JOURNAL OF AIRCRAFT
Vol. 32, No. 1, January–February 1995

What Can Aircraft Technology Accomplish by 2010?

HALFWAY through the last decade of this century it is appropriate for the aircraft technology community (you) to set a vision for the aircraft of tomorrow. It's your call. Are there going to be major changes in aircraft shapes, capabilities, and affordability, or do we only see modest incremental improvements? Many of those in my network seem to fear the latter, based on lean budget projections certainly, but maybe also on the lack of apparent technology breakthroughs (quantum leaps) on the horizon such as stealth. To help bound the issue, let's concentrate on the next 15 years (three five-year budget cycles). What technologies are emerging which could make a compelling difference in aircraft parameters? I know of three. One is nonlinear dynamics. We continue to develop new aircraft concepts using, for the most part, rapid turnaround, linear tools including linear aerodynamics. Much of the rest of the world is waking up to the technology of nonlinear dynamics. We are barely taking notice, if the papers coming into this journal are an indication. Real dynamics are nonlinear. We linearize for convenience or brevity and clarity but are repeatedly throwing out the baby in my view. The second area is unsteady aerodynamics. There are many papers appearing this year in *JA* on this subject. The promise is at least full recovery of attached flow pressures but goes well beyond this as we try to exploit this technology to fully manage vorticity (the way dragonflies already do). Application of smart skins, active aeroelastic wings, pneumatics, active surfaces, fluidic thrust vectoring, micromachinery, etc., should ultimately revolutionize future fixed and rotary wing aircraft. I don't sense that we are moving together toward that goal, however. My final aircraft technology, which I think has the most promising payoff in the next 15 years, is integration technology.

What is integration technology? It is interesting to hear the answers to that question. How would you answer? There are, in fact, many answers, depending upon whether you are talking about the promise of true multidisciplinary optimization vs suboptimization within disciplines, or perhaps about budget categories and budget tracking, or about conceptual design tools, etc.

This journal will take on the subject of **integration technology** (note the emphasis) on all levels and from all aspects (except organizational implications) and invites your creative contributions. The problem we have right now is that we are not developing true integration technology. When it comes time to enter into preliminary design, any technology integration required is often a matter of ad hoc compromise and may even be driven by personality (individual or corporate). Few validated tools and databases exist to aid the process. The result? Either a conservative evolutionary product (based in part on the view that the customer is not prepared to accept the revolutionary) or a truly revolutionary product, highly compromised in all but the driving discipline, or no product at all. I'll let you fill in your examples in each category. Had the design team been provided with validated synthesis tools (such as an inverse aeroservoelastic code) and analysis tools along with an adequate database to allow adequate trades, uncoupled from conventional (e.g. weight based) algorithms, we might see a new generation of affordable shapes and capabilites.

A major concern in all this is whether there will continue to be a market for advanced technology aircraft. Can't the current or emerging fleet, outfitted with life extension technology, carry us well into the future? Many argue this way. But that's because they think, as most of us do, in classical linear terms and need to be shown what aggressive focused aircraft technology development can really do.

I want to tell you about some aircraft technology planning, coming out of the U.S. Department of Defense, that I have been involved with over the past year or so. This represents the first time (on my watch) that DoD is putting together a new technology planning process in the form of Technology Area Plans to provide a vision and direction for investment of S&T dollars. There are currently 21 Technology Areas, and one of these is Air Vehicles (which may become Aerospace Vehicles as I write this). Under Air Vehicles appear the Sub-Areas: Fixed Wing, Rotary Wing and Unmanned Air Vehicles. Each Sub-Area has identified a set of joint (Army, Navy, Air Force, Marines) technology goals, challenges, approaches, payoffs, etc., for the next 15 years. They have also identified specific payoffs to the commercial sector. As this process matures and becomes updated (biennially), it will provide the aircraft technology community with a long-awaited, long-term investment strategy guide. A preview of the TAP may be seen in the DoD S&T Strategy released last October.

Underpinning both the Fixed Wing and Rotary Wing Sub-Areas are two other documents: "Fixed Wing Technology Development Approach" and the "Rotary Wing Technology Development Approach." The fixed wing document, developed by the Air Force and Navy, is under review by industry as of this writing. The Army-developed rotary wing document has completed its industry review. Plans call for coordination with NASA. The TDA provides more details as to specific goals to be addressed within the disciplines and by **integration technology** (again the emphasis). I invite authors to submit their creative solutions to attainment of the goals we are setting forth. Budgets will continue to decline in the short term, and so we must be focused and creative. In the longer term, budget constraints may well yield to development of innovative air vehicle concepts.

