50th Anniversary Observations

A HALF-CENTURY ago two societies were formed within two years: the American Rocket Society and the Institute of the Aerospace Sciences. In 1963 these two organizations merged to form the American Institute of Aeronautics and Astronautics. This year we celebrate the 50th anniversary of the founding of our society. Numerous events are planned, including a series of 50th Anniversary papers in this Journal and our sister publications.

The past 50 years have borne witness to many significant breakthroughs and advances in both the science and engineering associated with virtually all of the disciplines within aeronautics and astronautics. We in the guidance, control, and dynamics part of the field have had at least our share of innovative individuals who have definitively affected the way we practice the art today. They achieved this by breaking down technical barriers and offering new techniques and solutions which changed the way we thought about and addressed our design problems. Consider some examples in both differing technical fields and at different times during the past 50 years.

Classical Control Design Procedures

Despite the fact that the vast majority of us who are gainfully employed designing control systems learned these procedures during our formal education, there are those among us who learned on the job because these techniques were developed in their current practical form since the founding of the ARS and IAS. Reflect upon life before frequency domain design techniques including Bode charts, Nichols charts, and root locus—orderly synthesis of control systems as we now know it was not possible. The innovative thinking which led to these tools opened new horizons in design efficiency and established procedures which are still very much in use today.

Guidance and Control of Missiles and Boosters

The intensity of technical activity spurred by the Second World War provided dramatic advances in many technical fields. For modern purposes, the practical beginning of our success in both guiding and controlling large unmanned missiles and boosters in an accurate fashion began during this period 40 years ago. The early workers in Germany emigrated to the United States and elsewhere after the war and provided the technical beginning for achievements which came years later, such as the massive Saturn V which launched the Apollo spacecraft.

With the development of digital computers small enough to fly in these missiles by the late 1950's, another technical hurdle for this application was surmounted. It was known that with reference trajectories and a detailed model of Earth's gravity field one could calculate corrective steering signals for a missile which was close to, but off, a nominal course. Unfortunately, these could not reasonably fit in the flight computers available at the time. The development of what was called the "Q guidance" concept made it practical to perform this type of guidance without all the previous complexities.

Inertial Guidance

The problem of determining one's position on the surface of the Earth has been fundamental to mariners throughout the course of history. By marine standards the aviation field is brand new. Its birth, however, intensified the urgency associated with navigation because of the dramatic increase in speed available. The ability to routinely cross oceans without landing in only a fraction of a day forced the existing ground- and celestial-based navigation techniques to their practical limits. This barrier was surmounted by another innovation—the reduction to practice of the use of gyroscopic instruments to provide a self-contained spatial reference of sufficient accuracy to enable navigation through integration of the outputs of devices which sensed the specific force on a moving vehicle.

Automatic Control of Aircraft

If aviation is a mature adult today, it had but reached toddler stage by 1930—fifty years ago. In this state it possessed very little in the way of closed-loop devices to aid the pilot in controlling the aircraft. Manual inputs and pilot muscles were the accepted sources of intelligence and power for the airplane control surfaces. From that bare beginning the innovative minds in our field have brought us to a state in which automatic control modes are the norm, completely automatic landings in nearly blind weather conditions are an accepted airline practice, and aircraft surfaces are not only powered from auxiliary sources but may not even be mechanically connected to the pilot at all.

Space Applications

Here, of course, we observe a very recent and rapid development of a new branch of our guidance, control, and dynamics art. Within less than half of the 50-year segment we are considering we have achieved successful landings on the moon, flybys of, and landings on, other planets, and routine commercial operation of Earth-orbiting satellites. These have required the development of reaction jet and momentum wheel control for all classes and sizes of vehicle, including complex spinning and flexible spacecraft.

While many of us associate our space sector with new and recent achievements, we must remember that one sector, celestial mechanics, has existed for centuries. Even in this seemingly well developed field, however, the past 50 years have seen significant developments. The modern digital computer has opened new vistas in solutions to the classical problems. This opportunity has presented interesting challenges, a number of which have been surmounted to provide new and more practical approaches to the basic computations in this field.

Modern Control and Estimation Procedures

The classical control design techniques mentioned earlier were used to synthesize virtually all control systems until the use of digital computers for engineering use became widespread. With this poweful new design aid available, some of our more innovative people dedicated themselves to direct solution of control problems in the time domain in which the resulting systems always operate. Exploiting mathematical tools not previously in wide use in our field, such as the calculus of variations, these workers succeeded in making system optimization a practical reality. The net results of their labors are the optimal control and estimation methods many of us take for granted today.

