Ten Years Experience with a Multi-University Collaborative Graduate Education Program

Colin P. Britcher[1], Bernard M. Grossman[2]

Abstract – The National Institute of Aerospace (NIA) was founded as a non-profit research and educational institution located in close proximity to NASA Langley Research Center (LaRC). NIA's academic member institutions are Georgia Tech, Hampton University, North Carolina A&T, North Carolina State, the University of Maryland, Virginia Tech, the University of Virginia, Old Dominion University and the College of William & Mary, supplemented by the AIAA Foundation. A core component of NIA's mission from the outset has been a relatively unique collaborative graduate education program, wherein a graduate student from one of the member institutions can take up to 50% of their coursework from other member institutions, while pursuing research alongside NASA engineers and scientists. Faculty advisors may be in residence at NIA (as distinguished Langley Professors, regular, or adjunct faculty), or at the student's home campus. The cross-registration model avoids the complexities of multiple institutional registrations by the use of "ghost" courses at the student's home campus. In nearly ten years of program operation, 119 students have successfully completed their programs, about two-thirds at the Masters level and one-third PhD. Many graduates have gained employment at NASA LaRC or its support contractors. The paper presents background, objectives, statistics on the program and addresses successes, failures, and lessons learned.

Keywords: Graduate, NIA, NASA, Collaborative, Cross-registration, Aerospace

BACKGROUND

In the early 2000's, the concept for the National Institute of Aerospace emerged from NASA Langley Research Center as a non-profit research and graduate education institute created to conduct leading-edge aerospace and atmospheric research, provide graduate and continuing education opportunities, develop new technologies, and help inspire the next generation of scientists and engineers. Requirement #2 from the original solicitation [NASA, 1] stated that the new organization should:

> *"Provide comprehensive graduate and continuing education in science and engineering by using both a local campus and exploiting innovative distance-learning concepts"*

It is noteworthy that this requirement did not emerge in isolation; rather it represented a continuation of two symbiotic goals:

- Interest from NASA Langley Research Center (LaRC) in developing enhanced local educational opportunities, LaRC itself being some distance from major science and engineering University campuses.

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- A desire within the Commonwealth of Virginia to enhance cooperation between the many highly ranked Universities that operate successful Colleges of Engineering or Sciences, in order to enhance quality and broaden the scope of offerings, while doing so efficiently.

Three notable activities were in play at the time of NIAs inception:

- The Commonwealth Graduate Engineering Program (CGEP), a consortium composed of five Virginia Universities[3], focusing on Masters level programs delivered statewide by Distance Learning technology, which started operation in 1983. CGEP continues to operate successfully to the present day [anon, 2].
- The Virginia Consortium of Engineering and Science Universities (VCES) was founded by four institutions[4] and focused on delivery of PhD level programs to the Peninsula region, notably NASA LaRC. Both VCES and CGEP programs were configured to permit 50 percent of a student's course credits to be transferred from other institutions in a relatively seamless fashion. Residency requirements for the out-of-region schools was satisfied by residency in the Peninsula region, typically involving work at LaRC or the adjacent Langley Air Force Base.
- LaRC had hosted the Joint Institute for the Advancement of Flight Sciences (JIAFS), operated by George Washington University, since the mid-1970's. JIAFS offered on-site graduate programs, using resident GW faculty, supplemented by adjunct faculty drawn predominantly from the local Federal and contractor workforce [Cutler, 3].

LaRC anticipated that JIAFS would cease operations at the termination of their contract in late 2002, with existing students transferring to the new organization. Further, the original structure of NIA more-or-less absorbed the functional activities of VCES, with the VCES Director, David Chestnutt, becoming the Director of Graduate Education and Rita Aguillard, the administrative lead at VCES, taking over classroom operations at NIA. Dr. Bernard Grossman, then the outgoing Chair of Aerospace and Ocean Engineering at Virginia Tech, became the Vice President of Education and Outreach.