I'd like to shift gears now and extend thanks to all who help make this journal "the premier international Journal of aircraft technology." I'll start with the professional staff at AIAA Headquarters in DC. Norma Brennan, Division Director, Journals, continues to be my principal supporter and keeper of knowledge about all matters pertaining to the journal. Without Norma's sustained support and creative encouragement, we would not have the quality journal we now have. If you are in DC and want to do something useful, stop by and tell her what a great job she is doing. Of course, if there is something you think we can do better, please let me know anytime. Norma is ably assisted by her Managing Editor, Jacqueline Dupree, who worries about all of the details of getting out a journal of more than 200 pages every other month. She is commended for the professional quality and overall appearance of the journal as well as for keeping issues coming to subscribers on time. Jacqueline is ably assisted by Everett Johnson, Jason Peak, and Justin Russell. I am most pleased with their professional approach to the journal, demonstrated during my meetings with them as well as in the product.

If you glance at the inside front cover of this issue, you will see three groups of volunteers who help develop the journal. The Associate Editors handle your submittals from the assignment of Reviewers through the decision to publish or decline. They are accountable for maintaining the high standards expected of *JA* articles and are dedicated to this task. Please look them up at AIAA meetings and provide them with your suggestions and, certainly, your encouragement.

Just below our Associate Editor staff you'll see a second group of volunteers, our Editorial Advisory Board. This group was selected by the Chairmen of several of our Technical Committees that develop meetings papers on aircraft technology subjects. The idea is that the EAB member represents *JA* within each TC in helping to encourage archival quality publication. EAB members have been busy this past year, and as a result you will be seeing many high quality papers that might otherwise have been missed. I thank the EAB for their efforts and look forward to another year working with that group. At the top right column of the inside cover you'll come to the last list of volunteers, the International Board of Editors. Led actively by Associate Editor B.L. Nagabhushan, this group serves a role somewhat similar to the EAB. In this case, the members are selected for their active role in publication and their willingness to represent *JA* in their respective countries. They are available to help authors who may have problems with grammar or publication style. They also prepare editorials on recent happenings of interest to *JA* readers. They are key to making *JA* a truly international journal.

Elsewhere in this issue we list our Reviewers (through September of last year). They deal directly with the issues of quality, relevance, accuracy, conciseness, and readiness for application. Last year we asked reviewers to assess whether the author had validated the accuracy of any data presented. Reviewers are selected because of their own contributions to the field and willingness to help us publish only the best material. They are busy professionals who take the extra time to review articles and provide useful comments for improvements. When a paper is declined, the Reviewer has usually provided clear rationale and often invaluable guidance for possible future publication.

Thomas M. Weeks
Editor-in-Chief

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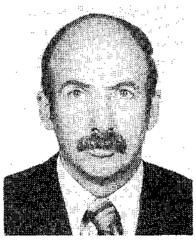
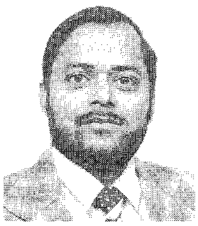
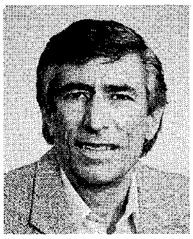


THOMAS M. WEEKS completed his degree work at Syracuse University, Department of Mechanical and Aerospace Engineering in 1965. He entered active commissioned service that year, assigned to the Air Force Flight Dynamics Lab at Wright-Patterson AFB, Ohio. His initial work was in the area of electrogasdynamics at the nearly completed 50 MW facility. In 1968, he separated from the Air Force but remained at the same location working as a civilian. He was assigned in 1972 to the Analysis Group attached to the Aeromechanics Staff working on transonic wind tunnel wall interference. In 1976, he became Technical Manager of the External Aerodynamics Group of the Aerodynamics and Airframe Branch. He then served as deputy and acting manager of the X-29 Advanced Technology Development Program. He is currently Chief of Technology Strategy in the Flight Dynamics Directorate of Air Force Wright Aeronautical Laboratory. Dr. Weeks is an Associate Fellow of AIAA.

