Distinction Award for the year 2007 from the university. Currently, Gavin is the President of the Micro Air Vehicle Club and an officer of the Tau Beta Pi Arizona Alpha Chapter. As a research assistant, under the supervision of Dr. Sergey Shkarayev, he has contributed to the development of several micro air vehicles including the world's first autonomous ornithopter.

**Roman Krashanitsa** graduated from the University of Arizona in 2006, with a Ph. D. degree in Mechanical Engineering and Applied Mathematics. Since then, he has been working as an Associate Professor in the Aerospace and Mechanical Engineering Department at the University of Arizona. His scientific interests include numerical modeling, differential equations, analysis of damage in materials and structures, control systems, smart agents and artificial intelligence.

**David Addai** is a student of Mechanical Engineering and Computer Science at the University of Arizona. He is a member of the Micro Air Vehicle club at the university and is currently the test pilot of the club. As a research assistant, under the supervision of Dr. Sergey Shkarayev, he has contributed to the development of several micro air vehicles including the world's first autonomous ornithopter.

### Equipment Details

- **Modem:** Aerocomm Transmitter and receiver set, Output Power :0 - 100mW; variable Range: 1.6km; Range of Operating frequencies: 902MHz - 928MHz Purpose: Transmits telemetry information to the ground station and receives command information from it.





# Profile of Team Members

## Team: University of Arizona, USA

- *Video/Audio Transmitter:* Black Widow AV; Output Power: 200mW; Range: 2km; Range of Operating frequencies: 2410Mhz-2470Mhz  
Purpose: Transmits video and audio signals to the ground station
- *RC Transmitter:* Futaba CAP9 Output Power: 350mW; Range: 1km; Range of Operating frequencies: 72Mhz-73Mhz Purpose: Allows pilot to have direct RC link to the aircraft

### Technical Write-Up

The team from the University of Arizona has proposed two types of MAVs that are capable of accomplishing three different missions. The first type is a fixed-wing autonomous MAV. The second type is a tail-sitter configuration MAV, based on the propulsion system, consisting of two coaxial contra-rotating motor-propellers. This type of vehicle is capable of Vertical Take Off and Landing (VTOL), being equipped with microphones or chemical sensors.

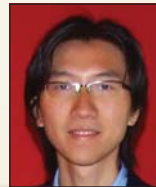
The autonomous MAV has a wingspan of 30 cm and an endurance limit of 20 minutes. It can be used for a reconnaissance mission. This vehicle will hover above the building at an appropriate altitude in an autonomous mode. The vehicle is equipped with a high-resolution digital CCD camera and will monitor the movements of the guards around the building. Results are displayed on the ground station computer and ground station video monitor. The use of this MAV ensures the proper timing of the hostage-rescue and minesweeping missions.

All the micro air vehicles used by the team are equipped with an autopilot board, a GPS unit and a wireless modem for two-way communication with the ground station. They are also equipped with a safety system, which tracks the boundary of the fly zone and monitors the status of the components. In the event of a failure (battery, GPS unit or safety link), it will disable the engine and land the vehicle safely. The vehicle stays on the ground while transmitting its location to the ground station to aid in its retrieval. All the vehicles entered in the competition operate at different frequencies. Collisions can be avoided if all the participating MAVs operate at different locations or at well-separated altitudes.



# Profile of Team Members

## Team : Micro Aerial Vehicles for Search, Tracking And Reconnaissance (MAVSTAR), Australia



*Lin Chi Mak (Team Leader)*



*Makoto Kumon*



*Mark Albert Whitty*



*Moises Alexis Nicoletti*

### Bio-Sketch

**Lin Chi MAK** graduated with a B. Eng. degree in Mechatronic Engineering from the University of New South Wales (UNSW), Australia, in 2005. Since 2006, he has been a research student of the School of Mechanical and Manufacturing Engineering. He received the university medal from UNSW for his undergraduate studies. His research interests include robotics and micro aerial vehicles. He developed a Non-Line-Of-Sight (NLOS) localization system for an indoor UGV using low-frequency sound and a visual localization system for an indoor rotary-wing MAV with a pair of blade-mounted LEDs. He is the leader of a team called Micro Aerial Vehicles for Search, Tracking and Reconnaissance (MAVSTAR), who developed a group of rotary-wing MAVs and UGVs for Urban Search And Rescue (USAR).

**Makoto Kumon** has a Ph.D. degree (2002) in the field of Informatics from Kyoto University, Japan. Till 2006, he was an Associate Professor in the Department of Intelligent Mechanical Systems, Graduate School of Science and Technology, Kumamoto University. Since October 2007, he has been at the School of Mechanical and Manufacturing Engineering, University of New South Wales, Australia (Program for the Internationalization of University Education by the Ministry of Education, Culture, Sports, Science and Technology, Japan). His

research interests include Robotics, Autonomous Mechanical Systems and Control Applications.

He is interested in sound localization using robots. With pinnae, or outer ears, he showed that a robot with two microphones succeeded in finding the vertical and horizontal directions of a sound source simultaneously. The robot was also able to track the sound source with an appropriate servo controller.

**Mark Whitty** has studied Mechanical Engineering and Computer Science at the University of New South Wales, Australia. He is deeply interested in miniature mobile robotics. His undergraduate work was related to technologies for unmanned ground and micro aerial vehicles.

A university medallist, Mark is now a research student (on a UNSW Research Excellence Scholarship). His current research interests include indoor localization of micro aerial vehicles, autonomous control of micro aerial vehicles and cooperation between micro aerial vehicles and unmanned ground vehicles.

**Moises Nicoletti** graduated with a B.Eng. degree in Aerospace from the University of New South Wales (UNSW) in July 2007. His areas of interest have been space flight technology and composites in aircraft structures. With his knowledge of





# Profile of Team Members

## Team : Micro Aerial Vehicles for Search, Tracking And Reconnaissance (MAVSTAR), Australia

aerospace design and structures and his outstanding academic results, he coordinates the manufacturing and assembly of the MAV.

### Equipment Details

- *For BS:* Laptop, Desktop PC, LCD display, Xbee modem, 2.4GHz directional antenna, 1.2GHz Wireless AV Receiver, 1.2GHz directional antenna, 5.8GHz Wireless AV Receiver, 5.8GHz antenna, Wind meter.
- *For 4 UGVs:* Xbee modem, 2.4GHz antenna, 5.8GHz AV transmitter, Colour CCD cameras, Frame, GPS, Digital Compass, Microcontroller, 4 cells LiPo Battery, 2 cells LiPo Battery, Electronic Speed Controller, Servos, Directional Mic, 1.2GHz Wireless AV Receiver.
- *For 4 MAVs:* Brushless MOTOR, SERVO, Carbon Fiber Frame, Heli components, IMU COMBO BOARD, Ultrasonic Range Finder, Colour CMOS camera with Mic, Xbee Pro Module, 1.2GHz AV Transmitter, 1.2GHz AV Transmitter, Microcontroller, GPS, Digital Compass, Electronic Speed Controller, 2-cell LiPo Battery.

### Technical Write-Up

The team has developed a group of cooperative rotary-wing MAVs and UGVs which are controlled by a remote base station (BS). The MAVs are based on a dual-rotor coaxial design with a mechanical stabilizer attached to the top blades. They are driven by a pair of brushless motors and are powered by a 4-cell Li-Po battery. The frame is made from carbon fiber and aluminium alloy. There are several on-board sensors, including a GPS receiver, compass, ultrasonic range finder, wireless camera, temperature sensor and an IMU. The weight and the flight time

of the MAVs are 350-400g and 10-20 minutes respectively.

The developed system is semi-autonomous. Using the on-board GPS, IMU and ultrasonic range finder, the MAVs are able to perform autonomous navigation along a desired path. The MAVs send all the sensor data to the computers in the BS, where human pilots monitor the sensor information, update the desired paths and provide manual control, if necessary. For indoor environments, the MAVs will be fully controlled by the pilots. If the communication between the MAVs and the base station is broken, the MAVs will still be able to hover, based on the on-board sensor data, until the communication system recovers.

The human pilots locate and mark the positions of the mines and the guard's tank in the BS software by monitoring the visual information provided by the MAVs and UGVs at known GPS positions. To locate the position of the hostages, directional microphones on the UGVs and omni-directional microphones on the MAVs send audio information to the BS for signal analysis. The BS software, utilizing Recursive Bayesian Analysis, will determine the path for the commandos.

The MAVs have two power saving techniques viz. to fly at optimal forward speed and to minimise its weight. The frames of the MAVs are made predominantly from carbon fiber plates, which have a high strength to weight ratio.

To conclude, several semi-autonomous rotary-wing MAVs powered by Li-Po batteries and brushless motors have been developed and selected to participate in the competition, along with supporting UGVs. The flight time of the MAVs is between 10 and 20 minutes. The mines, guard tank and hostages are located by visual and audio means and the BS software generates the path for commandos.



# Profile of Team Members

## Team: ENAC, France



Pascal Brisset

### Bio-Sketch

#### **Pascal Brisset:**

He has a PhD in Computer Science. Currently, he is a professor of Computer Science at ENAC and one of the software designers of the Paparazzi system.

#### **Michel Gorraz:**

He is an engineer with a degree in Electronics. Currently, he is a professor of Electronics at ENAC and one of the electronic designers of the Paparazzi system.

#### **Murat Bronz:**

He is a Master's student at the Technical University of Istanbul, an MAV designer and an active contributor to the Paparazzi project.

#### **Jeremy Tyler:**

He is the founder of the Miraterre UAS Company, an MAV designer and the most active contributor to the Paparazzi project. He has a Master's degree in Aerodynamics from the University of Arizona.



