

**Dr. Schrage's Memoir Book 3  
Developing A Graduate Program in  
Aerospace Systems Design  
Thirty Years of Supporting the Aerospace  
Community  
1992-2022**

Dr. Dan Schrage, Professor and Director Emeritus ASDL  
Dr. Dimitri Mavris, Regents Professor and Director ASDL  
School of Aerospace Engineering  
Georgia Tech

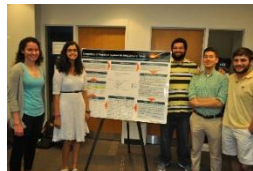


# Key Accomplishments

- The GT ASDL was established by Dr. Dan Schrage and Dr. Dimitri Mavris in 1992 as a Key Element in implementing a Graduate Program in Aerospace Systems Design
- Dr. Daniel P. Schrage joined GT as the Rotorcraft Design Professor in 1984 after having served as the Director of Advanced Systems and Associate Tech Director, S&T, AVRADCOM, 1980-84. In 1986 he became the Director of the GT RCOE, later called VLRCOE, until May 2019 when he retired as a Professor Emeritus
- Dr. Schrage was given the assignment by Drs. Ducoffe and Gray in 1986 to help build the School of AE from an Aeronautical Engineering School with limited disciplines, i.e. Aerodynamics, Aeroelasticity and Structures & Materials to a world renown Aerospace Engineering School.
- With the establishment of ASDL the GT School of AE expanded beyond Vertical Lift and has become a world renown laboratory and the largest AE School in the USA
- In addition, in 2003-2005 Dr. Schrage led the development of the first of the first Software Enabled Control (SEC) for Intelligent Unmanned Air Vehicles

# What is behind our claims of greatness?

## Faculty, Students, Curriculum, Research, and Alumni (School is ranked #1 Undergraduate AE & in Top Three Graduate)







# Some of the Key RCOE/VLRCOE Co-PIs

Back Row: Dr. Schrage; Second Row: Drs. Hodges, Smith & Ruzzene

First Row: Drs. Bader, Ohio St; Cesnik & Friedman, U. of Michigan; A.McKeev, UTA, Komerath GT

(Missing: Dr. J.V.R. Prasad, Dr. L.Sankar, Dr. K. Feigh, Dr. J. Remoli, Dr. E. Theodorou,  
Dr. J. Rogers, GT; Dr. D. Peters, WU; Dr. W. Yu, Purdue; Dr. G. Rajagopalan, Iowa St)





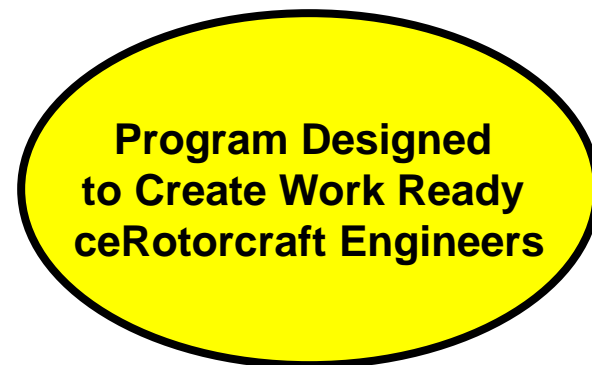
# GT Rotorcraft Graduate and Undergraduate Supporting Courses in 1992 ( Undergraduate Rotorcraft Design Courses Reduced w/ Curriculum Revisions)

## *Core Courses*

AE 4358 – Undergraduate Rotorcraft Design I\*  
 AE 4359 – Undergraduate Rotorcraft Design II\*  
 AE 4070 - Rotor/Propeller Theory  
 AE 6333 - Rotorcraft Design I\*      \*AHS SDC Focus  
 AE 6334 - Rotorcraft Design II\*      UG & GR entries  
 AE 6070 - Rotary Wing Aerodynamics  
 AE 6220 - Rotorcraft Structural Dynamics. & Aeroelasticity  
 AE 6372 – Aerospace Systems Engineering  
 AE 6503 - Helicopter Stability & Control

## *Supporting Courses*

**AE 4370 – Life Cycle Cost Analysis (LCCA)**  
 AE 4802 – Applied CAD/CSM/ CFD  
 AE 4903 - Airfoil Design  
 AE 6030 - Unsteady Aerodynamics  
 AE 6060 - Aeroacoustics  
 AE 6104 - Computational Mechanics  
 AE 6165 - Principles of Fracture & Fatigue  
 AE 6170 - Structural Optimization  
 AE 6230 - Structural Dynamics  
 AE 6240 - Numerical. Methods In Structural Dynamics