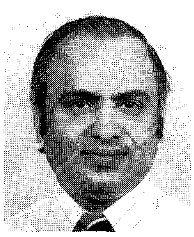
Associate Editors



RAMESH K. AGARWAL is currently the Bloomfield Distinguished Professor and Chairperson of the Department of Aerospace Engineering at Wichita State University in Wichita, Kansas. From 1978 to 1994, he was with McDonnell Douglas Aerospace in St. Louis where he was a McDonnell Douglas Fellow. He received a B.S. in Mechanical Engineering from the Indian Institute of Technology, Kharapur, India, in 1968; an M.S. in Aeronautical Engineering from the University of Minnesota in 1969; and a Ph.D. in Aeronautical Sciences from Stanford University in 1975. Dr. Agarwal has worked in all aspects of CFD, namely, grid generation, adaptive and multigrid methods, solution of nonlinear potential, Euler, and Navier-Stokes equations, viscous-inviscid interactions, boundary-layer flows, and turbulence modeling. He has also worked in other areas of computational aerosciences such as computational aero-acoustics, computational electromagnetics, parallel processing, and CFD-based expert systems. The author of over 100 articles and papers, Dr. Agarwal has been an Affiliate Professor of Mechanical Engineering at Washington University, St. Louis, since 1986. He is a Fellow of the AIAA; and has served on its Fluid Dynamics Technical Committee from 1986 to 1989, and on the AIAA Multidisciplinary Optimization Committee from 1991 to 1992. He is also an AIAA Distinguished Lecturer for 1994 to 1995.



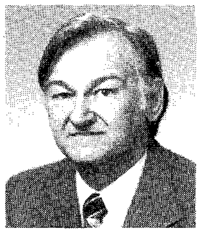
MARTIN E. BEYERS is currently Head of the Aircraft Aerodynamics Group, Applied Aerodynamics Laboratory, at the National Research Council of Canada. Before joining the NRC in 1979 he was Head of the Flight Mechanics Division of NIAST, CSIR, South Africa. He received his Ph.D. from the University of the Witwatersrand, Johannesburg in 1978. Dr. Beyers has served on the AIAA Technical Committees on Atmospheric Flight Mechanics and Applied Aerodynamics. He was a member of AGARD FDP Working Group 11 and technical editor of its final report. He is presently a coordinator of AGARD FDP Working Group 16, and Canadian National Leader on HTP-5, the TTCP panel on Manoeuvring Aerodynamics. He has conducted extensive research on high-alpha unsteady aerodynamics and free-flight dynamics, introducing a number of new wind-tunnel dynamic testing concepts, and recently initiated research projects on maneuvering aerodynamics, dynamic ground effects, and aerodynamics of contaminated wings. He is a Fellow of the Canadian Aeronautics and Space Institute, Fellow of the South African Institute of Aerospace Engineering, and the author of over 70 articles and papers.



INDERJIT CHOPRA is a Professor of Aerospace Engineering and Director for the Center for Rotorcraft Education and Research at the University of Maryland. He received a B.Sc. in Engineering from Punjab Engineering College, Chandigarh, India, in 1965; an M.E. from Indian Institute of Science, Bangalore, India, in 1968; and a Sc.D. from the Massachusetts Institute of Technology in 1977. He worked at the National Aeronautical Laboratory in Bangalore from 1966 to 1974. His research there included aeroelastic wind tunnel testing of scaled models of airplanes and launch vehicles. At MIT, he worked on aeroelastic analysis of wind turbine rotors for his doctoral dissertation. In 1977, he joined NASA Ames/Stanford University Joint Institute of Aeronautics and Acoustics, where he researched aeroelastic analysis of advanced rotor systems and dynamic testing of full-scale helicopters in the NASA Ames 40 × 80 ft wind tunnel. In 1981, he joined the University of Maryland. He has been working on problems related to helicopter dynamics, including aeromechanical stability, smart structures applications, active vibration control, structural health monitoring, composite blade modeling, and aeroelastic optimization. An author of over 120 articles and papers, Dr. Chopra was also an Associate Editor of the *Journal of the American Helicopter Society* and a member of the editorial advisory board of *Vertica, The International Journal of Rotorcraft and Powered Lift Aircraft*. He is a Fellow of AIAA.