Michel Gorraz



Murat Bronz



Jeremy Tyler

### Equipment Details

- Four laptops installed with the Paparazzi ground software
- Two 72MHz RC transmitters
- Radiotronix Wi232EUR Modems 868MHz
- XBee pro modems 2.4GHz
- 2.4GHz Pollin USB-R1 video converter, and analog receiver
- Antenna
- Two fixed-wing aircraft, one heli, all of them equipped with brushless motors, 72MHz RC receiver, Paparazzi autopilot, infrared sensors, video camera, 868MHz modems and 2.4GHz video transmitter

### Technical Write-Up

The fixed wing aircraft can be used to determine the main obstacles between the IP and the bank, as well as the locations of the mines, while monitoring the positions of the guards around the bank. The heli can be used to confirm the positions of the mines and search for the room where the hostages are imprisoned. The simulated UGV and the commando are equipped with a GPS receiver, a modem and a laptop. The laptop displays navigation instructions given by the control station operator. Two operators work on the ground station; one monitors the video information from the UAVs and the other controls the UAVs, the UGV and the commando.





## Team: ABES Engineering College, Ghaziabad, India



H C Agarwal (Team Leader)



Sushant Gupta



Rachna Singh



Chirag Puri

# Profile of Team Members

### Bio-Sketch

**Professor H C Agarwal** is working as Dean, Research & Development and as Head, Department of Electronics and Communication Engineering, ABES Engineering College, Ghaziabad, affiliated to UP Technical University, Lucknow and is running courses at the Bachelor's and Master's levels in Engineering, Management and Computer Applications.

He was awarded his Ph.D. in the year 1975 from the Department of Electrical Engineering, Indian Institute of Technology, Delhi and M.E. (Honours) from the University of Roorkee in the year 1970. He was a recipient of the Gold Medal for the First Position in the UOR Master's Program. Professor H C Agarwal retired as Professor of Electrical Engineering from Government Engineering College, Jabalpur, M.P. during the year 1993-94 and subsequently served as a top official in various private and public organizations. He was also sent on a foreign teaching assignment to the University of Tripoli, Libya. He has published papers in IEEE Transactions on Power Apparatus & Systems. He is a Fellow of the Institution of Electronics & Telecommunication Engineers and a Fellow of the Institution of Engineers (India).

**Sushant Gupta** has been working at ABES Engineering College, Ghaziabad as a project assistant in the R & D Lab since 2002. He is experienced in the fields of Image Processing and Robotics.

He has a B.A degree in English from CCS University (2002) and a diploma in Systems Management and Software Development from NIIT, Ghaziabad. He is the first Asian to have developed and flown a fully autonomous UAV at a US Air Field and demonstrated an Autonomous Unmanned Aerial Robot to the US Army and AUVSI at US Soldiers Battle Lab, Mount Mckenna Site, Georgia, US. He has quite a few patents to his credit, the most important of them being an Autopilot System for an Autonomous Helicopter (UAV).

**Rachna Singh** graduated with a B.Tech (Electronics & Communications) degree in the year 1988 from IET (Institute of Engg. & Technology), Lucknow (U.P.) and has experience of about 15 years. During different phases of her career, she has worked with various industries, training and educational institutes & universities.

**Chirag Puri** has a B.Tech degree from Uttar Pradesh Technical University.

### Equipment Details

- Autopilot 2028G ( MAV)
- Wireless Camera ( MAV)
- GPS EM-406 USB with Evaluation Board ( UGV)
- Inertial Measurement Unit (UGV)



# Profile of Team Members

**Team: ABES Engineering College, Ghaziabad, India**

- MaxStream wireless modems ( UGV)
- JR9303 radio set ( UGV)
- Three MAVs for the aerial Demonstration
- One UGV for Demonstration
- Li – Poly batteries for MAV and UGV

Two big UAVs for display (One raptor F–22 and one E620, which will participate in the International Aerial Robotics Competition at US Soldiers Battle Lab, Fort Benning, USA in July 2008)

## Technical Write-Up

The 29-cm airplane intruder has been designed and built by the team, with an integrated autopilot on board. This vehicle possesses the following flight characteristics: GPS navigation by following a specified flight plan, altitude and altitude hold modes and autonomous climbing and landing. The ground station performs two major tasks: pre-flight programming of the autopilot and downloading of in-flight telemetry and video information; it includes a laptop computer, a radio receiver and an antenna. The airplane is equipped with a tilting video camera that captures and transmits video information to the ground station for analysis, making it very effective for surveillance missions. The flight communication takes place at 2.4 Ghz. The wingspan of the intruder is 29 cm and the total weight is 168 g. The airplane is controlled by an elevator and a rudder. The vertical tail, installed on the bottom surface of the wing, provides positive coupling between the yawing and rolling moments from the rudder. Mines can be chemically detected (via the UGV) using quadropole resonance technology. To detect landmines, the nitrogen in explosives is excited by a sequence of pulses, causing it to emit QR signals consisting of a sequence of echoes. The QR sensor collects the data. To improve the performance, the

spatial and temporal correlations of Radio Frequency Interferences are exploited.

Three MAVs and an EOD robot are being used for the Multi – System Coordination & Mission Approach. According to this, two MAVs will fly simultaneously to the designated building. The third MAV will coordinate with the UGV to reach the designated area. The UGV will use a chemical detection technique as well as image processing algorithms to detect land mines. Cameras mounted on the UGV effectively detect a mine from as far as 30 meters, using image-processing algorithms. All the robots used in the mission are capable of autonomous take off, navigation and landing.

At any moment during its flight, the autonomous mode of operation can be overridden and manual control of the airplane can be imposed using the RC unit command link. As an additional safety measure, the airplane is assigned an in-plane circular boundary. When the airplane is in a restricted area, it switches to the “home mode” or “reversion mode” and navigates to a pre-assigned location until an explicit command for normal flight is received. If the command link is lost and not restored in 10 sec, the airplane switches to the reversion mode. The MAV is provided with a kill switch / termination mechanism which will cut off the power to the propeller and guide the vehicle in a downward trajectory, in the case of an emergency / upon the discretion of the judges.





# Profile of Team Members

## Team : Chiba University, Japan



Kenzo NONAMI, Team leader



Wei WANG



Daisuke IWAKURA



Zhenyu Yu

### Bio-Sketch

**Dr. Kenzo Nonami** received his Ph.D. degree in Mechanical Engineering in 1979 from Tokyo Metropolitan University. He was the chief of the Dynamics, Measurement and Control Division of the Japan Society of Mechanical Engineers in 1997. Since 2004, Dr. Kenzo Nonami has been the Vice Dean of the Faculty of Engineering. He is also one of the directors of the Japan Society of Mechanical Engineers. He was an NRC research fellow of NASA from 1985 to 1988. His research interests are land mine detection robots with a multi-functional arm, manipulator and hand systems, fully autonomous unmanned small-scale helicopters, micro air vehicles, unmanned aerial vehicles, quad-tilt-wing unmanned aerial vehicles, energy storage flywheels with magnetic bearing systems, vibration control, motion control and nonlinear control. Dr. Kenzo Nonami is a member of the Japan Society of Mechanical Engineers, Robotics Society of Japan, the Society of Instrumentation and Control Engineers, IEEE, ASME and AHS (American Helicopter Society).

Dr. Kenzo Nonami has published more than 300 journal papers and seven textbooks. He has guided 36 Ph.D students. He has also won many awards and medals from the Japan Society of Mechanical Engineers and the American Society of Mechanical Engineers.

**Wang Wei** graduated from the University of Shanghai for Science and Technology in the year 1992, majoring in mechanical engineering. He has practical experience in designing and manufacturing several varieties of electronic apparatus. Presently, he is a doctoral candidate at Chiba University in the Controls and Robotics Division. His research subject is "Autonomous Flight Control of MAVs".

**Daisuke Iwakura** is a student of Chiba University. He works on MAVs, with an interest in "the obstacle avoidance of quad-rotor MAVs using ultrasonic sensors".

**Zhenyu Yu** is studying for his doctoral degree in robotics and control systems. He has been working for Motorola (China) and Nortel Networks (China) as a system engineer responsible for mobile communication network engineering. His current research includes vision based UAV control, autonomous boats, embedded systems for unmanned vehicles and computer vision for mobile robots.

### Technical Write-Up

The MAV system is a "Quad-Rotor MAV", based on the X-UFO BL with an X-3D system. This flying robot is small and light and



# *Profile of Team Members*

**Team : Chiba University, Japan**

can carry payloads up to 500g. It is 200mm high and 540cm in diameter. The dry weight is about 320g and the mass of the video camera to gather information is about 50g. The mass of the compact auto pilot unit including the microcomputer systems and the sensors is about 70g, the same as the weight of the lithium-ion battery enabling its 20- minute flight. The aggregate mass is about 510g.

In order to measure the relative position of the X-UFO, a sensor-board has been installed which includes a GPS, a gyro and acceleration sensors. Also, a nonlinear control algorithm has been written, to fly against strong wind disturbances. This MAV goes up to a height of several hundred meters. Moreover, it can fly at a maximum speed of more than 100km/h and three X-UFO units can simultaneously fly in a group without any collisions.





