AWARD DESCRIPTION

Dr. Reddy has earned outstanding reputations in research and development through personal contributions as well as various leadership positions during his 42 year career in technology advancement in aerospace propulsion including air-breathing propulsion in all speed regimes as well as auxiliary and primary spacecraft propulsion for near-Earth and deep space missions. As a researcher, he has significantly advanced the state of computational fluid dynamics technology applied for complex three-dimensional viscous flow analysis to enhance the understanding of key flow physics in the advanced aerospace propulsion systems. In his 25 years of leadership positions, he has provided excellent leadership, vision, and motivation to the research groups he has led.

DETAILS OF THE NOMINATION

Leadership in the Engineering Profession

Dr. Reddy has provided excellent leadership, vision, and motivation to the research groups he has supervised during his 25 years of managerial positions. His leadership helps to maintain and enhance NASA Glenn Research Center's role as the world leader in aerospace propulsion technology development by providing the proper structure and climate for research to thrive.

In his current role as the chief of Aeropropulsion Division at NASA Glenn Research Center, he leads a staff of over 120 aerospace propulsion researchers in high-impact areas including: turbomachinery, combustion, propellants, icing, acoustics, inlets, nozzles, propulsion system simulation, engine systems, and computational methods, as well as experimental techniques. He also leads internal and external partnerships designed to conduct research and development, as well as plan new initiatives. He also ensures technical capabilities in strategic areas consistent with the Center's roles and mission, maintains NASA Glenn's technology leadership, and interfaces with customers and stakeholders to transfer technology.

- Dr. Reddy initiated and led a major collaborative efforts with aerospace industry including propulsion and air-frame companies such as Boeing, General Electric, Pratt & Whitney, and Honeywell. These efforts have led to formalized Space Act Agreements for collaborative research in the areas of mutual interest. Some of the examples include agreement with Boeing Commercial Aircraft (BCA) division in the area of propulsion aerodynamics and propulsion/air frame integration areas; agreement with Honeywell in the area of aircraft engine icing including a full-scale engine test in the NASA Glenn's altitude engine test facility (Propulsion Systems Lab) with ice crystal ingestion; and agreement with General Electric in the area of highly-loaded compressor technology for future engines to understand key loss mechanisms in the multi-stage turbomachinery.
- He played a key role in managing the change resulting from the refocusing and reformulation of the Aeronautics program at NASA Headquarters to ensure that division management and the researchers had a major impact in setting the direction of the technology advancement and developing long-term technology roadmaps for the Agency.
- He provided leadership to the division management and the staff to strengthen the existing partnership with other NASA centers, as well as numerous industrial partners by proposing collaborative research efforts in a broad range of technology development areas such as Cryogenic Fluids Management (CFM) and propellant technology for the Crew Exploration Vehicle (CEV) program, heat transfer assessment for the external tank in support of the Space Shuttle Return to Flight, and iced aircraft wing performance database development.

As Chief of On-Board Propulsion Branch at NASA Glenn, Dr. Reddy provided the necessary leadership to maintain a high-quality research program. Under his leadership, a number of significant milestones have resulted from the high-quality on-board propulsion research and development executed by his team.

- Ion thruster technology was successfully validated through the NSTAR (NASA Sloar electric propulsion Technology Application Readiness) mission which flew a 2.3-kW ion thruster (30-cm size) on Deep Space (DS–1) spacecraft (October 1998). The ion thruster technology was developed at Glenn, including the design of the thruster and subsequent support to the contractor, Hughes, in fabrication. The successful operation of the ion thruster on DS–1 mission marked a significant milestone in Glenn's electric propulsion technology development.
- Pulsed plasma thruster (PPT) technology was successfully transitioned to flight for demonstration on the New Millennium Program's EO–1 (Earth Orbiter) spacecraft that was flown in 2000. PPT is an enabling technology for precision formation flying, and the EO–1 mission would demonstrate this technology. A significant amount of component technology was developed at Glenn and transferred to the contractor, Primex Aerospace Company of Redmond, Washington.
- Rhenium/iridium chamber technology has been successfully transferred to industry. The first in-space firing of an iridium-coated rhenium apogee engine occurred on board a Hughes commercial communications satellite enabling an increase in the station-keeping propellant, thus extending a typical commercial satellite's life from 12 to 15 years.

As Chief of Computational Fluid Dynamics Branch at NASA Glenn, Dr. Reddy provided leadership to a staff of 15 research engineers to develop world-class algorithms and models such as the higher-order upwind algorithms and the Probability Density Function (PDF) model, which have given NASA Lewis Research Center (currently Glenn) worldwide recognition in the development of leading-edge CFD technology.