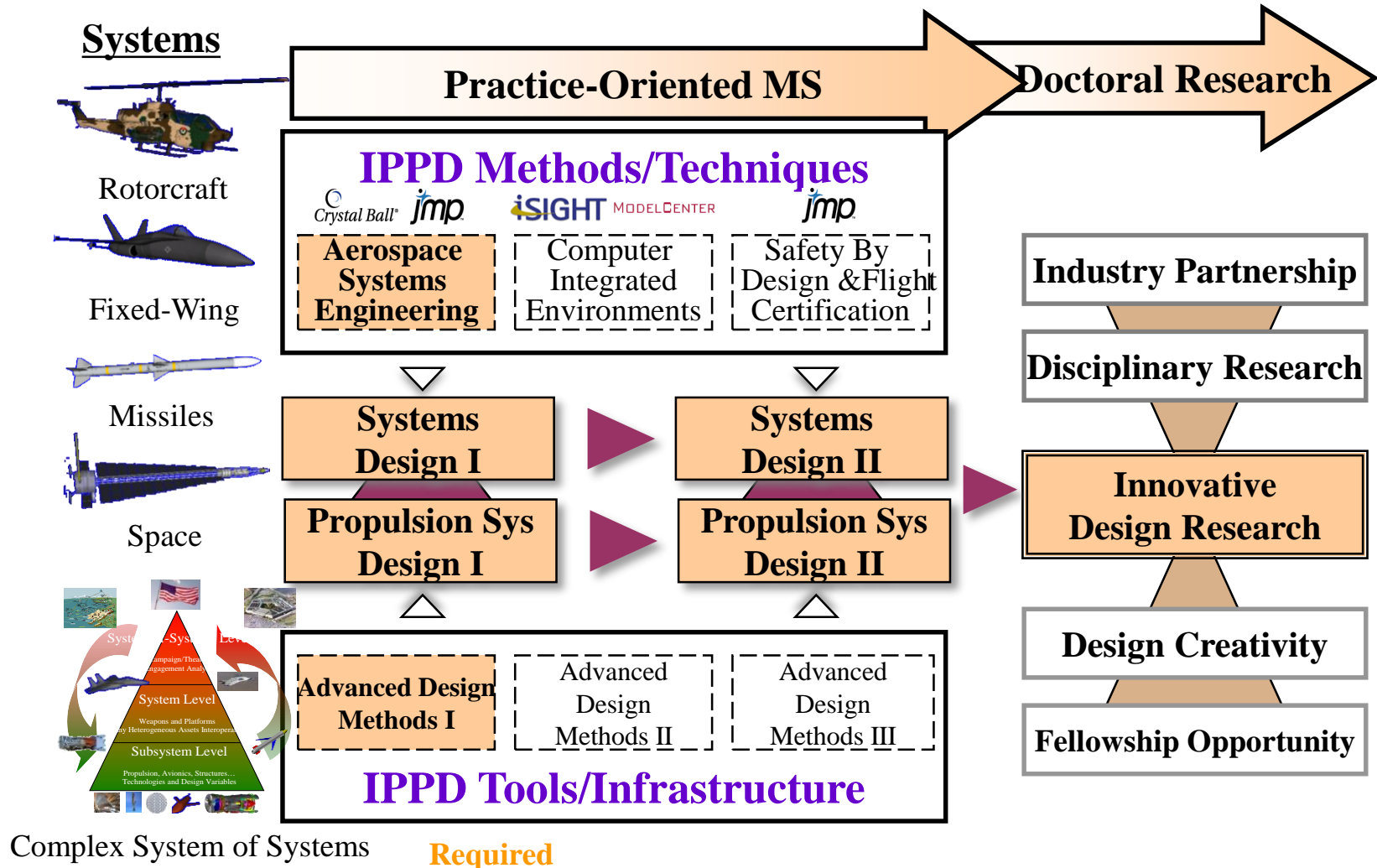


Program Scope has changed  
 which presents challenges in  
 GTAE VL UG and Grad Curricula