Team : Universitat Pompeu Fabra / ICREA, Spain



Paul F.M.J. Verschure



Sergi Bermudez i Badia



Ivan Herreros



Zenon Mathews

## Profile of Team Members

### Bio-Sketch

**Dr. Paul F.M.J. Verschure** is a research professor at Catalan Institute of Advanced Research (ICREA), Technology Department, Universitat Pompeu Fabra. He is also the Director of the Institute of Audio-Visual Studies, Universitat Pompeu Fabra and the Director of the Research Program in Intelligence, Interaction and Perception, Barcelona. His scientific aim is to find a unified theory of the mind, brain and body through the use of synthetic methods and to apply such a theory to the development of novel cognitive technologies. Paul has pursued his research at different institutes in the US, San Diego and at various universities in Europe.

Paul works on biologically constrained models of perception, learning, behavior and problem solving that are applied to wheeled and flying robots and interactive spaces. He has many publications in leading scientific journals including Nature, Science, PLoS and PNAS. He applies concepts from his study of perception, cognition and behavior to the development of interactive creative installations and intelligent immersive spaces. Since 1998, he and his team have generated a series of 17 public exhibits of which the most ambitious was the exhibit "Ada: Intelligent space" for the Swiss national exhibition Expo.02, that was visited by 5 million people. He leads a multidisciplinary group

of 10 doctoral and post-doctoral researchers including physicists, psychologists, biologists, engineers and computer scientists.

**Dr. Sergi Bermudez i Badia (1979)** is a post-doctoral researcher at the laboratory for SPECS in the Technology Department of University Pompeu Fabra. He received his PhD from the Swiss Federal Institute of Technology Zürich (ETHZ). His scientific goal is to investigate the underlying neural mechanisms of biological systems and to exploit them using real world artifacts, ranging from flying and industrial robots to interactive spaces. He has pursued research at several institutes in Europe. His interest in neuroscience has led him to develop a number of computational neural models to provide UAVs and mobile robots with autonomous navigation capabilities.

**Zenon Mathews** is a PhD student at Pompeu Fabra University in the Specs group lead by Prof. Paul Verschure. His research interests are: multimodal tracking, intelligent sensor recruitment, deployment and attention mechanisms. He received his M.Sc. in Computer Science from the Federal Institute of Technology ETH Zürich in 2006. His master's thesis on the implementation of the Rational Krylov Algorithm for Eigenvalue Computation was carried out at the Royal Institute of Technology KTH Stockholm.

**Ivan Herreros-Alonso** is a PhD student at the laboratory for Synthetic Perceptive, Emotive and Cognitive Systems (SPECS)



# Profile of Team Members

## Team : Universitat Pompeu Fabra / ICREA, Spain

in the Technology Department of University Pompeu Fabra. He has a double degree in Computer Engineering from the Universitat Politècnica de Catalunya (Barcelona, Spain) and the Istituto Politenico di Torino (Italy).

His main interest is in implementing biologically inspired cognitive models, using unsupervised neural networks, so that they can be applied and assessed in different tasks.

### Equipment Details

Outdoor mobile robot. Large Lithium-Polymer rechargeable batteries (Kok 3270, Kokam, Korea, 24 cells with a total capacity of 39.6 Ah, provide 7.2V), erasure multiple hours of autonomy. Weight: 5.22 kg (incl. batteries) Dimensions: 400x280 mm.

Supplementary board of outdoor mobile robot, Works together with outdoor blimp and brings additional functionality: 32 digital whiskers, 2 analogue whiskers, 6 servos; 2d accelerometer.

### Technical Write-Up

A minimum of one Quodrocopter will be used together with a single Unmanned Ground vehicle capable of mine disarming. The ground vehicle is an outdoor tracked vehicle equipped with GPS, compass, whiskers, a metal-thin chemical sensor and a color video camera, with an autonomy exceeding the mission time. The outdoor mobile robot based is equipped with large Lithium-Polymer rechargeable batteries (Kok 3270, Kokam, Korea, 24 cells with a total capacity of 39.6 Ah, provide 7.2V), ensures several hours of autonomy. Weight: 5.22 kg (incl. batteries) Dimensions: 400x280 mm. A supplementary board for the outdoor mobile robot brings additional functionality: 32 "digital" whiskers, 2 "analogue" whiskers, 6 servos; 2d

accelerometer. A radio link (2.4GHz transceiver AC1524 from Aerocomm, Lenexa, USA) exchanges information with the base station where a computer system sends motor commands. All these sensors are connected to a common bus which allows easy system interfacing with a pair of chemosensors and easy system expansion. The path to the bank will be autonomously pursued based on GPS coordinates delivered by the MAV. In emergency case or when the platform is unable to avoid detected collisions, then it will be manually controlled from the base station. The chemical sensor and other sensors (camera) will be used to detect mines and the disarming behavior will be triggered from the base station.

The MAV is a X-3D-BL\_scientific from Asctec Gmbh with 250 g of payload, equipped with an autonomous control loop for stability based on inertial sensor readings, a GPS, ultrasonic altimeter, a camera and with a metal-thin chemo-sensor, will inspect (remotely controlled using the 35.890 MHz channel) the area at a prudent altitude to generate a map on the basis of which obstacles and proper pathway for the ground vehicle will be specified. Items of interest will be stored with its GPS coordinate and this information will be continuously shared with the ground vehicle via the base station. Landing at safe places may be used to save energy when the operation of the MAV is not required. The sonar altitude sensor uses 5V, 3mA standby power consumption. The sampling frequency is 40KHz and the sensitivity range is from 3cm to 6m. This signal will be used for autonomous landing, collision avoidance and for controlling the altitude during chemical detection. The sensor measures 32mm x 15mm x 10mm height. The platform will have an emergency flight termination mode that will render it ballistic. In addition, if no contact with the base station is detected for a period of time, the hovering mode will be triggered.





## Team : Martin Mueller Engineering, Germany



*Martin Mueller*



*Christian Carl Lindenberg*



*Antoine Drouin*



*Arnold Schroeter*

# Profile of Team Members

### Bio-Sketch

**Martin Müller** has been associated with Technical University Braunschweig from 1993-1997 and worked in Aerodata GmbH during 1997. From 1997-1999 he was with Fachhochschule Braunschweig/Wolfenbüttel. Presently he is with Blaupunkt GmbH and is associated with MAV development.

**Christian Lindenberg** is the youngest display pilot on national model flying demonstration. He regularly participates in national RC-1 (F3A) flying contests and double winner of nationals. He is involved in building and flying several ins RC models with flying categories: F3A (aerobatics), F3D (pylon racing), F5D (pylon racing). He ranked 4 in German indoor nationals F3AI-B in 2004 and 10 in German indoor nationals F3AI-A 2005. Currently he is involved in MAV development.

**Antoine Drouin** is an engineer from ENAC with electronics major and member of the UAS team at ENAC. He is also designer and developer of the Paparazzi, UAS. He developed a hots wapable backup for ATC radar and flight plans systems (Service Technique de la Navigation Aérienne) and graphical user interfaces for studies on datalink and ASAS at Centre d'Etude de le Navigation Aérienne. He also teaches programming languages at ENAC.

**Arnold Schröter** is presently linked with Blaupunkt GmbH. He was associated with several Institutes and universities viz., Technical University Hannover from 1984-1986, Technical University Munich from 1986-1990, Max-Planck-Institute for biophysical chemistry in 1990, Göttingen Technical University Munich, Gesellschaft für Schwerionenphysik, Darmstadt from 1990-1993. He is presently involved in MAV development.

### Equipment Details

The equipment associated with ground station

- RC transmitter Graupner MC-24
- Radiotronix Wi232EUR Modems 868MHz
- XBee pro modems 2.4GHz
- Pollin USB-R1 video converter
- Nokia N770 internet pad and the aircrafts, containing
- Paparazzi autopilot
- Blackwidowav video transmitter 50mW
- Radiotronix Wi232EUR Modems 868MHz
- XBee pro modems 2.4GHz
- servos
- LiPo batteries
- brushless motors and controller



# Profile of Team Members

**Team : Martin Mueller Engineering, Germany**

## Technical Write-Up

In this mission two aircrafts will be operational at the same time wherein one aircraft will be doing surveillance from higher altitude while the second aircraft will operate for close information gathering or digital video relaying. The two aircrafts will be constantly replaced for recharging during the mission to prolong the operation time. Chemical sensors can be connected to the aircraft's hardware by serial industry standard interfaces and the information could be used by the autopilot's software for decision making. The fully autonomous flight control system is based on a micro controller. The controller compares the current GPS position and direction with waypoints of a predefined mission to calculate desired intermediate positions, target values for turn, climb and roll rates and the corresponding settings of the tailerons. The ground control station operator can easily control more than one aircraft at the same time using the Paparazzi flight control software. Unmanned ground vehicles will be simulated by persons.

The aircraft that will be flying here is the fifth aircraft type that has been equipped with an autopilot. More than 20 aircraft types have been used with Paparazzi autopilot systems by several teams. The autopilot hard- and software has been used by many teams all over the world in different weather conditions including extreme temperatures, humidities, wind, altitudes, visibilities and light conditions (e.g. Northern Germany, Arizona deserts, Iceland Highlands). A safety pilot is monitoring the aircrafts all the time. It is always possible to return to manual control even if unforeseen software problems occur in the autopilot process. Whenever a loss of the telemetry link is detected or when predefined no fly zones are entered the plane automatically aborts its mission and tries to return to a predefined home position. Alternatively the

flight control system can be programmed to shut down the motor and put the airplane into a shallow dive in such a situation.

The air frame does have instable flight characteristics and needs constant active control by either a manual pilot or the autopilot. In case of a control loss this will lead to an immediate end of the flight and avoid any extended glide. An airframe overload will decrease the lift to drag ratio so that the aircraft will come down very close to the incident site inside the security area. The two aircrafts will be operating in different altitudes for safety. The two-way telemetry data-link transfers the current position of each aircraft to all other aircrafts in air to enable them to calculate trajectories and avoid proximity.