In addition to his technical and leadership contributions, Dr. Reddy has made numerous service contributions to aerospace community through his active participation in professional societies such as AIAA (American Institute of Aeronautics and Astronautics) and ASME (American Society of Mechanical Engineers). Following are some representative examples.

Dr. Reddy served as the Technical Area Chair for Air Breathing Propulsion for the 47th AIAA Aerospace Sciences Meeting to. He has chaired numerous technical sessions and presented technical papers at the AIAA technical conferences (Aerospace Sciences Meeting, Joint Propulsion Conference, Applied Aerodynamics, and CFD conferences) during his career. He has reviewed several technical papers for publication in AIAA journals and encouraged a number of researchers in his organization to participate in the AIAA technical committees and support the AIAA journals by volunteering for associate editor opportunities. As a mid-level Senior Executive Service manager, he has influenced the active participation of several of his organizations' staff in AIAA by emphasizing journal publications, conference presentations, and technical committee participation as the metrics for career advancement opportunities. As an active participant in technical committees in AIAA and ASME, Dr. Reddy has facilitated discussions of joint conference opportunities in the area of aerospace propulsion. He has been contacted by one of the ASME International Gas Turbine Institute (IGTI) Board member regarding the possibility of having a joint meeting of the ASME TURBO conference and AIAA/ASME/SAE/ASEE Joint Propulsion Conference, since both meetings are held in summer annually.

He serves on the editorial advisory board of the JANNAF (Joint Army NASA Navy Air Force interagency propulsion committee) Journal of Propulsion and Energetics and represents NASA on the JANNAF Executive Committee as one of the two NASA representatives. He has also served on the U.S. National Committee of the International Society for Air Breathing Engines (ISABE) and actively participated in the technical conferences organized by ISABE. He has been a co-coordinator of the International Symposium on Fluid-Structure Interaction and Flow-Induced Noise in Industrial Applications and Symposium on Algorithmic Development in CFD at the ASME Fluids Engineering Conference for the last ten years. He has chaired numerous technical sessions and presented technical papers at the ASME and AIAA technical conferences during his

30-year career. He has reviewed several technical papers for publication in journals such as AIAA Journal of Propulsion and Power, ASME Journal of Turbomachinery, International Journal of Computers & Fluids, and Journal of Fluid Engineering. He has also organized technical sessions on the topic of aerospace propulsion for the International Conference on Computational & Experimental Engineering and Science (ICCES) and presented keynote papers in the sessions in 2003 and 2005. He is an active participant on the review teams for the U.S. Air Force IHPTET (Integrated High Performance Turbine Engine Technology) and VAATE (Versatile Affordable Advanced Turbine Engines) programs involved in reviewing the technology development work of the aerospace propulsion industrial partners such as General Electric, Pratt & Whitney, Honeywell, and Liberty Works (Rolls-Royce).

Research and Development

In addition to the above described leadership role, Dr. Reddy personally contributed to the research and development as an engineer and scientist. Here are few examples:

As a Senior Project Engineer at Allison Gas Turbine Division (currently part of Rolls-Royce North America), Dr. Reddy made significant contributions to advance the state of CFD technology for viscous flow analysis in turbomachinery.

- He formulated and developed a solution algorithm to solve internal three-dimensional viscous flow based on the Reduced Navier-Stokes (RNS) model. He has also developed a quasi-steady wake analysis procedure, using the two-dimensional version of the RNS code, for the Air Force Turbine Vane-Blade Interaction Program.
- He formulated a mathematical model for viscous throughflow analysis in an axial flow compressor to develop an efficient and accurate loss prediction capability for the design system.
- He was a key member of the team responsible for the development of improved numerical methods for viscous recirculating flows under Element A of the NASA HOST (Hot Section Technology) Aerothermal Modeling Program.

As a Senior Scientist at the Defense Research and Development Laboratory, India, Dr. Reddy advanced the state of technology by conducting research and development in the area of Flight Sciences for Rockets and Missiles which included development, static testing, and performance evaluation of rocket motors for various weapon systems such as surface-to-air, anti-tank, and surface-to-surface missile projects. Most of these technologies were subsequently transitioned into real products in practical military applications.

At the Sverdrup Technology, Inc. (Contractor to NASA Lewis Research Center), Dr. Reddy he significantly advanced the understanding of dominant flow physics in air- breathing propulsion systems through his research in the area of CFD with emphasis on viscous flow analysis.