ROBERT E. DUFFY is currently president of RED Associates, a recently formed research and consulting firm. A former member of the faculty of the Department of Mechanical Engineering, Aeronautical Engineering, and Mechanics at Rensselaer Polytechnic Institute, he was for a number of years the chairman of the aeronautical engineering academic program. He is the author of over 50 published papers and research reports in the areas of applied aerodynamics, flight mechanics, and experimental fluid dynamics. Dr. Duffy has served as a consultant to numerous governmental agencies, industrial concerns, and individuals. He is a past member of the Atmospheric Flight Mechanics technical committee and is an Associate Fellow of AIAA.

FRANKLIN E. EASTEP is a Professor, the Director of Aerospace Engineering, and the Associate Dean for Graduate Engineering at the University of Dayton. He received a B.S. from Ohio State University in 1958, an M.S. in Aeronautical Engineering from the Air Force Institute of Technology in 1963, and a Ph.D. in Aeronautics and Astronautics from Stanford University in 1968. Dr. Eastep has been teaching and conducting research within the technical areas of structural dynamics, aeroelasticity, and unsteady aerodynamics since 1968. During this period, he has been the principal thesis advisor for 15 doctoral students and over 35 master's students. He served on active duty with the U.S. Air Force for 20 years, retiring in 1978. Dr. Eastep is a member of the American Academy of Mechanics and an Associate Fellow of AIAA.



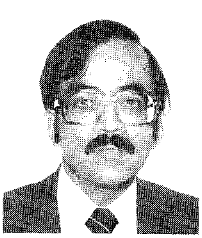
LARS E. ERICSSON received his Ph.D. from the Royal Institute of Technology, Stockholm, Sweden, in 1972. He retired from Lockheed Missiles and Space Company in August 1991 and is presently freelancing as an Engineering Consultant in Unsteady Aerodynamics and Structural Dynamics, especially in cases where separated flow has a dominating effect. Dr. Ericsson is a Fellow of the AIAA and has published over 200 papers in his technical fields of interest.

THOMAS N. FARRIS received his BSME from Rice University in 1982. His graduate education was at Northwestern University in Theoretical and Applied Mechanics leading to a Ph.D. in 1986 at which time he joined the School of Aeronautics and Astronautics of Purdue University where he is now Associate Professor, teaching courses in tribology, structural analysis, plates and shells, and elasticity. He spent the summer of 1991 on a Japan Society for the Promotion of Science Fellowship and the fall of 1991 as a sabbatical visitor to the Cambridge University Engineering Department. He has made contributions in using fracture mechanics to explain the material removal mechanism in the fine finishing of ceramic materials and various aspects of contact fatigue. These contributions led to support by NSF through a Presidential Young Investigator Award in 1990 and the ASME Burt L. Newkirk Award in 1992.

RONALD A. HESS received his B.S., M.S., and Ph.D. degrees in Aerospace Engineering from the University of Cincinnati in 1965, 1967, and 1970, respectively. After completing his doctoral work, he joined the faculty of the Department of Aeronautics at the Naval Postgraduate School in Monterey, California. In 1976, he joined the staff of the Flight Systems Research Division at NASA Ames Research Center. At NASA he conducted research in the areas of aircraft handling qualities, control/display analysis and design, and manual control. In 1982, he joined the faculty of the Department of Mechanical Engineering at the University of California, Davis, where he is currently a Professor in the Department of Mechanical, Aeronautical, and Materials Engineering. His current research interests lie in the areas of automatic and manual control of aircraft and in man/machine systems. Dr. Hess is an Associate Fellow of the AIAA, a member of the IEEE, Sigma Xi, and Tau Beta Pi, and is an Associate Editor of the *IEEE Transactions on Systems, Man, and Cybernetics*. He is a Vice-President of the IEEE Systems, Man, and Cybernetics Society and chairman of the Society's Manual Control Technical Committee. He is a member of the Technical Committee on Atmospheric Flight Mechanics of AIAA.

HARRY H. HEYSON earned his B.Ae.E., cum laude, at the Polytechnic Institute of Brooklyn in 1949. He received his M.S. in Aeronautical Engineering from Virginia Polytechnic Institute in 1958. He joined the staff of NACA's Langley Laboratory in 1949. His research at NACA and NASA has resulted in 75 papers on the theoretical and experimental aspects of helicopters and V/STOL induced flowfields, ground effects, and wind tunnel wall effects, as well as on innovative new aircraft concepts. He is a frequent lecturer in university short courses and helicopter safety seminars. After a brief period as an Associate at the Hampton Division of Eagle Engineering, Mr. Heyson has established his own consulting practice specializing in helicopter and V/STOL aerodynamics and wind tunnel wall effects. Mr. Heyson is an Associate Fellow of AIAA and a member of the American Helicopter Association.