For video downlink a 2.4GHz transmitter is used. The video pictures are transmitted as an analog frequency modulated NTSC signal. As an additional sensor a digital camera with a digital 2.4GHz modem can be deployed to transmit digital still images. The picture transfer can be relayed by an aircraft if obstacles prevent direct view to the modem.

A digital 868MHz transceiver is used to establish a bidirectional telemetry link. A number of data messages can be chosen, e.g. attitude, position, waypoints, mission status, voltages or debug information. Commands can be given during flight, e.g. change of waypoint positions or flight plan. The safety link is done with RC equipment operating at 35MHz.





# Profile of Team Members

## Team : Indian Institute of Technology, Bombay, India



*Hemendra Arya*



*Kiran Verma*



*Ashish Bhat*



*Vishal Prabhu*

### Bio-Sketch

**Hemendra Arya:** PhD. Aerospace Engineering, Asst. Professor, Department of Aerospace Engineering, IIT Bombay.

**Kiran Verma:** Aeromodeller, Indian Aeromodeler club, Virar

**Ashish Bhat:** B.Tech., Electrical Engineering, IIT Bombay, Technologist. Director, IdeaForge Pvt. Ltd., Mumbai

**Vishal Prabhu:** Student, 4th Year, Dual degree, Aerospace Engg., IIT Bombay.

### Equipment Details

900 Mhz for video transmission; 2.4 GHz for telecommand; 72 MHz for radio operation.

### Technical Write-Up

Perceived mission is as follows:

To accomplish an event where one assumes hostages are held in a bank building which is roughly 1 km from the launch point the following conditions can be visualized. Bank building is being

guarded by two guards. When both the guards are on the same side of the building the situation will be ideal for the vehicle to enter. Since the Guards have visibility of only 100 ft, they cannot see a micro aerial vehicle flying above. Few other building around bank can be used for perching the vehicle and to monitor the guards. Path from launch point to bank is barricaded and have land mines. Land mines are assumed to be diffused if the vehicle identifies and raises the flag. Simulated ground vehicle is available if required. Commandos require continuous commands from the control station.

Three or more autonomous hovering vehicles will be used for perching on the adjoining building. Continuous video from these will help in monitoring the guards from at least two sides of the bank building. These vehicles will be having capability of analysing the audio signatures of the hostages.

At present it is proposed to use the simulated ground vehicle. Simulated ground vehicle will be given commands in the form of move left, right, straight or stop and the speed. A mechanism to raise the flag will be mounted on the vehicle. It is also expected that the vehicle will be carrying a video camera.

Commandos will follow the ground vehicle till some other command is given from the ground control station. All the



# Profile of Team Members

## Team : Indian Institute of Technology, Bombay, India

commands and the analysis will be conducted at the ground station. Commandos will be given very specific commands (hide, move etc) when they are close to the bank building. All the decisions during the mission will be based on the live videos from the various sources.

All the autonomous vehicles will be having secured data link of 1.5 km range and working at 2.4 GHz. Video links will be 900 MHz and 2.4 GHz. A separate switch will be given to the judges for aborting the mission if necessary. 0.3 m vehicle is circular with thick airfoil shape which will allow burying the equipment inside the body so that clean configuration can be obtained. Controls are elevon type. Airfoil shape is chosen which gives maximum lift and less drag for large range of angle of attack values. Landing and take-off speed is around 5 m/s. Aircraft can easily cruise upto 15 m/s. Aircraft is having low roll inertia and it will be improved by distribution of the weight. Aircraft will be flying autonomous.

Hovering vehicle is a conventional quad rotor aircraft of 0.3m size and have a payload capacity of 100 gms. Base of the vehicle is designed such that it can hover and land on uneven surface. Camera will be having capability to pan and tilt to have good visual monitoring without moving the vehicle.

Display will be provided for simulated vehicle for real time guidance and navigation. As of today we are not planning for any autonomous ground vehicle.



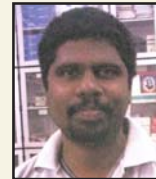


# Profile of Team Members

## Team : National Aerospace Laboratories, Bangalore, India



*Roshan Antony, Team leader*



*Radhakrishna*



*P Eshwar*



*Ratheesh R Nath*

### Bio-Sketch

**Roshan Antony** is a B.E. in Mechanical Engineering from Visveswaraiah Technological University. He is now working at NAL in the MAV group. His interests are Design, 2D Animation, Audio editing, Level design for video games. He is involved in aero-modeling and hobby flying. He has worked on the development of Rotary Engines, Low Cost Wind Turbines and MAV. He is now leading the NAL team in the MAV'08.

**P. Radhakrishna** has been with NAL for the past 10 years. He has a BSc in Mathematics and has a degree in Aircraft Maintenance Engineering. He is an aero-modeler with a passion for flying powered hang-glider. He is the integration and equipping in-charge for the HANSA and SARAS aircrafts projects. He also takes part in the flight testing of the aircrafts. He has been flying RC models for the past 5 years and with a sharp skill in model repairs.

**P. Eshwar** is a hobby flyer by profession. He has been flying model planes for the past 32 years. His company, E.N.R. Models, is into the Design, Building and Flying of Model aircrafts and is the major supplier of Model aircrafts throughout India. He is a certified Aero Model Instructor and gives training to students and interested persons. He has been building Fixed wing, Helicopter,

Car and Boat models. His models include NISHANTH, SARAS, LCA and other Wind Tunnel models.

**Ratheesh R Nath** is a Senior Lecturer in MSRSAS, teaching Automotive Engineering. With a M.Sc. Engineering degree from Coventry University, UK. He is designing the UGV and fabricating it. His areas of interest are Vehicle Dynamics and Vehicle Safety. He will be operating the UGV and the rotary MAV.

### Equipment Details

#### **MAV: Fixed Wing (2 nos)**

- Fixed Wing, Mean Airfoil plate, Carbon Composite frame
- Size: Fits in 300 mm sphere
- RC operating frequency: 2.4 GHz
- Power: LiPol Battery
- Power Plant: Miniature Brushless motor and miniature electric propeller
- Payload: Miniature color camera operating at 2.4 GHz

#### **MAV: Rotary Wing (2 nos)**

- Coaxial Rotary Wing
- Size: Fits in 300 mm sphere
- RC operating frequency: 2.4 GHz
- Navigation: Point-to-point



# Profile of Team Members

**Team : National Aerospace Laboratories, Bangalore, India**

- Power: LiPol Battery
- Power Plant: Miniature Brushed motor and miniature electric propeller
- Payload: Miniature color camera operating at 2.4 GHz

## **UGV (1 no)**

- RC operating frequency: 2.4 GHz
- Power: Lead acid Battery operated
- Power Plant: Brushed motor with gearbox and steering system
- Payload: Miniature color camera operating at 2.4 GHz, Rotary MAVs and Launch Pad.

## **Technical Write-Up**

The Mission will be carried out by 2 Fixed wing MAVs, 2 Rotary MAVs and 1 UGV. The Fixed wing MAVs will do the surveillance and terrain mapping by miniature cameras mounted on the MAVs. The video signal from the MAVs will be used to map out and Mosaic the terrain for bombs and obstacles. This data will then be used for the navigation and bomb detection by the UGV. The UGV will be carrying Rotary MAVs on a launch pad which is integrated on the UGV. It will navigate through the terrain and proceed to the Bank Building. The rotary MAVs will be deployed to detect activities in the Bank Building, thereby completing the mission.





# Profile of Team Members

## Team : Massachusetts Institute of Technology, USA



Nicholas Roy

### Bio-Sketch

**Nicholas Roy** is the Boeing Assistant Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology. He is a member of the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT. Roy received his B.Sc. in Physics and Cognitive Science in 1995 and his M.Sc. in Computer Science in 1997, both from McGill University. He received his Ph.D. in Robotics from Carnegie Mellon University in 2003. Roy's research interests include autonomous systems, mobile robotics, human-computer interaction, decision-making under uncertainty and machine learning.

**Ruijie He** graduated with a Bachelor's of Science in Aeronautics and Astronautics from Massachusetts Institute of Technology (MIT) in 2007. He is currently a Master's candidate in the Department of Aeronautics and Astronautics at MIT.

**Daniel Gurdan** received his Bachelor of Science in Electrical Engineering in 2006 and his Diploma in Electrical Engineering in 2007. He is currently a Ph.D. Student in the German Aerospace Center and a CEO of Ascending Technologies GmbH.

**Jan Stumpf** received his Bachelor of Science in Electrical Engineering in 2005 and his Diploma in Electrical Engineering



Ruijie He



Daniel Gurdan



Jan Stumpf

in 2007. He is currently a Ph.D. Student in the German Aerospace Center and a CEO of Ascending Technologies GmbH.