- He made a major contribution of CFD analysis to the mach 5 inlet testing program that involved experimental investigation of a proposed mach 5 aircraft mixed-compression inlet model in Glenn’s 10×10 Supersonic Wind Tunnel. His analysis provided clear insight into the bleed regions’ flow physics and led to significant, second-phase, data acquisition changes, and a successful program conclusion.
- He formulated a methodology for viscous throughflow analysis of multistage turbomachines to improve the design methodology for radial, axial, and mixed flow turbomachines.

Experience

SUMMARY

Aerospace engineer with forty two years of experience in aerospace propulsion including air-breathing and rocket propulsion in all speed regimes as well as auxiliary and primary spacecraft propulsion for near-Earth and deep space missions. Experience includes over twenty five years of leading research teams to advance the state of technology for a broad range of aerospace propulsion applications. Research experience includes advancement of the state of computational fluid dynamics technology applied for complex three-dimensional viscous flow analysis to enhance the understanding of key flow physics in the advanced aerospace propulsion systems.

NASA GLENN RESEARCH CENTER, Cleveland, OH. 1991 to present

Chief, Aeropropulsion Division (2002 to present)

Appointed as a member of the U.S. Senior Executive Service, responsible for providing enabling capabilities to the aerospace community by leading research and developing technology in the area of propulsion for aero as well as space applications. Also responsible for leading the partnership, with internal and external organizations, to conduct research and development to plan new initiatives and insure technical capabilities in strategic areas consistent with the Center's roles and mission, maintain GRC technology leadership, and interface with customers and stakeholders to transfer technology.

- Initiated and led major collaborative efforts with General Electric and Pratt & Whitney in the area of compressor and turbine aerodynamics and heat transfer research which led to a number of formal agreements using the NASA Glenn compressor and turbine experimental facilities leveraging resources where appropriate for mutual benefit of advancing the state of turbomachinery technology for future propulsion systems to meet NASA's high-level energy efficiency and environmental goals for near-, mid-, and long-term time frames. These collaborative agreements have been developed in close interaction with the project leadership of the Fundamental Aernautics and Aviation Safety programs in the NASA Aeronautics Research Mission Directorate (ARMD)

- Played a key role in managing the change resulting from the refocusing and reformulation of the Aeronautics program at Headquarters to ensure that the division management and the researchers had a major impact in setting the direction of the technology advancement and developing long-term technology roadmaps for the agency.

- Provided leadership to the division management and the staff to Strengthened the existing partnership with other NASA centers, as well as numerous industrial partners by proposing collaborative research efforts in a broad range of technology development areas such as Cryogenic Fluids Management and propellant technology for the Crew Exploration Vehicle (CEV) program, heat transfer assessment for the external tank in support of the Space Shuttle Return to Flight, and iced aircfraft wing performance database development .

- Led the division Represented the division in the discussions for potential collaborative research opportunities with Idaho National Labs (INL) in the areas of High Temperature Gas-cooled Nuclear reactors and Hydrogen production which led to a formal Space Act Agreement with INL.

In addition, I am currently serving as:

- A member of the AIAA Applied Aerodynamics Technical Committee.

- A member of the ASME Turbomachinery Technical Committee.
- A member of the JANNAF (Joint Army Navy NASA Air Force interagency propulsion committee) Executive Committee as one of the two NASA representatives.
- A core member of the Super Problem Resolution Team (SPRT) for propulsion representing Glenn in support of the NASA Engineering and Safety Center (NESC)

Chief, On-Board Propulsion Branch (1998 to 2002)

Responsible for planning, defining, establishing, directing, and coordinating research and technology programs and projects under the branch's responsibility which is to develop advanced on-board spacecraft propulsion technologies for Earth-orbital and deep space missions by advancing the state of the art in chemical, electric, and other propulsion systems.

- Provided the necessary leadership to the staff to maintain a high quality research program in the face of declining resources and uncertain funding priorities through a non-advocate review of the technology program and successfully advocated a robust long-term research program.
- Successfully transferred the ion thruster technology for the NSTAR mission which is currently flying a 2.3 KW Ion thruster (30 cm size) on Deep Space (DS-1) spacecraft launched in October 98. marking a significant milestone in Glenn's electric propulsion technology development.
- Successfully transferred the Pulsed Plasma Thruster (PPT) technology to the contractor, Primex, and ensured timely delivery of the PPT for New Millennium Program's EO1 (Earth Orbiter) spacecraft which will be flown in April 2000.