As these examples illustrate, we have indeed enjoyed the good fortune of many innovative advances in our guidance, control, and dynamics field during the past 50 years. Many of the innovators are still active in our community. In each of the above fields one of the pioneering innovators has agreed to write a History of Key Technologies for the Journal of Guidance and Control during this 50th anniversary year. Each will recall the technical obstacles as they existed and the steps which resulted in the practical solution in each area which led

to the breakthrough. These will be the invited personal reminiscences of each author and, as such, will present his own version of events. The first of these, on modern estimation procedures, appears as the lead article in this issue.

Let me turn now to a report on a topic more current for some of our readers than those above—the title of this publication. A year ago in my annual editorial I observed that there were a number of people who wanted to see the word "Dynamics" appear in the title and invited correspondence on that subject. We did receive letters and cards on both sides of the issue. At its October meeting the Publications Committee, the controlling body of all AIAA publications, addressed this issue. It counseled that the addition would not be in the best interest of further development of the applications orientation of this journal, that the word dynamics is by no means uniquely associated with our field, that continuity of the archival publication could be confused, and that the title would be too long. It then voted to leave the title as is and emphasize with larger print and boldface type the dedication to Dynamics and Control which has always appeared at the bottom of the front cover of every issue. The result is as you see on the cover of this issue. Dynamics as it pertains to the basic motion of the plants we control remains, however, very much within our scope.

Each year we have changes to report. This year Ronald O. Anderson retires from his duties as Associate Editor. Ron began his service in this capacity as a member of the original team of editors when we founded this journal three years ago. As such, he participated in the intensive efforts at the beginning to create this new publication in a very short period of time. He then went on, as did the others, to routinely handle his share of the reams of manuscripts and correspondence we receive each year. I wish him well in his future activities and hope he enjoys the time which he now has restored to his day.

I am pleased to name to the Associate Editor post created by this retirement Dr. John W. Edwards of the Loads and Aeroelasticity Division of the NASA Langley Research Center. Dr. Edwards' interests have been in aircraft controls, aerodynamics, and structural dynamics. He will be handling papers on aircraft applications, stability, and control. I welcome him to the masthead and look forward to working with him in this new capacity.

Finally, there appears below a list of the anonymous cadre without whom any archival publication cannot survive—our reviewers. On behalf of the entire editorial staff I wish to thank them for their efforts.

Donald C. Fraser
Editor-in-Chief

Reviewers for *Journal of Guidance and Control*, September 1, 1979—August 31, 1980*

Abrams, Charles R.
Aiken, E.W.
Aldrich, Ralph
Alfriend, K.T.
Anderson, Gerald M.
Andrisani, Dominick, II
Ash, Michael E.
Asher, Robert
Aspenwall, D.
Aubrun, Jean N.
Ausman, J. Stanley
Bainum, Peter M.
Balas, Mark
Barba, Peter M.
Beal, Robert
Benhabib, R.S.
Berg, Donald
Bierman, Gerald J.
Blue, Robert
Book, Erwin
Bowles, Roland L.
Brandeau, George W.
Breakwell, J.V.
Briggs, Peter
Broucke, Roger
Brown, Jack I.
Bryson, Arthur E., Jr.
Buckley, Charlie
Burton, Thomas D.
Calise, Tony
Cameron, John D.M.
Carberry, R.L.
Carlson, Neal A.
Cefola, Paul J.
Chalk, Charles R.
Clark, C.K.
Clark, Lyle G.
Cochran, John E., Jr.
Collins, D.H.
Cooley, Dale
Cooley, James L.
Dahl, P.R.
Daly, Kevin
D'Amario, Louis
Danby, J.M.A.
Davis, J.W.
D'Azzo, J.
DeBra, Daniel B.
Defrees, Robert E.
Deyst, John J.
Didaleusky, Dennis
Dougherty, Hugh
Duval, Ronald W.
Edwards, John W.
Eller, Don
Erzberger, H.
Farquhar, Robert W.
Farrenkopf, Robert
Feagin, Terry
Fosth, D.C.
Freudenstein, F.
Fuchs, Arthur J.
Goodstein, Robert
Grantham, William D.
Gupta, Narendra K.
Gustafson, Donald
Hablani, Hari
Hague, Jack
Hall, W. Earl, Jr.
Hart, Hal
Hart, John E.
Harvey, C. Arthur
Headley, R. Paul
Hess, Ronald A.
Hibbard, William
Hodapp, Albert E., Jr.
Hodgkinson, John
Hoehne, Vernon O.
Hoffman, Dale P.
Hopkins, Albert L., Jr.

*Because it is difficult to include the reviewers from September, October, November, and December 1980 in this issue of the Journal, they will be listed with the reviewers for 1981 in the January 1982 issue.