### Technical Write-Up

The entry into the MAV 08 competition will consist of a coordinated set of "autonomous micro-quadrotor helicopters". A fully autonomous system consists of COTS components and specialized software. MIT and Ascending Technologies are developing a micro-quadrotor helicopter with onboard attitude control via an IMU, and a 100g payload for GPS navigation and a video camera system. Each MAV will have two wireless communication links to the base station: a wifi link for low-bandwidth sensor information and trajectory commands; and a 2.4GHz analog link to transmit camera images from each MAV to the base station for object tracking. The helicopters will perform GPS-waypoint trajectory execution autonomously and utilize an onboard stabilization device to maintain controlled flight. Each vehicle has a flight time of approximately 10 minutes. To allow battery replacement, multiple helicopters will be deployed in a rotating handoff such that a helicopter will operate over the mission arena at all times. A distributed software architecture comprising of multiple processes will be used. The software suite will consist of modules for planning and control, map building, as well as vision-based object classification and tracking. All mission tasks except hostage room identification in full autonomous mode will be executed. The mapping module will



# *Profile of Team Members*

**Team : Massachusetts Institute of Technology, USA**

mosaic images received from the video cameras to create a consistent bird's-eye model of the environment. This map will be anchored to the global coordinate system, providing a view of the mission progress and a space in which to plan. During missions, camera images will also be registered with the map to refine GPS position estimates. The images from onboard cameras will be used to detect and track objects of interest on the ground. Optical flow combined with color and shape will be used to detect the guard vehicle. Probabilistic state estimation will be used to maintain consistent target tracks. Mine detection will be performed using shape and color information from the images. Airborne chemical detection will not be implemented. The planner module will consist of a centralized task-level planner and a path planner to determine MAV trajectories for each task. The task-level planner will coordinate mission tasks for each vehicle, such as map building, target tracking, and mine disposal. The action-level planner will employ predictive planning algorithms to select MAV and UGV trajectories to minimize the likelihood of being detected by the guard vehicle.





# Profile of International Organising Committee Members



**Dr. S G Sampath**  
Engineering Director  
US Army International Technology  
Center - South East Asia Office  
American Embassy Singapore  
Box ODC, FPO AP 96507, Singapore  
Sreerangapatam.Sampath@us.army.mil

Dr. S. G. Sampath has a Master's degree in Physics, a Master of Science degree in Aeronautical Engineering, and a Ph.D. degree in Engineering Mechanics from the Ohio State University. Currently he is the Director of Engineering at the U.S. Army International Technology Center, Southeast Asia Office. He joined the Army at the end of 1998 after a 10-year period of employment with the Federal Aviation Administration (FAA). His career in the FAA began as the Manager of the National Aging Aircraft Research Program, having to deal with issues of import in the context of the nation's infrastructure. During the subsequent years, he served successively as the Manager of the Catastrophic Failure Prevention Program, as Program Manager within the Aircraft Maintenance Division, as Program Manager of the Risk and Decision Support Program, and then as the FAA's Liaison with the Air Force, based at Wright-Patterson AFB. He was on the Science and Technology Panel of the Joint Aeronautical Commanders Group (JACG). Prior to his employment with the FAA, he was in the Research and Special Projects Administration, another agency within the U.S. Department of Transportation, involved mainly in crashworthiness and survivability research. Between 1986 and 1989, he was employed by the Defense Systems Division of Goodyear Aerospace Corporation that was acquired by Loral Corporation.

His research and other involvements included the subject of failure mechanics of materials at ultra-high strain-rates, qualification of sub-systems subjected to ship-board shock

loading, electronic counter-measures for ground-air missiles with RF seekers, and a simulator for the radar weapon systems in the F-15 aircraft. Dr. Sampath was employed by the Battelle organization for about 13 years, first by their Columbus Division and then by their Geneva Research Center. He was the Manager of the Stress Analysis Projects Office while in Columbus, and a Senior Program Manager for Structural Technology at Battelle-Geneva.

Dr Sampath served for several years on the Structures and Materials Panel of NATO's Advisory Group on Aerospace Research and Development (AGARD) and chaired the Group on Durability and Damage Tolerance, in addition to several technical activities. He has also been active in the AGARD's successor organization, the Research and Technology Organization (RTO). He was a member of the Damage Tolerance Committee of the American Helicopter Society, and the Design and Analysis Committee of the Pressure Vessel and Piping Division of ASME. He is a member of Sigma Xi Scientific Society.

Dr Sampath received the Distinguished Alumnus Award from the Aeronautical Engineering Department of the Indian Institute of Science during their Golden Jubilee Celebration in 1993.



# *Profile of International Organising Committee Members*



**Lieutenant Colonel Eric Stierna**  
Commander  
Southern Asia Office US Army  
International Technology Center - Pacific  
(AMSRRD-SS-PAC-SA)  
Unit 4280 Box 23 FPO AP 96507-0023  
Singapore  
eric.stierna@us.army.mil

LTC Eric Stierna holds a Bachelor's Degree in Materials Engineering from Brown University and a Master's Degree in Software Engineering from the US Naval Postgraduate School. His military education includes: the Aviation Officer Basic Course, the Aviation Officer Advanced Course, the Combined Arms Services Staff School, the Material Acquisition Management Course and the Army Command and General Staff College. LTC Stierna's aviation education includes: US Army Rotary Wing and Fixed Wing Qualification Courses; OH-58D Instructor Pilot Course; US Naval Test Pilot School at Patuxent River, Maryland; and various aircraft qualification courses.

LTC c Stierna received a commission upon graduation from Brown University in 1989. Originally commissioned into Aviation Branch in 1989, he is now a member of the Army Acquisition Corps. LTC Stierna has served in various command and staff, training and acquisition positions during more than 18 years of active military service. His assignments include: Platoon Leader and Motor Officer, 11th Armored Cavalry Regiment, Fulda, Germany; Instructor Pilot and Company Commander, C Company, 1-14th Aviation Regiment, Fort Rucker, AL; Technical Representative and Operations Officer, Science and Technology Center – Far East, Camp Zama, Japan; Chief, Integrated System Testing Division, Flight Test Directorate, US Army Aviation Technical Test Center, Fort Rucker, Alabama; Chief, System Integration Division, Technology Directorate, US Army Aviation

Technical Test Center, Fort Rucker, Alabama and Commander, Southern Asia Office, International Technology Center – Pacific, Singapore.

His awards and decorations include the Defense Meritorious Service Medal, the Army Commendation Medal, Army Achievement Medal, Senior Aviator Badge, Air Assault and Parachutist Badges.





# Profile of International Organising Committee Members



## **Michelson, Robert C**

President, Millennial Vision, LLC and  
SEPDAC, Inc.

Principal Research Engineer, Emeritus  
Georgia Tech Research Institute

Adjunct Associate Professor (Ret.)  
School of Aerospace Engineering

Michelson, Robert C graduated getting B.S.E.E., from Virginia Polytechnic Institute and State University in 1973 and M.S.E.E from Georgia Institute of Technology in 1974. He is currently the President, Millennial Vision, LLC and SEPDAC, Inc., Principal Research Engineer, Emeritus Georgia Tech Research Institute and also Adjunct Associate Professor (Ret.) School of Aerospace Engineering. Earlier he held positions like Technical Area Manager, Battlefield Robotics & Unmanned Systems (1990-2004) and Adj. Associate Professor, School of Aerospace Engineering (1996-2004),

Currently a consultant through Millennial Vision, LLC in the area of unmanned aerial vehicles (UAV) with emphasis on biologically inspired micro and nano air vehicles (MAV/NAV), he also works in the areas of stratospheric and tropospheric unmanned airships, and remote sensing. He has been Director and Principal Investigator (PI) for over 30 major projects during his career at the Georgia Institute of Technology. He was GTRI Director for stratospheric airship programs at NASA Institute for Advanced Concepts to develop an autonomous Mars surveyor for flight in the lower atmosphere of Mars. Other examples include: Director/PI for (1) DARPA Mesomachine program to develop a small free-flying/crawling robotic insect-like surveillance platform; (2) DOT's Traffic Surveillance Drone project; (3) DARPA program to show the feasibility of a non-line-of-sight radio-acoustic sensor for bending radar signals using the Bragg principle to detect obstacle-masked targets; (4) the avionics suite for an Air Force Robotic Air-to-Air Combat vehicle; (5) a project to specify dual-

mode IR/MMW seeker parameters for a lethal unmanned aerial vehicle (UAV) system; (6) evaluation of ground penetration radar for the detection of buried natural gas leaks in urban utility systems; (7) development of a Sonar Scan Converter for the Navy; (8) creation of a Coherent Repeater to test foreign threat assets; (9) Army CDEC Indirect Fire Simulator for war-gaming; (10) the development of a Ka-band Linear ECM Source (KABLES) for the Army; (11) construction of a transponder for flight tests against Army threat simulators; (12) NASA's Sirenian Tracking Project, which involved remote electronic sensing of location and tracking of the aquatic mammal *Trichechus manatus*.

He is an Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA) and Senior Member of the Institute of Electrical and Electronics Engineers. Presently he is the Editor for Robotics Systems as well as IEEE Transactions on Aerospace and Electronic Systems. He is a Full Member of the Scientific Research Society of North America, Sigma Xi and past President and member of the Board of Directors of AUVS International organization. He was appointed on the NATO Advisory Group for Aerospace Research and Development (AGARD) (AAS-36 panel) considering "Future Use of Unmanned Air Vehicle Systems in the Maritime Environment." He is also the recipient of Pioneer Award (1998) & Pirelli Award (2001). He has 8 US patents to his credit



# Profile of International Organising Committee Members



**Dr Arabinda Mitra**  
Executive Director  
Indo-US Science & Technology Forum  
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After a distinguished academic career at Patna University, Arabinda Mitra started his first professional assignment in 1985 as a research scholar in Delhi University, on a Department of Ocean Development Fellowship. In 1987 he joined the Department of Atomic Energy as a Scientific Officer, and was involved in the exploration of the geology of the Himalayas.

In 1988, he was awarded the prestigious Cambridge Nehru Fellowship to pursue his doctoral research at the University of Cambridge, UK. His PhD project was jointly carried out with MIT, USA in the area of mid oceanic ridge hydrothermal systems. His research work was published in international journals such as Nature, Marine Chemistry and Geo-chimica Cosmo-chimica Acta, Journal of Remote Sensing etc.