Senior Leader and Consultant (1997 to 1998)

Responsible for providing leadership and consultation to professional research engineers and support personnel involved with major project engineering or program development efforts.

- Led the effort to formulate and plan the inverse design methodology development for multistage turbomachinery and integrate it with the flow analysis and optimization elements to enhance design capability.
- Conducted feasibility study and provided CFD support for the Turbine-Based Combined Cycle project in support of the Hypersonics program, Single-Stage-to-Orbit Propulsion System.

Chief, Computational Fluid Dynamics Branch (1991 to 1996)

Responsible for planning, defining, establishing, directing, and coordinating programs and projects under the branch's responsibility which was to develop new and highly innovative techniques for the computation of internal flows in advanced aerospace propulsion systems.

- Provided leadership to a staff of fifteen research engineers to develop world class algorithms and models such as the higher order upwind algorithms and the Probability Density Function (PDF) model which have given NASA LeRC a world-wide recognition in the development of leading edge CFD technology.

- Focused the various research elements of the branch towards the common strategic goals of the division which are integrated into the agency's long-term research thrusts.

- Developed a research plan in partnership with Textron Lycoming, to address the industry's need for technology development in the inverse design methodology. This activity resulted in a Space Act Agreement between NASA and Textron Lycoming (now part of AlliedSignal).

- Collaborated with AlliedSignal in developing a joint research activity in the area of multi-disciplinary design optimization of a gas turbine engine performance at design and off-design conditions.

- Directed and coordinated the Probability Density Function (PDF) modelling activity for high speed reacting flows which has provided the industry with an order of magnitude improvement in emission prediction capability.

- Coordinated the full engine flow path analysis for a government base line scramjet engine including the combustor reacting flow and inlet unstart effects in support of the NASP (National Aerospace Plane) program.

- Provided CFD analysis for the successful aerodynamic design of the inlet for the Russian TU-144 engine which was successfully ground-tested in Russia in 1996 Summer under the US/Russian cooperative effort in support of the HSR program.

In addition, he served as:

- A member of the Aeronautics Directorate Total Quality Board.

- Chairman of the center's Asian Advisory Council.

- A member of the center's Multicultural Advisory Board.

- A member of the Blue Ribbon panel to address the AGT1500 gas turbine engine (used in the M1 Abrams tank) high oil consumption (HOC) issue commissioned by the U.S. army.

SVERDRUP TECHNOLOGY, INC., (Contractor to NASA LeRC), Cleveland, OH 1987 to 1991

Supervisor, Turbomachinery Analysis Section

Responsible for planning, directing, and coordinating research programs. Duties also included conducting research in the area of Computational Fluid Dynamics with emphasis on viscous flow analysis applicable to air-breathing propulsion.

- In a joint effort with LeRC Internal Fluid Mechanics Division (IFMD) and Propulsion Systems Division (PSD), initiated and established Laser Doppler Velocimetry (LDV) experimental facility for turbomachinery and supersonic flows.

- Collaborated with LeRC propulsion Systems Division and initiated research effort to study Wave Rotor concept and its feasibility in gas turbine engine applications.

- Provided design help for remodeling the 8 ft X 5 ft wind tunnel compressor.

- Provided heat transfer measurement capability for the transonic cascade experimental facility in IFMD.

- Validated a 3-D full Navier-Stokes time-marching code (PARC3D) for application in viscous flow simulation of hypersonic inlets in support of the National Aerospace Plane (NASP) program.

- Analyzed the 3-D viscous flow for a 1/3 scale model of a proposed Mach 5 aircraft inlet in support of the NASA LeRC hypersonic research program.

- Formulated a methodology for viscous through-flow analysis of multi-stage turbomachines to improve the design methodology for radial, axial and mixed flow turbomachines.

ALLISON GAS TURBINE DIVISION, GM, Indianapolis, IN 1984 to 1987

Senior Project Engineer

Responsibility was to advance the state of Computational Fluid Dynamics (CFD) technology for viscous flow analysis in turbomachinery.

- Formulated and developed a solution algorithm to solve internal 3-D viscous flow based on the Reduced Navier-Stokes (RNS) model which was used successfully for 2-D external flows in my Ph.D. dissertation work.

- Formulated a mathematical model for viscous through flow analysis in an axial flow compressor to develop an efficient and accurate loss prediction capability for the design system.

- Developed a quasi-steady wake analysis procedure, using the two-dimensional version of the RNS code, for the Air Force Turbine Vane-Blade Interaction Program.