ORGANIZATION OF THE NATIONAL INSTITUTE OF AEROSPACE

NIA was founded as a consortium of six leading regional research universities; Georgia Tech, North Carolina A&T State University, North Carolina State University, the University of Maryland[5], the University of Virginia, and Virginia Tech, plus the AIAA Foundation. Following inception, three additional local institutions were added, with Hampton University as a full member, plus Old Dominion University and the College of William & Mary as Affiliate members. The Institute is governed by a Board of Directors, with representation from all full members, plus three at-large seats[6]. The executive structure is corporate-style, with a President and Executive Director, three Vice Presidents (Operations, Research, and Education & Outreach) and a Chief Financial Officer. The core mission of the organization has been unchanged since its formation [NASA, 1]:

1. Foster research collaboration among national laboratories, academia and industrial partners to stimulate innovation and creativity
2. Provide comprehensive graduate and continuing education in science and engineering via local campus presence and distance learning technologies
3. Incubate and stimulate the commercialization of new intellectual property developed through NIA's research activities
4. Promote aerospace science and engineering and provide outreach to the region

Bullets 1 and 2 above have consistently been considered mission-critical to NIA's identity. The existence of a strong graduate education activity within a collaborative research-oriented organization is relatively unique in the nation.

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3 George Mason, Old Dominion, University of Virginia, Virginia Commonwealth, and Virginia Tech
4 Old Dominion, Virginia Tech, College of William and Mary, and the University of Virginia
5 The only member institution outside the geographic boundaries of ASEE's Southeast region
6 Added later

Langley Professor Program

An important component of the academic identity of the institution from its outset has been the Langley Professor program, wherein a distinguished faculty member from each of the founding Universities is in residence at NIA for a substantial portion of the year while also maintaining a strong presence at their home campus. Hampton University also has a distinguished Professor in Residence, functioning similarly. The Langley Professors (LaPs) initially received base support as part of NIAs start-up funding, subsequently receiving a lower level of support via a separate award from LaRC. They receive partial salary from their home institutions, and are expected to develop substantial supplemental funds via competitive awards from NASA and elsewhere. The current complement of LaPs and Professors in Residence is shown in Figure 1. Previous holders of these appointments include Dr. Kathryn Logan (VT), Dr. Robert Tolson (NCSU), and Dr. David Song (NCA&T).

Figure 1 - NIA Langley Professors and distinguished Professors in Residence, 2013

Graduate Program Governance

The Vice President of Education and Outreach is responsible for the graduate program and operates with one administrative staff member and one classroom/IT coordinator. Educational Outreach (notably the Center for Integrative STEM Education, CISE) also reports to the VP for E&O, but has its own Director. The E&O office is annually base-budgeted within NIA.

Since NIA is not a degree-granting institution, it functions as a facilitator/coordinator/clearing house between the member institutions. All degree programs are provided by member institutions, with the current suite including, but not limited to those shown in Table 1 below. Academic direction of the program is the responsibility of the office of E&O but is carried out as a grand collaboration. Interfaces to the member institutions are provided via a Technical Advisory Committee, comprised of academic representatives from all members, and via the Langley Professors. A very recent change, designed to improve coordination of program development, has been to revise the charter for the TAC and to add LaPs as members and to focus the committee's attention more towards NIA's academic activity. Figure 2 illustrates the organizational structure; the efficacy of which is discussed later in the paper.

GRADUATE PROGRAM DESCRIPTION

Sources of Full-Time Student Funding

The original proposal anticipated significant support for graduate research assistants ("NIA GRAs") from two major sources:

1. The LaP program was initially configured to provide support for 20 graduate students. After the 5 year start-up period, this funding level was reduced to 12 (i.e. 2 per LaP).
2. A number of GRAs are supported under discretionary awards from LaRC Branches or Projects through a Task Order mechanism.

Table 1 - Degree Programs Offered, 2012/3	
Georgia Tech	Aerospace Engineering
Hampton University	Planetary and Atmospheric Sciences
North Carolina A & T	Mechanical, Electrical and Computer Engineering
North Carolina State	Mechanical and Aerospace Engineering
Old Dominion University	Mechanical and Aerospace Engineering
University of Maryland	Aerospace Engineering
University of Virginia	Mechanical and Aerospace, Electrical and Computer, Materials Science & Engineering, Engineering Physics, Systems & Information Engineering
Virginia Tech	Aerospace, Mechanical, Ocean, Materials Science & Eng., Engineering Mechanics, Electrical and Computer, Computer Science
William and Mary	Applied Science

These awards were set up with an element of standardization, such that the "cost" of a student was independent of the student's institution of choice, avoiding any skewing of student's affiliations based solely on tuition costs. The typical current funding profile is shown in Table 2. The total number of students supported by these mechanisms peaked at 50, but in recent years, there has been a decline driven by the tight fiscal situation at NASA. This has been a major cause for concern, as discussed more fully later in this paper. A switch in funding mechanisms for the discretionary population from the Task Order route to internal alternatives, such as Co-Op or Intern hires, or existing programs such as the Langley Aerospace Summer Scholars (LARSS) program, has also been a cause for concern. These options are slightly cheaper to NASA, but cuts off an important flow of overhead funds to NIA, which would otherwise help support the cost of the program infrastructure.