AE 6240 - Numerical. Methods In Structural Dynamics  
 AE 6260 - Flexible Multi-Body Dynamics  
 AE 6361 - Multidisciplinary Design Opt.  
**AE 6362 - Safety by Design & Flight Certification**  
 AE 6380 - Fundamentals of CAD/CAE  
 AE 6381 - Software Development for Engineering Apps  
 AE 6511 - Optimal Guidance & Control  
 AE 6531 - Aerospace Robust Control I  
 AE 6532 - Aerospace Robust Control II



# Georgia Tech Aerospace Systems Design Masters (MS) Core Program based on IPPD





## **Integrated Product and Process Development (IPPD) evolved from Concurrent Engineering in Industry and Required by Secretary of Defense for New & Modified Systems**

- In the early 1990s IPPD evolved as a form of Concurrent Engineering used by U.S. industry in response to the Japanese Total Quality Management (TQM) success. ASDL led a major research effort in IPPD through RDS
- In the Mid 1990s the Air Force used IPPD and Concurrent Engineering in their Lean Aircraft Initiative (LAI) at MIT with Dr. Schrage's participation
- Dr. Schrage then helped develop & present National Center for Advanced Technology (NCAT) IPPD Courses for industry & government which introduced an IPPD Methodology that was developed in the GTAE graduate program in Aerospace System Design and ASDL
- The Methodology includes Systems Engineering as a decomposition approach and Quality Engineering as a re-composition approach
- Down the middle is a Top Design Decision Support Process for Systems Engineering and Quality Engineering Tradeoffs of Product and Process for complex systems
- Robust Design Simulation (RDS) was included in the IPPD Methodology through research as illustrated in a follow-on chart.





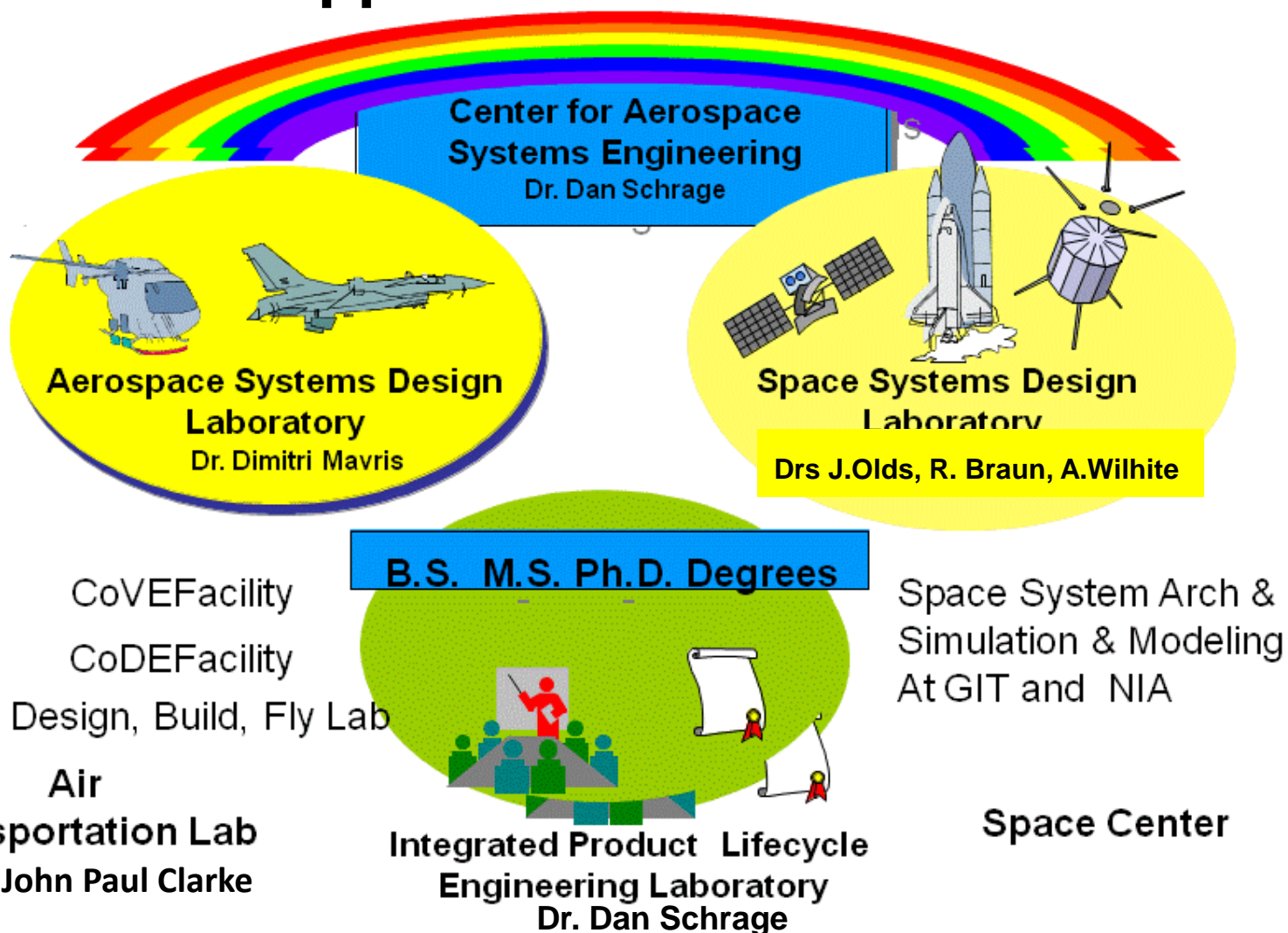
# Expansion of the Graduate Program in Aerospace Systems Design during 1990s-2000s