KENNETH J. HOLT retired from the McDonnell Douglas Corporation in 1990. He had been involved in flight test operations and marketing. He received his B.Sc. from Hampton University in Virginia and his M.B.A. from the University of Missouri, St. Louis. He served 20 years in the U.S. Air Force and retired as Lieutenant Colonel and a Command Pilot. His background is in fighters, having flown the F-86, F-100, F-4, F-15, and F-18, and also tours in the Air Training Command and Strategic Air Command. He joined McDonnell in 1973. There he flew production test flights and was the company's interface with the military and Federal Aviation Administration for test flights. He developed much of the flight test operating procedures for the F-18 and AV8B, and was the McDonnell flight operations consultant to the Government Aircraft Factory F-18 facility at Avalon, Australia. He retired from active flying in 1984. Mr. Holt served as chairman of the Aircraft Operations Technical Committee from 1985–87. He is a Member of AIAA.



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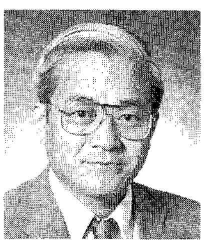
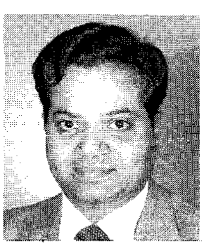


CHING F. LO is a Professor of Aerospace and Mechanical Engineering at the University of Tennessee Space Institute. He received his B.S. from National Taiwan University, Taipei, Taiwan, in 1959 and his M.S. and Ph.D. degrees from Cornell University in 1964 and 1967, respectively. He joined the research staff of Arnold Engineering Development Center at Arnold Air Force Base, Tennessee, in 1967. His research involved the development of aerodynamic ground test facilities and testing techniques including Reynolds number effects and wind tunnel wall interference technology for various types of wind tunnels from low speed V/STOL to transonic, supersonic speed and adaptive wall tunnel. He has been responsible for the application of Artificial Intelligence (AI) technology to wind tunnel facilities. As a senior research fellow at NASA in 1987, he initiated an AI application program for the operation of the NASA/ARC wind tunnel facilities in the Aerodynamics Division. He assumed his present position at the University of Tennessee in 1988. Dr. Lo's current interest concerns the development of AI/expert systems for wind tunnel facilities and Space Shuttle, engineering monitoring expert systems, neural network based systems for propulsion, and tunnel wall interference. He is a member of AIAA and a member of the American Association for Artificial Intelligence.



BELLUR L. NAGHABHUSHAN is a Professor of Aerospace Engineering at Parks College of Saint Louis University in Cahokia, Illinois. He received his B. Tech. degree in Aeronautical Engineering from Indian Institute of Technology, Madras, India, in 1971 and his M.S. and Ph.D. degrees in Aerospace Engineering from Virginia Polytechnic Institute and State University in 1973 and 1977. After completing his graduate studies, he joined the Defense Systems Division of Goodyear Aerospace Corporation in Akron, Ohio. Here, he evolved conceptual and preliminary designs of advanced V/STOL airship and hybrid rotorcraft configurations and investigated their flying qualities. Subsequently, he was involved in developing aircraft based weapon systems. He conceived, developed prototypes, and demonstrated innovative concepts for tactical weapons which sequentially dispense munition into desired patterns. He also served as a consultant on projects related to aircraft system design, performance analysis, and flight simulator development. In 1987 he joined the Bendix/King Avionics Division of Allied Signal Aerospace Company in Fort Lauderdale, Florida, as a senior staff engineer and was involved in the development of a digital FBW system for aircraft flight control. Dr. Nagabhushan has broad research interests which include all types of flight vehicles and associated flight mechanics and control technologies. He has authored over 60 technical papers and articles in archival journals. He holds several patents in the U.S. and Europe and has received numerous Engineering Awards for Technical and Scholarly Achievements. He is an Associate Fellow of AIAA and serves on its Lighter-Than-Air Systems technical committee. In addition to being an Associate Editor of this journal, Dr. Nagabhushan also serves as an Associate for its International Board of Editors and is responsible for their activities.