In 1993, Dr. Mitra joined the Department of Ocean Development and was assigned the responsibilities of the Indian Antarctic Program. He has to his credit the planning and launching of several multidisciplinary experiments in the Indian Antarctic station and inducting a strong element of international programs in the Antarctic program. He was nominated as the Indian representative to international bodies such as SCAR & COMNAP of the Antarctic Treaty.

In 1998, Dr. Mitra moved to the National Centre for Antarctic & Ocean Research at Goa, in the capacity of Program Manager. He played a pivotal role in formulating the long-term science strategy of the Indian Antarctic missions and also initiated the

setting up of the low temperature ice core laboratory and the remote sensing laboratory at Goa.

In the course of the above assignments, Dr. Mitra has won several academic awards like the ORS Award of UK, Bursary Award of St. Edmund's College, UK and JSPS Award of Japan and was also elected as a Fellow of Geological Society, London. He was a member of the Indian expeditions to Antarctica and has undertaken several scientific cruises to the Indian, Atlantic & Pacific Oceans.

In 2001, Dr. Mitra joined (as a Director) the International Division of the Dept of Science & Technology, Government of India. He proficiently enriched the scope of the DST-NSF cooperation through several new initiatives. In Nov 2004, Dr. Mitra was confirmed by the two governments as the first Executive Director of the bi-national Indo-US Science and Technology Forum. He has since added a new paradigm in the Indo-American S&T cooperation by bridging the performing science and technology groups in academic and research sectors of USA and India.





# Profile of International Organising Committee Members



**Ajai Kumar**  
C-II/33 Bapa Nagar  
New Delhi 110003  
Phone: 23387275 (R), 9810020946 (M)  
ak47@mail.com  
DOB: 17-01-1947

Ajai Kumar graduated with a B.Tech degree in Aeronautics from IIT, Kanpur securing 1st position in the year 1968. he got his MS (Aero and Astro) from MIT, USA in the year 1971. He retired from DRDO as Director of Aeronautics and Secretary, AR&DB. He started his career at National Aerospace Laboratories in the year 1971 and moved to GTRE in 1972. Then he held various important positions like DTE of Aeronautics, SA to CIDS, SA to Chief of Air Staff.

His field of specialization is in Technology Management, Promotion and Review of Aeronautics R&D, futuristic Research and System Development, special interest in Strategic Planning for Aeronautical Projects and Plans.



**C U Hari**  
Director of Aeronautics and  
Secretary, AR&DB  
DRDO Bhavan, Room No.311  
New Delhi 110 011  
cuhari@hotmail.com

C U Hari graduated with a Physics (main) degree from Mar Ivanious College, Trivandrum and moved to Madras Institute of Technology, Chennai for his Graduation & Post Graduation in Aeronautical Engineering with specialization in Aircraft Structural Mechanics.

He was a CSIR Senior Research Fellow for one year at National Aerospace Laboratory, Bangalore before joining Aeronautical Development Establishment, Bangalore. He held various positions such as Project Director Low Level Missile Target, Joint Project Director LCA-Flight Control System and Controller of Administration at ADE, Bangalore. He is presently a fellow of the Aeronautical Society of India and member of the Governing Council. He is also a Life Member of Indian Society for the Advancement of Materials and Process Engineering.

His field of expertise includes Composite Materials and Structures, Experimental Stress Analysis, Project Management as well as Contract negotiations.

He has been the Director of Aeronautics and Secretary Aeronautics Research and Development Board under Defence and Development Organisation, Ministry of Defence from 1 February 2007.



# Profile of International Organising Committee Members



## **Prof C Venkatesan**

Pandit Ramachandra Dwivedi Chair Professor  
Department of Aerospace Engineering  
Indian Institute of Technology  
GT Road at Kalyanpur  
Kanpur 208 016  
cven@iitk.ac.in

Prof C Venkatesan was awarded the Ph.D (Engg.) degree from Indian Institute of Science, Bangalore in the year 1980 and M.Sc (Engg.), Indian Institute of Science in 1975. He did his M.Sc (Physics), Indian Institute of Technology, Madras, 1972

### *Experience*

1999-	Professor, Dept. of Aerospace Engg., IIT Kanpur, India
1993-1999	Asso. Professor, Dept. of Aerospace Engg., IIT Kanpur, India
1989-1993	Asso. Research Engineer, Mechanical, Aerospace and Nuclear Engg. Dept. Univ. of California, Los Angeles, USA
1986-1988	Senior Design Engineer, Helicopter Design Bureau Hindustan Aeronautics Limited, Bangalore, India
1981-1985	Asst. Research Engineer, Mechanical, Aerospace and Nuclear Engg. Dept. Univ. of California, Los Angeles, USA

*Administrative Positions:* Vice Chairman, GATE, 2001-02  
Dean, Students' Affairs, 2003-05

*Research Interest:* Helicopter Dynamics and Aeroelasticity Smart  
Structure Analysis

*Publications:* More than 80 research publications (29 Journal  
Papers + 56 Conference papers)

*Industry-Academic Collaboration:* At IIT Kanpur he initiated a new one-semester Certificate Program on Helicopter Technology for industry/ defense services

*Projects:* Currently under progress: Major activity on autonomous helicopter (DST); 5 sponsored projects from ARDB, ISRO, DST; 2 consulting projects from HAL

*Technical Consulting:* Rotary-wing R&D Centre, HAL, Bangalore  
DRDL, Hyderabad

*National Activity:* Coordinator, Structures Panel AR&DB Member,  
Aeroelasticity team for gas turbines

*A ward Recognition:* Dr.V.M. Ghatage award (2001), Aeronautical  
Society of India, Fellow, Indian National Academy of Engineering.





# Profile of International Organising Committee Members



**Gp Capt S K Sharma, KC**  
Director, ORSAT (Air Force)  
HQs, Integrated Defence Staff  
Kashmir House  
Rajaji Marg  
New Delhi 110 011

Gp Capt Sudhir Kumar Sharma, KC, is an alumnus of National Defence Academy. He was commissioned into the Indian Air Force in December 1984. He has flown various types of helicopters and trainer aircraft on the inventory of the IAF. He has more than 6500 hours of incident/accident free flying with more than 1800 hours of instructional flying and 3500 hours of operational flying to his credit.

During his illustrious career in the IAF, he has held various key appointments such as Director, Operational Research System Analysis & Technologies (Air Force) at HQ IDS. (Nov 06 - till date), Chief Military Aviation Officer at Congo (Africa) on United Nations Assignment. (Sep 05 - Oct 06), Joint Director, Appraisal Cell, ACRs (Officers) (Jul 04 – Sep 05), Commanding Officer of Flying Squadron (Jun 02 - Jul 04) and Chief Flying Instructor, Army Aviation School, Nasik.

He was awarded Chief of Air Staff Commendation in 1988.  
'Kirti Chakra', Second highest gallantry award by the President of India on 26 Jan 05.  
Inducted into the 'Laureate's Hall of Fame' by the US at Smithsonian Air and Space Museum, Washington D.C. for the highest rescue operation ever conducted by the helicopter at 23240 ft. Third Indian to receive this honor in US after Dr APJ Abdul Kalam and Late Mr JRD Tata.  
Commendation by Force Commander, MONUC, UN troops (Congo) in Oct 06.

He has Actively participated in flying operations in 'Op Meghdoot' in Siachen Glacier, 'Op Pawan' in Srilanka, 'Op Cactus' in Republic of Maldives, 'Op Vijay' in Kargil and 'Op Parakram' in Leh Sectors.



# Profile of International Organising Committee Members



**Air Cmde R K Dhir, VM**  
Principal Director  
Air Staff Requirements (PDASR)  
Room No.442, Air Headquarters  
Vayu Bhavan, Rafi Marg  
New Delhi 110 011

Air Cmde R K Dhir VM was commissioned as a fighter pilot in the IAF on 15 June 1979. He has flown more than 3200 hours on various types of training, fighter and transport aircraft including frontline aircraft of IAF viz., M-2000, Jaguar and Su-30. He had field tenures on MiG-21 aircraft and commanded the first bison squadron.

He is a qualified flying instructor and an experimental test pilot. He had three tenures at ASTE, the last being commanding officer of the test pilots' school. He has commanded an important forward airbase. He was promoted to present rank in June 2007 and was part of the project management team for LCA induction.

Air Cmde R K Dhir has assumed the appointment of Principal Director of Air Staff requirements at Air Headquarters from January 2008. He is responsible for coordinating the acquisition of aircraft, systems and weapons as per the perspective plan of Indian Air Force.



**Dr Jiro Nakamichi**  
JAXA, 6-13-1 Ohsawa  
Mitaka, Tokyo  
Japan  
nakamichi.jiro@jaxa.jp

He graduated from the faculty of Aeronautics, Department of Engineering, the University of Tokyo, in 1974. After completing the graduate program, he joined the National Aerospace Laboratory, Japan, in 1979. He has been active in the fields of Unsteady Aerodynamics, Aeroelasticity and Computational Fluid Dynamics for more than twenty years. He has been responsible for the MRJ national project from 2003. At present, he is the head of Civil Transport Team, Aviation Program Group, Japan Aerospace Exploration Agency.





# Profile of International Organising Committee Members



**Mr P S Krishnan**  
Director  
Aeronautical Development Establishment  
C V Raman Nagar  
Bangalore 560 093  
director@ade.ernet.in

Mr P S Krishnan, has taken over as Director, ADE with effect from May 2007. ADE is a leading lab involved in Design and Development of Unmanned Air Vehicles as well as Combat and Engineering Simulators.