- To continue expansion to a world class School of AE required the establishment of new laboratories and graduate courses
- The new laboratories are identified in the next chart as
  - The **Aerospace Systems Design Laboratory (ASDL)**, the largest in world
  - The **Space Systems Design Laboratory (SSDL)**, numerous changes
  - The **Integrated Product Lifecycle Engineering (IPLE)** Laboratory
- Initially, a Center for Aerospace Systems Engineering (CASE) was formed to overlook the laboratories and coordinate their collaboration; however, it was abandoned as faculty left and as the Laboratories, especially SSDL and Air Transportation Laboratory were individually managed & Operated
- Over the years with changes in faculty the cohesion in using the IPPD through RDS methodology along with changes in curriculum, both graduate and undergraduate, have been reduced in the Program.
- **A Modular Open Systems Approach (MOSA) is now desired and required by Government Agencies and being implemented in Industry**





# GT Aerospace Systems Design Support Centers/Labs





# GT AHS SDC Winners, 1984-2014

## (AHS SDC has been the catalyst for Worldwide Vertical Lift Interest)

### Variety of VTOL Concepts Evaluated

Year	Sponsor	Project	Winners
1984	Boeing	Combat Search & Rescue	RPI and GIT
1985	Boeing	Sport Helo for Home Construction	GIT 1 <sup>st</sup> & 2 <sup>nd</sup> ; PSU 3 <sup>rd</sup>
1986	Boeing	One Man RW Racer	GIT all categories
1987	Bell	Low Cost TR Commuter Opns	GIT 1 <sup>st</sup> & 2 <sup>nd</sup> ; RPI 3 <sup>rd</sup>
1988	Sikorsky	Heavy Lift Helicopter	GIT 1 <sup>st</sup> & 2 <sup>nd</sup> ; UMD 3 <sup>rd</sup>
1989	MDHS	Light Utility Helicopter	GIT all categories
1990	Boeing	Remotely Piloted Surv Vehicle	GIT all categories
1991	Bell	High Speed VTOL	GIT all categories
1992	Sikorsky	VTOL Package Express AC	GIT 1 <sup>st</sup> ; RPI 2 <sup>nd</sup>
1993	MDHS	Scout Reconnaissance	NPGS 1 <sup>st</sup> & ASU 2 <sup>nd</sup>
1994	Boeing	Dual Use VTOL	GIT 1 <sup>st</sup> & NPGS 2 <sup>nd</sup>
1995	Bell	UAV cap extracting 2 people	NPGS 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
1996	Bell	Fire Fighting Rotorcraft	GIT 1 <sup>st</sup> & NPGS 2 <sup>nd</sup>
1997	Boeing	Armed Escort for V-22	GIT 1 <sup>st</sup> & USMA UG1 <sup>st</sup>
1998	Boeing	12 seat VTOL Transport	UMD 1 <sup>st</sup> & RPI 2 <sup>nd</sup>
1999	Bell	VTOL 4-6 seat aircraft	UMD 1 <sup>st</sup> & RPI UG1 <sup>st</sup>
2000	Sikorsky	Mars Autonomous Rotorcraft	GIT 1 <sup>st</sup> 2 <sup>nd</sup> & UMD 3 <sup>rd</sup>
2001	Boeing	VTOL with Innovative Control	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2002	Bell	Upgrade & remanuf 4-6 VTOL	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2003	Sikorsky	VTOL Urban Response Vehicle	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2004	Agusta WL	High Altitude Rescue Helicopter	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2005	Boeing	Heavy Lift VTOL Aircraft	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2006	Bell	Two Place Turbine Training Helicopter	GIT 1 <sup>st</sup> & UMD 2 <sup>nd</sup>
2007	Sikorsky	Adv Deployable Compact VTOL for SOFs	GIT 1 <sup>st</sup> & UMD 2 <sup>nd</sup>
2008	Eurocopter	VTOL "Smart Copter" Concept	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2009	Agusta WL	New non-conven Drive on Existing VTOL	GIT 1 <sup>st</sup> & UMD 2 <sup>nd</sup>
2010	Boeing	Multi-Lift VTOL Aircraft	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2011	Bell	Multi-Role VTOL Aircraft	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2012	Sikorsky	Rotary Wing Racer	UMD 1 <sup>st</sup> & GIT UG 1 <sup>st</sup>
2013	Eurocopter	VTOL Natural Disaster Rescue Vehicle	UMD 1 <sup>st</sup> & GIT 2 <sup>nd</sup>
2014	Agusta WL	VTOL X-Plane Concept	GIT 1 <sup>st</sup> & Polit Milano 2 <sup>nd</sup>