Table 2 - Typical NIA GRA Funding Profile, 2012	
M.S. first year stipend	$22k
M.S. beyond first year stipend	$23k
PhD first year stipend	$24k
PhD beyond first year stipend	$25k
PhD completed coursework	$26k
Tuition (varies by school)	Full tuition and fees
Student travel allowance	$1.5k
Faculty allowance	$5k
Cost to sponsor; average of above, plus overheads	$49.9k

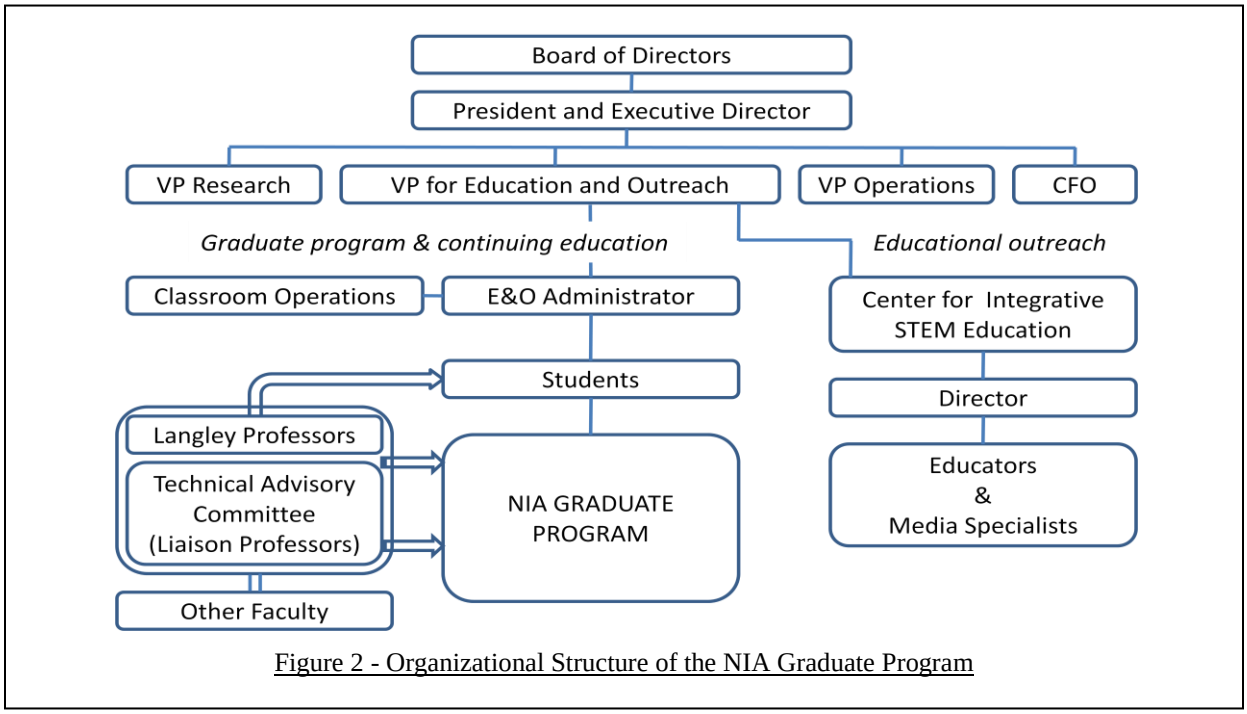


Figure 2 - Organizational Structure of the NIA Graduate Program

Student Headcounts

Until recently, the emphasis had been on full-time students, since this allows the strongest linkage with NASA research programs. In turn, the majority of full-time students in the early years were classical NIA GRAs, as discussed above. Figure 3 shows the headcounts of full-time students broken down by institution over the last few years, also the cumulative count of graduates up to the present. Note that one response to the decline in LaRC funding was to more fully integrate the Affiliate member schools into the graduate program, circa 2010. Full-time student complements of forty or above are considered viable, in the sense that a critical mass permitting establishment of a genuine sense of student community is reached.