Mr PS Krishnan has graduated and also obtained a Post-Graduation degree in Mechanical Engineering from IIT, Chennai and specialized in the field of Flight Mechanics & Flight Controls. He served in DRDL, Hyderabad initially for 4 years in the development of gimbaled INS. He joined ADE in 1976 and has successfully executed a number of System related projects, namely, Development of Flight Control System for UAVs such as Missile Target, Pilotless Target Aircraft - Lakshya, Mini RPV - Nishant, Nirbhay, Sudarshan etc. Prior to this appointment, he was the Project Director for LCA Flight Control System, one of the critical technologies of Tejas which is the full authority Quadruplex Digital Fly By Wire FCS developed successfully in the country. He has contributed to several hundreds of flight trials of Tejas combat aircraft which did not have even a single real failure of FCS in any channel.

He is a Member of the Aeronautical Society of India and won several DRDO and Laboratory awards including Prime Minister's award for path breaking research for the development of Fly By Wire Flight Control System for Tejas in the year 2002.



**Dr Chong Kok. Ong**  
Associate Director  
Office of the Naval Research Global  
American Embassy Singapore  
Box ODC, 27, Napier Road  
Singapore – 258 508

Chong Ong did undergraduate work in Electrical Engineering at the Imperial College of Science and Technology, University of London, U.K. and graduated with a First Class Honors. He then completed his M.Sc. in Electrical Engineering and Computer Science at Columbia University in New York. He obtained his D.Sc. in Systems Science and Mathematics from Washington University in St. Louis. His doctoral dissertation is on Quantum Nondemolition Filtering, a methodology of using quantum nondemolition measurements for extracting a classical signal coupled to a quantum system. He performed research and teaching in the fields of quantum communications, cryptography and error correction codes at Clarkson University and George Washington University. Following the stint in academia, Dr. Ong joined the industry as a systems engineer performing systems and simulation studies for communication systems leading to the development of key modulation techniques, signal processing algorithms and error correction codes. Dr. Ong transitioned to a management role to lead projects in mobile communications and satellite communications. At Hughes Network Systems, Dr. Ong was the Program Director for numerous satellite projects including the first geostationary mobile satellite system. Dr. Ong also worked for General Dynamics C4 Division as the Project Lead for several government projects. Dr. Ong has worked many projects internationally and especially in the Asia Pacific Region. He is conversant in several regional languages and has traveled widely in Asian countries.

Dr. Ong joined ONR Global as an Associate Director in April of 2005. He is based in Singapore and is responsible for the S&T programs in the Region. In his current role, he provides technology awareness for the region as well as facilitates integration of International S&T into ONR programs.



# Profile of International Organising Committee Members



**Mr G Elangovan**  
CC R&D R&M  
Ministry of Defence  
DRDO, Room No.101/A  
Rajaji Marg, New Delhi – 110 011  
Fax No.(011) 2301 5395  
elan@hqr.drdo.in

Mr G Elangovan, has taken over as Chief Controller R&D (R&M) in DRDO Headquarters since April, 2007. Prior to this, he was Director of Aeronautical Development Establishment (ADE) at Bangalore.

He graduated from Thiagaraj College of Engineering, Madurai, with a BE (Hons) in Electrical Engineering in 1972. He received Gold Medal for securing the first rank in the college and received Shri Bakhtavatchalam award for securing first rank in the University. He then obtained his M.Sc.(Engg) in Applied Electronics (during 1974) from PSG College of Technology, Coimbatore,

He joined ADE (DRDO) in the year 1975 and was part of the Avionics & Flight Simulation Division. During his career of 32 years at ADE, he has successfully executed a number of system related projects, viz., development of CCTV terrain model visual system, setting up of a research simulation facility, training simulators for Ajeet and Kiran and setting up of an air-to-air combat simulator facility. He was also instrumental in developing a PC based flight simulator and part-task trainers which were demonstrated at Aero India-2003 and 2005 and Asian Aerospace Air Show at Singapore. He was Project Director for a number of simulator projects including LCA Engineering Simulator, Avionics Part-Task Trainer and Computerised Pilot Selection System.

He has worked in several areas of simulation technology including Low Cost visual system, Digital variable electrical feel system, Aural simulation, Voice command system, distributed

computing for real time applications, High speed real time data link, mathematical modeling etc. Before taking over as Director, Flight Simulation, Software Engineering, Aerodynamics and Air Weapons Integration, Material Management and Budget & Accounting Divisions were working under his guidance.

He is a Fellow of IETE. He has been awarded 4th IETE – BV Baliga Memorial award in the year 2001 and was one of the recipients of DRDO Path Breaking Research/Outstanding Technology Development award – 2002 for the contributions to Digital Flight Control Systems for Light Combat Aircraft. He received the Agni Award of excellence – 2005 for the development of Computerised Pilot Selection system.





# *Profile of Panel Discussion Members*



**Mr. Jason Denno**  
Director  
Battle Command Battle Laboratory  
US Army

Mr. Jason Denno is the Director of the Battle Command Battle Laboratory – Fort Huachuca. He is directly responsible for the army's intelligence concept experimentation program and advanced prototype developments. In this role, Mr. Denno directs the Battle Laboratory's identification and evaluation of intelligence shortfalls as well as technology developments for rapid enhancement of the current and future intelligence forces. He is a former military officer, serving both with the military intelligence and infantry branches.



**Mr Makoto Ono**  
Director, System Division  
Air Systems Research Center  
Technical Research & Development Institute (TRDI)  
Ministry Of Defense (MOD), Tokyo  
Date of Birth: 24 October 1952

Mr Makoto Ono got his BS from Kumamoto University in Mechanical Engineering in the year 1976 and MS from Nippon University in the field of Aeronautics and Astronautics in 1988. He is currently the Director of Systems Division at Air Systems Research Center Technical Research & Development Institute (TRDI), Ministry Of Defense, Tokyo. He is occupying this chair from 2007. Earlier he held various positions at TRDI like Chief of Aeronautics Research Section, Chief, 1st Section, Programs Division, Plans & Programs, Chief, F-2 Follow-up Group, & Senior Research Scientist, Department of Air Systems.



# Profile of Panel Discussion Members



**Colonel Steve Kinloch**  
Director General Land Development

Colonel Steve Kinloch studied at the Royal Military College of Science, Shrivenham in the United Kingdom where he was awarded a Masters Degree and then a PhD for studies in the field of Explosive Ordnance Engineering. He joined the Australian Army in 1980. He graduated from the Royal Military College, Duntroon as a Blamey Scholar in 1983, and was commissioned into the Royal Australian Army Ordnance Corps (RAAOC). Colonel Kinloch was appointed as Director General Land Development in January 2008.

Colonel Kinloch's early service, centred on appointments within the ammunition trade. After completing the Ammunition Technical Officer (ATO) Course in 1985 he served in a range of technical appointments in Land Command, RAAOC Headquarters, and as the Senior Instructor of the RAAOC Centre's Ammunition Wing.

After attending Command and Staff College at Fort Queenscliff in 1994, Colonel Kinloch served as the Operations Officer of the 1st Brigade Administrative Support Battalion and then as the DQ on Headquarters 1st Brigade. He returned to Canberra to take up an appointment as the Staff Officer to the Assistant Chief of the Defence Force (Operations).

After promotion to Lieutenant Colonel he served on the 'Army in the 21st Century' Logistics Review Team in 1997 and then in the 'Restructure the Army' Trials Directorate in Army Headquarters (AHQ) in 1998. Colonel Kinloch served as the Commanding Officer of the 3rd Brigade Administrative Support Battalion in

1999 and 2000. His tour included command during Operation WARDEN.

After leaving his command appointment Colonel Kinloch served in Industry Division of the Defence Materiel Organisation (DMO, 2001) and in the Directorate of Logistics in AHQ (2002). He has served in his current rank in both the DMO (in Land Systems Division, 2003-2005) and Capability Development Group (as Director Land Support Development in Land Development Branch, (2006-2007).





# Profile of Panel Discussion Members



**Dr. Charles H. Kimzey**  
Science and Technology Advisor  
United States Pacific Command

Dr. Charles H Kimzey has a BS in Finance from the University of Maryland; an MBA from American University; a Masters in Engineering from Vanderbilt University; and a Ph.D. in the Management of Technology from Vanderbilt University. He has served as adjunct faculty on strategic and technology management at the University of Maryland University College and Vanderbilt University.

Dr. Kimzey is the Science and Technology Advisor to the Commander, United States Pacific Command. He has the overarching objective to maximize the benefit of Science and Technology to improve the effectiveness of the Pacific warfighter. Dr. Kimzey came to the Pacific Command in 2005 from the Office of the Secretary of Defense (OSD) where he was Executive Oversight Manager, Advanced Systems and Concepts, Defense Research and Engineering, Washington, DC. His oversight responsibilities included design, development and execution of Advanced Concept Technology Demonstration (ACTD) programs. His programs included unmanned surface vessels, C2 for unmanned vehicles, precision terrain mapping, high resolution 3D visualization, automated sniper counterfire, and global networking.

While at OSD from 1987 to 2005, he served as Executive Secretary for Defense Science Board Task Forces; Director, Commercial Technology Insertion Program; Chief Strategic Planning, Dual Use Technology; Director, Manufacturing Technology Program; Executive Director, Defense Manufacturing Board and was an Office of the Secretary of Defense Fellow.