# Georgia Tech 1985 AHS Graduate Design Team B Receive their First Place Awards from Boeing Vertol President Joe Mallen and AHS Executive Director







## Georgia Tech 1985 AHS Graduate Design Team A Receive their Second Place Awards from Boeing Vertol President Joe Mallen & AHS Executive Director



John Zugswert, Executive Director American Helicopter Society, Dr Dan Schrage,  
Ed Parleman, N.S. Abhyankar, V.R.P. Jonnalagadda, Al Brand, A.K. Sareen,  
Joseph Mallen, President of Boeing-Vertol Company





**First Place in the 1990 AHS Student Design Competition from Mr. Dean Borgman, former AVRADCOM Director for Advanced Systems, President, McDonnell Douglas Helicopter Company, then Sikorsky Aircraft, Providing Check to CPT Jim McConville, now CSA**





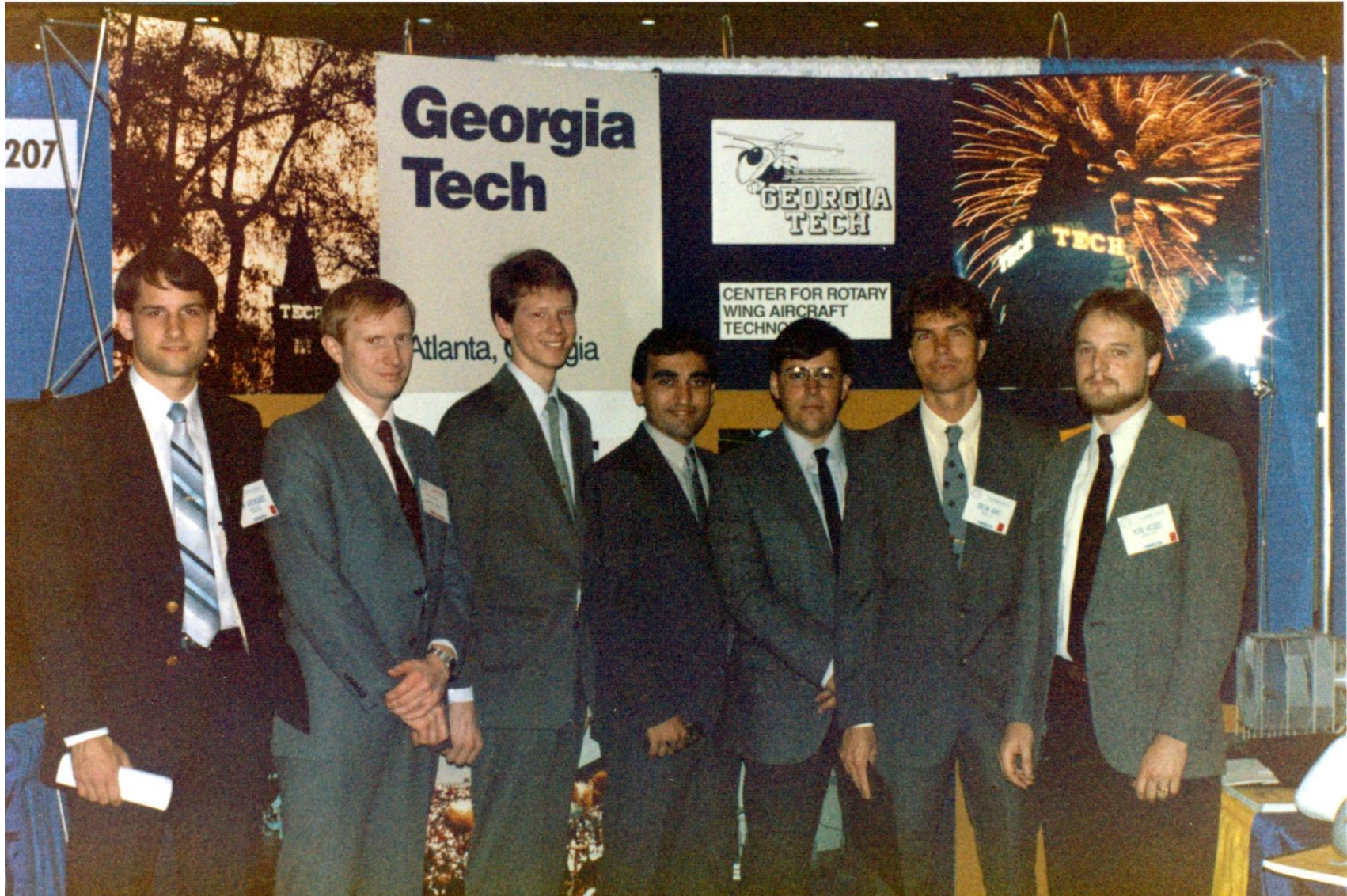
## **Video of Appreciation from GEN Jim McConville, Chief of Staff of the Army (CSA) on November 7, 2022**