- Contributed as a team member to the development of improved numerical methods for viscous recirculating flows under Element A of the NASA HOST Aerothermal Modeling Program.

UNIVERSITY OF CINCINNATI, Cincinnati, OH, 1980 to 1984
Res. Assistant (1980 to 1983), **Post-Doc. Res. Assoc.** (1983 to 1984)

DEFENSE RESEARCH AND DEVELOPMENT LAB, Hyderabad, India 1974 to 1979

HONORS/AWARDS (Representative List)

- Group Achievement Award for contributions to the Internal Fluid Mechanics (IFMD) management, September 1995, NASA LeRC.

- Invited to give a keynote address at a Computational Fluid Dynamics (CFD) seminar, sponsored by the University of Toledo, Center for Bioengineering, December 1995.

- Citation for contributions to High Speed Research, Phase I Program, in support of the High Speed Civil Transport (HSCT) project , May 1996, NASA LeRC.

- Group Achievement Award for contribution to TU-144 Inlet design in support of the US/Russian TU-144 ground test program, July 1997, NASA.

- Selected as an Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA), October 1997.

- Turning Goals Into Reality (TGIR) Award for contribution to High speed Research Program – Experimental Aircraft, Oct. 2000, NASA GRC.

- Listed in "Who's Who among Asian Americans."

- University of Cincinnati, College of Engineering Distinguished Alumnus Award in 2007.

- Invited to present a key note address at the ASME Eighth International Congress of Fluid Dynamics & Propulsion (ICFMP 8) in December, 2006 and a plenary presentation at the ASME Fluids Engineering Division Summer Meting in July, 2013.

PROFESSIONAL ASSOCIATIONS

AIAA (Associate Fellow), ASME (member), AIAA Air Breathing Propulsion technical committee (member); ASME Turbomachinery Technical Committee (member); JANNAF (Joint Army Navy NASA Air Force interagency propulsion committee) Executive Committee (member);

PUBLICATIONS

Authored/coauthored 40 technical papers published as refereed journal articles, book chapters and presented at technical conferences (List attached). Ten most important publications are listed below.

1. Reddy, D. R. and Rubin, S. G., "Consistent Boundary Conditions for Reduced Navier-Stokes (RNS) Scheme Applied to Three-Dimensional Viscous Flows," Journal of Fluid Engineering, Vol. 110, September 1988, pp 306-314.

2. Reddy, D. R., and Weir, J. J., "Three-Dimensional Viscous Analysis of a Mach 5 Inlet and Comparison with Experimental Data," Journal of Propulsion and Power, vol. 18, no. 2., March-April 1992, pp 432-440.

3. Reddy, D. R., "3-D Navier-Stokes Analysis of Crossing, Glancing Shocks/Turbulent Boundary Layer Interactions," Computers & Fluids, Vol. 24, No. 4, pp. 435-445, May 1995.

4. Reddy, D. R., and Reddy, E. S., "Aerodynamic Shape Optimization of a Subsonic Inlet Using Three-Dimensional Euler Computation," Journal of Propulsion and Power, Vol. 14, No. 2, March-April 1998, pp 225-233.

5. Reddy, D. R., Steffen. Jr., C. J., and Zaman, K. B. M. Q., "Computation of 3-D Compressible Flow from a Rectangular Nozzle with Delta Tabs," Journal of Engineering for Gas Turbines and power, Vol. 121, No. 2, April 1999, pp 235-242.

6. Reddy, D. R. and Zaman, K. B. M. Q., “Computational Study of Effect of Tabs on a Jet in a Cross Flow,” Computers and Fluids, Vol. 35, 2006, pp. 712-723.

7. Reddy, D. R. and Sree, D., “Computational Study of Flow in a Rocket Based Combined Cycle (RBCC) Engine Inlet, ” Computers and Fluids, Vol. 35, 2006, pp. 724-732.

8. Reddy, D. R., “An Overview of Gas-Turbine Engines, ” Book chapter No. eae087, Encyclopedia Aerospase Engineering, John Wliey & Sons, 2010.

9. Reddy, D. R. and Blankson, I. M., “Emerging Air-Breathing Propulsion Technologies,” Book chapter No. eae099, Encyclopedia Aerospase Engineering, John Wliey & Sons, 2010.

10. Reddy, D. R., “70 Years of Aeropropulsion Research at NASA Glenn,” Journal of Aerospace Engineering, Vol. 26, No. 2, April, 2013.