In addition to the full-time, somewhat traditional, student population, NIA-based programs are made available to a part-time population, including NASA civil servants and contractors, Air Force officers, and other local individuals engaged in the high technology workforce. The headcounts of part-time students have grown steadily and are now roughly equal to the full-time population. It is thought that the part-time populations represent a potential growth area, provided the funding issues (lack of funds flowing in direct support NIA educational infrastructure) can be resolved.

The breakdown of students (full-time and part-time combined) by discipline is shown in Table 3. Not surprisingly, Aerospace (or combined Aerospace/Mechanical) Engineering programs dominate, but roughly 30% of past and current students are enrolled in other disciplines.

Table 3 - Breakdown of Students by Program

Program	Current	Previous
Aerospace (incl. Aerospace and Ocean)	64%	56%
Mechanical and Aerospace	7%	13%
Electrical	11%	15%
Mechanical	10%	6%
Materials Science	6%	6%
Atmospheric Science	1%	4%
Systems Engineering	1%	-

Course Delivery

NIA operates four classrooms of various sizes, each fully equipped for distance learning using a range of IP-based protocols. As distance learning and online classes have become more prevalent at the member institutions, the number of classes available to students has grown exponentially.

Table 4 - Classes Made Available

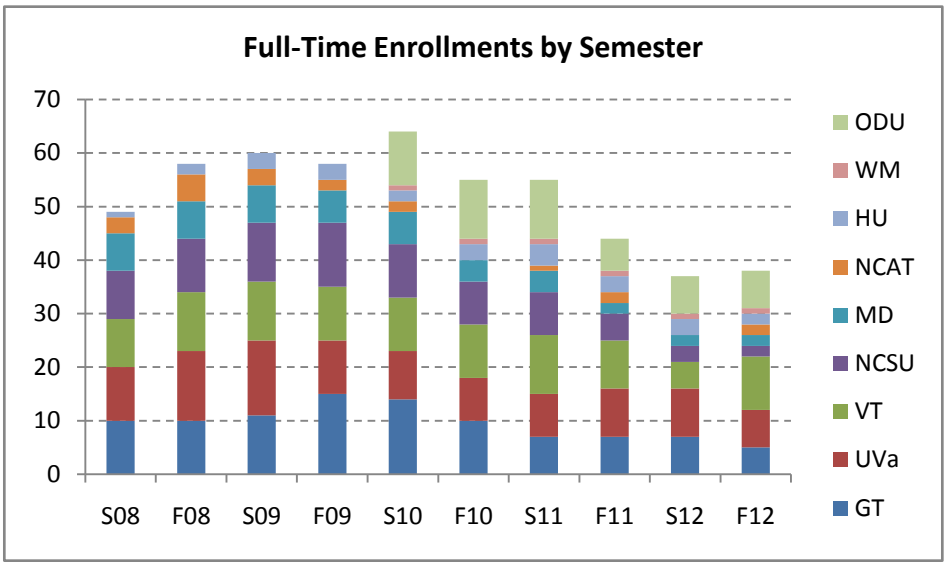
Semester	Number (live at NIA)
Spring 2010	28 (7)
Fall 2010	92 (6)
Spring 2011	109 (8)
Fall 2011	100 (5)
Spring 2012	117 (7)
Fall 2012	113 (6)

For example, Table 4 lists the number of classes made available in the last three years. Clearly availability of raw courseware is not a constraining factor.

Course Exchanges

A major benefit of a collaborative program is the opportunity for students to register for coursework from institutions other than their "home" school. In this case, students are permitted to take up to 50% of their required coursework from other participating institutions. The course exchange arrangement utilizes "ghost" courses at the student's home campus, with their academic advisor (perhaps a LaP) or their institutions Liaison Professor acting as instructor of record. This arrangement avoids the otherwise problematic exchange of funds between institutions or the requirement for students to register at multiple institutions. NIA notifies the actual course instructor and appropriate individuals involved in the distance delivery technology as appropriate. At the completion of the course, the instructor officially notifies NIA of the grade for any cross-registered students and NIA then notifies the instructor of record. This process has worked well, although there are some issues that must be carefully monitored, as discussed below.

The headcount of course cross-registrations is shown in Table 5 below, with institutions listed simply as A-I for reasons of privacy. The numbers are relatively small, so it must be concluded that the program has not yet realized its full potential.