Prior to OSD, he was with the Army Material Command, 1981 - 1987 where he was Deputy Director of the Manufacturing Technology Program; Director, Industrial Modernization Incentives Program, and Chief, Industrial Preparedness Division.

Dr. Kimzey's publications include "Technology Strategy for New Product Development: Research on U.S.-Japan Technology Outsourcing Practices;" "Strategic Advantage Through Externally Sourced Technology, Practical Management Considerations for Exploiting Global Technology Sources."



# Profile of Panel Discussion Members



**Dr Dipankar Banerjee**  
Chief Controller R&D  
(Aeronautics & Material Sciences)  
Defence Research and Development  
Organisation

Dr Dipankar Banerjee got his B.Tech from IIT, Madras in Metallurgy in 1974 and Ph.D. from Indian Institute of Science, Bangalore in Metallurgy in 1979. Presently he holds the position of Chief Controller R&D (Aeronautics & Material Sciences) at the Defence Research and Development Organisation. In this position he coordinates the activities of DRDO's 6 Aeronautical laboratories and 3 Material laboratories. He joined DRDO at the Defence Metallurgical Research Laboratory (DMRL) Hyderabad in 1979 and held the position of the director of the laboratory from 1996 to 2003. He was promoted to the rank of 'Distinguished Scientist' in 2004.

Dr. Banerjee is an expert in materials science and one of the country's leading metallurgists, known especially for his contributions to the understanding of the science, technology and application of titanium alloys. He has two patents and above 100 publications in leading international journals to his credit. He has held visiting positions in the world's premier institutions of materials research such as the Carnegie Mellon University, USA, Los Alamos National Laboratory, USA, General Electric Corporate Research and Development Laboratory, USA, the University of Michigan, USA and the University de Paris-Sud, France.

As the Director of the Defence Metallurgical Research Laboratory, he provided leadership to the nation's key metallurgy programmes for defence applications covering military aircraft and engines, missiles and armoured vehicles, and naval platforms.

He has been honoured with National Metallurgist Award 1987, DRDO Scientist of the Year Award 1987, Shanti Swaroop Bhatnagar Award 1993 and Materials & Superconductivity Prize 2001. He has been conferred with the 'Padma Shri Award' in 2005.

Dr Banerjee is a Fellow of the Indian Academy of Science, Indian National Science Academy, National Academy of Sciences and the National Academy of Engineering. He has also served on the strategic advisory committee of the Metallurgical Society (TMS) of USA.





## About Agra and Spouse Tour

Agra is famous as being home to one of the seven wonders of the world-the Taj Mahal. The architectural splendour of the mausoleums, the fort and the palaces is a vivid reminder of the capital in the 16th and early 17th centuries. Agra was once the capital of the Mughal empire and even today it seems to linger in the past .

Agra is the one of the prominent destinations of the World Tourism map with three heritage monuments-The Taj Mahal, Red Fort & Fatehpur Sikri. It is more just a decadent city of graveyards and stones, but it is a vibrant centre of Culture, Art and Religious philosophies that have enriched mankind and shaped human thought over centuries.

Agra is situated in the State of Uttar Pradesh, India. Agra is famous for handicrafts products such as Inlay work on Marble, Leather work, Footwear, Brassware, Carpets, Jewellery, Zari and Embroidery work. It is also well known for Petha, Dalmatians and Gajak.

Agra is famous as being home to one of the seven wonders of the world-the Taj Mahal. The architectural splendour of the mausoleums, the fort and the palaces is a vivid reminder of the capital in the 16th and early 17th centuries.

While its significance as a political centre ended with the transfer of the capital to Delhi in 1634 by Shah Jahan, its architectural wealth has secured its place on the international map.

A pleasant town with comparatively slow pace, Agra is known for its superb inlay work on marble and sootstone by craftsmen who are descendant of those who worked under the Mughals. The city is also famous for its carpets, gold thread embroidery and leather shoes.

Agra was once the capital of the Mughal empire and even today it seems to linger in the past . Not surprising , for the Mughal emperors with their passion for building, endowed the city with some of the finest structures in the world . It is very easy to slip away here through the centuries into the grandeur and intrigues of the Mughal court .

Agra is an old city and it is said that its name was derived from Agrabana, a forest that finds mention in the epic Mahabharata.

In more recent times Agra came into prominence when Sikandar Lodi made it his capital city in 1501 . The Lodi rule was to end very soon and Agra passed into the possession of the Mughals .

It was during the time of the third emperor Akbar that Agra came into its own . He embarked on the construction of the massive Agra Fort in 1565. Though Akbar was diverted into building a new capital at Fatehpur Sikri not far away.





## About Agra and Spouse Tour

### Spouse Tour and Local Site Seeing Schedule

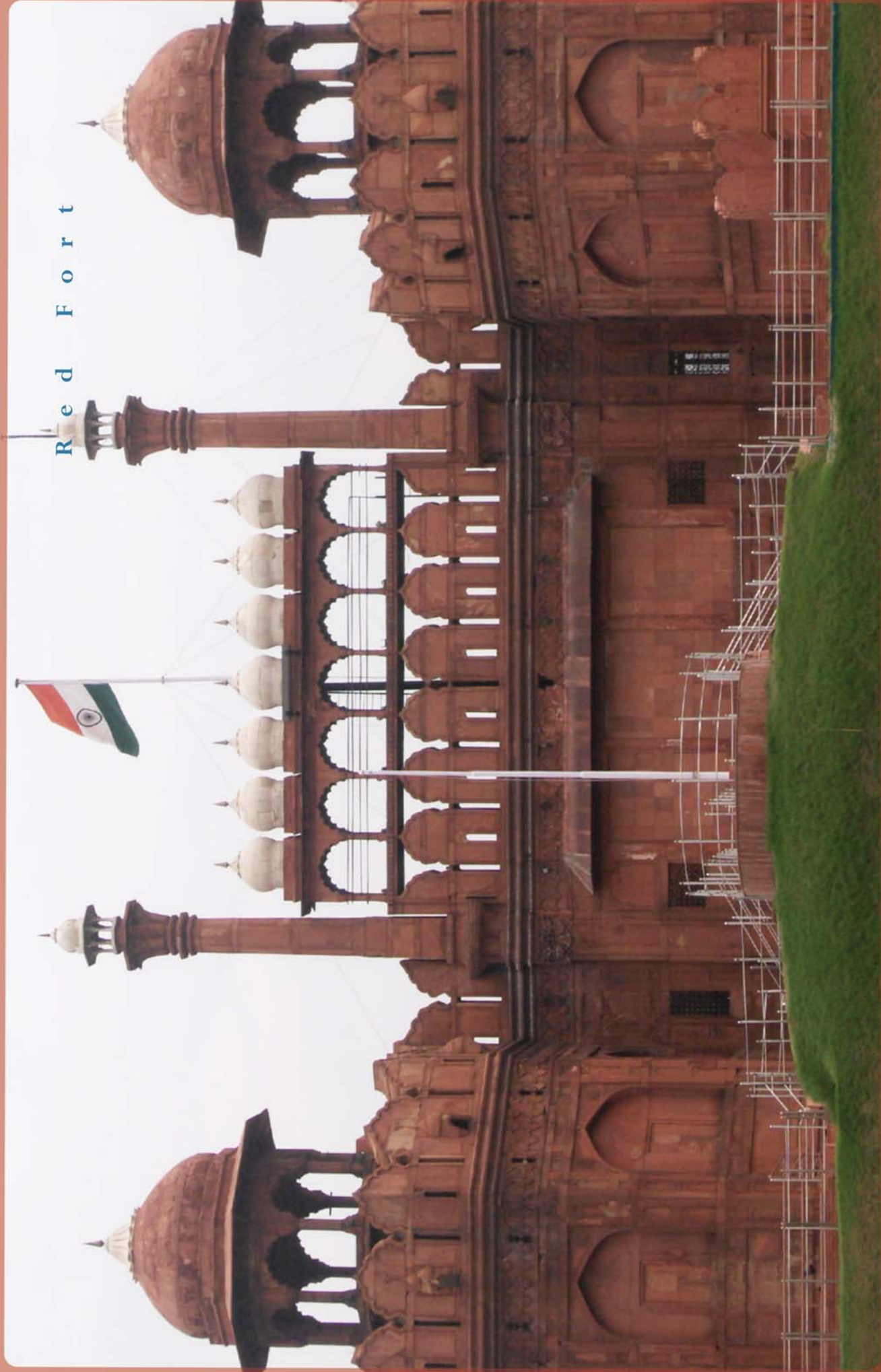
<i>Date/Day</i>	<i>Time</i>	<i>Place</i>	<i>Ticket Cost/head (For Foreigners)</i>
11/03/08 Tuesday	1100 Hrs-1400 Hrs 1530 Hrs-1830 Hrs	<b>Kohinoor Agra Red Fort</b>	- Rs. 300
12/03/08 Wednesday	0800 Hrs-1400 Hrs 1600 Hrs-1800 Hrs	<b>Fatehpur Sikri Sadar Market</b>	Rs. 260 -
13/03/08 Thursday	0800 Hrs-1330 Hrs 1730 Hrs-1900 Hrs	<b>DZ Taj Mahal</b>	- Rs. 750
14/03/08 Friday	0800 Hrs-1200 Hrs 1500 Hrs-1800 Hrs	<b>Sikandra Local Agra Shopping (Kalakriti, Imperial Gems)</b>	Rs. 110 -
<b>Total</b>			<b>Rs. 1420*</b>

\* Total tour tickets cost will be collected at reception in advance.





# Red Fort







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Aerial Delivery Research and Development Establishment (DRDO) India