- CPT McConville was the Team Leader for the Graduate Winning Team in the 1990 American Helicopter Society (AHS) Student Design Competition (SDC) for designing a Light Utility Helicopter (LUH), which was issued and funded by the McDonnell Douglas Helicopter Company (MDHC) and then developed as the MD 309 Light Commercial Helicopter (LCH)
- Over 40 military officers and 100 students received their advanced degrees with Dr. Schrage as their instructor and advisor
- A number were promoted to rank of General Officers and four became Astronauts
- In addition about half of the students became managers, executives, senior fellows and faculty in industry, government and academia





# Rotorcraft Fellows at the AHS Forum





# Georgia Tech Led Software Enabled Control for Intelligent Uninhabited Air Vehicles (UAVs)

Contract Number: # F33615-98-C-1341

Award End Date: 4Q-FY04

## Principal Investigators:

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## Co-PIs and Key Personnel:

Bonnie Heck (ECE), Eric Johnson (AE), J.V.R. Prasad (AE), Linda Wills (ECE)

[controls.ae.gatech.edu/projects/sec](http://controls.ae.gatech.edu/projects/sec)







# SEC Rotary Wing Final Experiments Demo August 2004 at Ft. Benning, Georgia



Georgia Institute  
of Technology

Dr. Daniel P. Schrage  
Georgia Tech



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SCIENCE &  
ENGINEERING



Scientific Systems  
Company, Inc.

Honeywell



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# Summary and Conclusions

- The School of AE transitioned from mostly an undergraduate Aeronautical Engineering Curriculum in the 1960s and 1970s to a full scale graduate Aerospace Engineering Program by the 1990s
- The award of the first Army Aviation Rotorcraft Center of Excellence (RCOE) in 1982 helped to propel the School with necessary resources and recognition to expand its program
- In January 1984 Dr. Schrage, as the Rotorcraft Design Professor, developed the necessary graduate courses in response to the AHS Rotorcraft Student Design Competitions and used the IPPD methodology
- In 1990-1992 Graduate Courses in Fixed Wing Design and Spacecraft Design were also developed and helped generate the ASDL and SSDL.
- Dr. Schrage in partnership with GTRI researchers initiated the First International Aerial Robotics Competition (IARC) which still exists today
- Dr. Schrage and Dr. Mavris also conducted numerous studies for industry & government
- Other initiatives Drs. Schrage and Mavris conducted were for Air Force, Army, NASA, Army and industry.