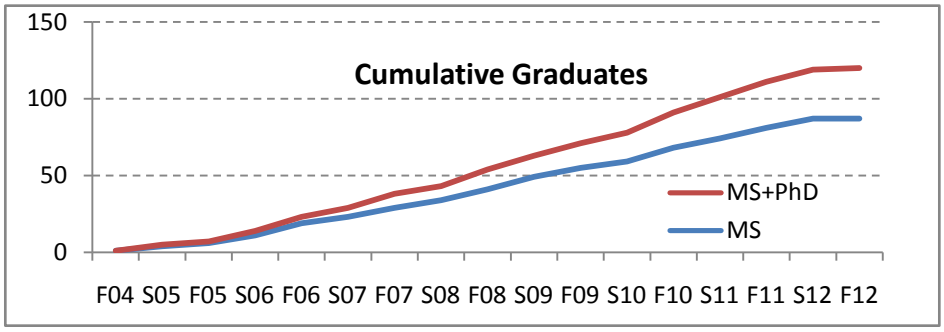


Figure 3 – Program Statistics

Table 5 – Cross-Registrations, Fall 2009 thru Fall 2012 inclusive (4.5 years)

		Receiving Institution								
		A	B	C	D	E	F	G	H	I
Originating Institution	A				13	4	10	3	6	1
	B	1			2	1	1	2		
	C									
	D	5		4		2	15	5	2	
	E	5			3		1	4	2	
	F		1	1	3	2		6	1	
	G	1	7	1	4	6	17		2	
	H				1					
	I									
Total		12	8	6	26	15	44	20	13	1

Program Evaluations

NASA establishes extensive metrics for NIA and requires extensive evaluations by various constituencies. The graduate program has been formally reviewed by NASA stakeholders each year and has consistently scored well, as illustrated in Table 6. Also important is the perspective of the participants, i.e. the students, whom NIA polls each year as part of the Annual Report process. Student evaluations have typically also been quite positive, also shown in Table 6.

Supporting Infrastructure

From the outset, NIA made office space available in the HQ building for use by students who did not have permanent work locations provided on-base at LaRC. NIA's support staff handles class registrations, NASA badging, travel arrangements, and so forth. An active Chapter of AIAA hosts regular technical and career events. Students are encouraged to participate in the extensive array of continuing education offerings, which have averaged between one and two events per week since NIA was founded. It is often possible for students to register for on-site or nearby conference at no charge if NIA is involved as host or organizer.

Table 6 – Graduate Program Evaluations (out of 5 maximum)

Year	External stakeholders	Internal (Students)
2009	3.93	n/a
2010	4.37	4.40
2011	4.34	4.17
2012	4.44	4.33

SUCCESS STORIES

One of NIAs first, and finest - **Jody Davis** (Fisher) completed a Bachelors degree at Embry-Riddle Aeronautical University, Prescott campus, before coming to NIA. She graduated with a degree in Mechanical and Aerospace Engineering from the University of Virginia in August 2005, working in the Exploration Systems Engineering Branch at LaRC. Her academic advisor was NIAs founding Executive Director, Dr. Robert A. Lindberg and she took coursework from UVa, University of Maryland and Georgia Tech. She received a NASA Engineering and Safety Center (NESC) award in 2005 for her work on the Cassini-Huygens team. She subsequently worked on the EDL problems for the Mars Science Laboratory, and was in the control room at JPL for the "seven minutes of terror" which led to the successful landing on August 6, 2012.

Taylor Spalt came to NIA in January 2009 and completed a Masters degree in Mechanical Engineering through Virginia Tech in 2010. He is currently in the final stages of completing a PhD, also with VT. His academic advisor was/is Dr. Chris Fuller, VT's Langley Professor. Along the way he was hired by NASA as an Intern in the Aeroacoustics Branch and has become a key player in a multi-million dollar acoustics test program of a Hybrid Wing-Body aircraft design, which got underway in 2012 and has recently been completed in early 2013.

In each "success" cited above, the combination of a direct work assignment within NASA, on-site faculty guidance, the ability to pursue a full academic program without traveling away to a home campus, and access to NIA's supporting infrastructure created an outcome otherwise beyond reach.

CHALLENGES

For best results, participating Universities must be committed to the success of the program and, critically, must also value the "intangible" rewards from the program at least as much as any direct financial returns. Intangible benefits are considered to include:

- Research and academic program collaborations
- Research, instructional and employment opportunities for graduate students
- Real-world, relevant research experiences for students and faculty
- Contribution to engineering and scientific problems of national importance

WHAT DOES OR DOES NOT WORK

What Works

Various features of the program, each not unique individually but perhaps unique in combination, have been recognized as drivers of the perceived value of the program:

- University residency requirements are fulfilled at NIA - students view NIA/NASA as their home campus. Of course this is a trade-off - student miss out on the breadth of academic and social activity on their home campus, but gain from interaction with their peers from other institutions and from work experience in Federal laboratory.
- Availability of a wide array of classes to resident students via the multi-University collaboration. This presents unique opportunities for students to expand their coursework beyond the scope of any single institution and, from time to time, take highly specialized courses from world experts in particular fields.
- Flexible cross-registration procedures, with no funds exchanging hands for individual registrations. This process has worked well, but some level of equity between institutions must be maintained in the long run, and program accreditation requirements must be given careful attention.

What Hasn't Worked (or has fallen short of expectations)

- Current GRA opportunities from LaRC tend to be very specifically targeted and relatively limited in number. This has made it quite difficult to maintain a continuous viable pool of graduate student candidates; instead recruiting tends to be done in response to a specific opportunity.
- The inherent disconnect between the member Universities responsibility for academic program development and NIAs responsibility for coordination of programs delivered has mitigated against initiation of new and tailored academic programs. It has even proved difficult to establish long-term course schedules, although this situation is improving.

SUMMARY OF LESSONS LEARNED

Successes

- A collaborative graduate program can be successful and effective if the participating institutions are committed to the enterprise, if the program structure is straightforward, and if appropriate incentives are incorporated for all parties.
- Interaction between faculty and students from multiple institutions and on-site experience at a major research lab adds considerable value to each student's academic experience.
- Unique graduate academic programs can be created by melding the "best of the best" from multiple institutions, although coordination is a major challenge.

Unrealized Potential

- As mentioned above, the effort has not spawned new academic courses or programs to the extent that had been hoped. Inherent pressures at each member institution have made the consolidation of course offerings from multiple institutions quite difficult.

REFERENCES

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Additional Material can be Found at:

https://www.aiaa.org/NIA/
http://www.hampton.gov/ed/releases/nia_opens.html
http://www.eng.vt.edu/distancelearning/programs
http://www.val.me.vt.edu/resources/facilities/national-institute-of-aerospace
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Dr. Britcher earned B.S. and Ph.D. degrees from the Department of Aeronautics and Astronautics at the University of Southampton, U.K. He served as an NRC Postdoctoral Fellow at NASA Langley for two years, then moved to Old Dominion University, serving in the Department of Mechanical Engineering and Mechanics and Aerospace Engineering, where he served as Chair from 2005-2010. He is currently is a full Professor in the Mechanical and Aerospace Engineering Department. His research interests include experimental aerodynamics, ground testing, flight mechanics, and magnetic levitation. He has published around 100 technical papers. He is an a Associate Fellow of AIAA, has served on the AIAA Ground Testing Technical Committee and is a member of ASEEE and SAE.

Dr. Bernard M. Grossman

Dr. Grossman obtained his B.S. in Aerospace Engineering and his M.S. and Ph.D. in Astronautics from the Polytechnic Institute of Brooklyn. From 1968 to 1980 he worked at Grumman Aerospace Corporation, holding the position of Head of the Theoretical Aerodynamics Laboratory. He was an Associate Professor of Mechanical and Aerospace Engineering at the Polytechnic Institute of New York from 1980-1982, then a full Professor Virginia Tech, serving as Department Head of Aerospace and Ocean Engineering from 1993 to 2002. In 2004, after serving on the successful proposal team, he was assigned to the newly created National Institute of Aerospace as Vice President of Education and Outreach. In 2008 he retired from Virginia Tech, was honored with the designation as professor Emeritus of Aerospace and Ocean Engineering, and simultaneously became a full-time NIA employee. In May 2012 he retired from NIA, but continues to teach and mentor graduate students. His research interests include computational fluid dynamics and multidisciplinary design optimization. He has published more than 250 technical papers and has taught courses in computational fluid dynamics, numerical analysis, fluid mechanics and gasdynamics U.S. and Europe. He is a Fellow of the American Institute of Aeronautics and Astronautics, where he has served as an Associate Editor of the AIAA Journal, a member of the Fluid Dynamics and Multidisciplinary Design Optimization Technical Committees and was the Technical Chair of the 12th AIAA Computational Fluid Dynamics Conference.