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 Department of Aerospace Engineering Sciences
 University of Colorado
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BIRTHDATE-PLACE: February 28, 1938: McAlester, Oklahoma

DEGREES: B.S., Aeronautical and Space Engineering, with highest honors, University of Oklahoma, 1960
 M.S., Aeronautical Engineering, University of Colorado, 1963
 Ph.D., Aerospace Engineering Sciences, University of Colorado, 1966. Thesis: "A Necessary Condition and a Corner Condition for Optimal Coplanar Orbit Transfer," directed by Professor Adolf Busemann

POSITIONS: University of Colorado:
 Department of Aerospace Engineering Sciences
 Chairman 1990 - 1995
 Acting Chair, 1989 - 1990
 Department of Aerospace Engineering Sciences
 Professor Emeritus, 2010 - present
 Professor, 1980-2010
 Associate Professor, 1974-1980
 Assistant Professor, 1968-1974
 Research Associate, 1966-1968
The Martin Company (now Lockheed Martin Corp.) (1960-62)
Convair-Fort Worth (now Lockheed Martin Corp.) (summers, 1958-59)

SELECTED HONORS: 2008-2010 National Academy of Science, National Research Council, Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies
 2008-2010 NAS NRC Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, Survey/Detection Panel.
 2004 Named one of the Outstanding Graduates of the University of Oklahoma's Aerospace Engineering Program.
 2002-2004 Doctoral Program Review Panel, Office of Graduate Studies, Texas A&M University
 2002 Fellow, Big Twelve Conference
 1997 Fellow, American Institute of Aeronautics and Astronautics
 1995-97 National Research Council, Commission on Engineering and Technical Systems, Aeronautics and Space Board, Committee on International Space Station Meteoroid/Debris Risk Management.
 1995 John Leland Atwood Award of the ASEE Aerospace Division and the American Institute of Aeronautics and Astronautics (AIAA)
 1995 American Institute of Aeronautics and Astronautics Mechanics and Control of Flight Award
 1994 Distinguished Engineering Alumni Award, U of Colorado
 1995 NASA Award for Outstanding Contribution on the Orbital Debris Radar Calibration Spheres II Project, STS 63, February
 1994 NASA Award for Outstanding Contribution on the Orbital Debris Radar Calibration Spheres Project, STS 60, February
 1993 Dirk Brouwer Award, American Astronautical Society
 1981 Fellow, American Astronautical Society
 1973 Associate Fellow, American Institute of Aeronautics and Astronautics

CONTRIBUTIONS TO ASTRONAUTICS & AEROSPACE:

In 1966 Dr. Culp received early recognition for applying Pontryagin's Maximum Principle to optimal impulsive orbit transfer, thus completing the rigorous solution of this popular problem. From 1969 through 1975, Dr. Culp published the complete theoretical solution to the problem of optimal hyperbolic flyby. These definitive results have allowed the application of this optimal transfer technique to many multi-planet missions. He has developed less restrictive and more accurate solutions to the basic problem of satellite drag and decay. He has made significant and lasting contributions to orbit determination techniques, atmospheric entry theory, and optimal atmospheric flight mechanics. In recent years, Dr. Culp has become one of the leading authorities on space debris, satellite fragmentation modeling, hazard to resident space objects, and the space environment.

Service Activity (selected)

National Service

National Academy of Science, National Research Council, Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, 2008-2010.

NAS NRC Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, Survey/Detection Panel. 2008-2010.

National Research Council, Aeronautics and Space Engineering Board, Committee on International Space Station Meteoroid/Debris Risk Management, analyzing NASA's plans for space debris mitigation for the International Space Station, 1995-1997.

Review Team for NASA Orbital Debris Engineering Model, ORDEM 2000, 2000-2001.

National Security Council Policy Coordination Committee Space Research and Development Industrial Base Study, 2001.

Classified Working Group, Conjunction Assessment/Debris Workshop to Support the Space Surveillance Integrated Concept Team, HQ, AF Space Command, 1999-2001.

USAF Satellite Lethality and ASAT Test Task Force, 1989-1993.

USSPACECOM Center for Aerospace Analysis Task Force, 1990-1993.

DOD/DNA Orbital Debris Spacecraft Breakup Modeling Program, Technical Working Group, 1990-1993.

NASA Orbital Debris Radar Calibration Spheres Project, 1992-1996.

USAF Eglin AFB Satellite Fragmentation Working Group, 1989-1993.

SMART Catalog Working Group, USAF Space Command, 1988

Space Debris Environment Definition, Small Satellite Statistical Database Study, USAF Space Command, 1988.

SDIO/IST Pathways to Space Workshop, invited lecturer, 1986.

SOCIT (Full-scale satellite hypervelocity impact test) Test Team, Defense Nuclear Agency, 1989-1992.

Consultant for General Accounting Office on Protecting the Space Station from Meteoroids and Debris, 1997

Consultant for General Accounting Office on Space Surveillance Network, 1997.

IN-STEP, NASA OAST, 1988.

Aerospace Department Chairman's Association, 1989-1996.

Consulting (paid and *pro bono*)

National Research Council

NASA

Martin Marietta Corporation

Lockheed Martin Corporation

Ford Aerospace Corporation

AVCO

Nichols Research Corporation

Failure Analysis

Computer Technology Associates

Astron Corporation

University of Michigan

Universities Space Research Association

The Canada Council

Society of Professional Engineers

Dover Publications

Prentice Hall

Allyn and Bacon

Reviewer (irregular, but frequent basis)

AIAA Journal

Journal of the Astronautical Sciences

Journal of Spacecraft and Rockets

Journal of Guidance, Control and Dynamics

Applied Mechanics Reviews

Acta Astronautica

Optimal Control, Applications and Methods

Journal of Optimization Theory and Applications

Space Debris

Transactions for Aerospace and Electronic Systems (IEEE)

Automatica

Professional Societies

American Institute for Aeronautics and Astronautics

AIAA Fellow (1998)

AIAA Fellow Grad Selection Committee, 2006-2007
AIAA Fellow Grade Selection Committee, 1998-2000
Technical Committee on Spaceflight Mechanics, 1996-2000
Orbital Debris Committee on Standards, 1994
Orbital Debris Subcommittee on Launch Vehicles, 1997
Technical Committee on Astrodynamics, 1972-1975
General Chair, AAS/AIAA Astrodynamics Conference, 1999
Session Chair at numerous AIAA Conferences

American Astronautical Society

AAS Fellow, (1980)
Vice President, Technical Publications, 1982-1984
Chairman, Rocky Mountain Section, 1976-1979
Director, Rocky Mountain Section, 1980-2002
General Chairman, AAS/AIAA Astrodynamics Specialists Conference, 1973
Chairman, Guidance and Control Conference, 1979
Co-Chair, Guidance and Control Conference, 1978
General Chair, AAS/AIAA Astrodynamics Conference, 1999
Chair, Guidance and Control Technical Committee, 1978-1979
AAS Spaceflight Mechanics Committee, 1996-2001
AAS Spacecraft Systems and Technology Committee, 1982-1988
Technical Committee on Guidance and Control, 1982-2002
Technical Committee on Satellite Systems, 1994-2002
Editor, Advances in the Astronautical Sciences, G&C, 1979-2009
Session Chair at numerous AAS Conferences

Other Society Service

Associate Editor, *Space Debris*, 2000-2002

IFAC, Aerospace Technical Committee, 1996 World Congress

IFAC International Workshop on Control of Small Spacecraft, organizer and session chair, 1997

Joint Automatic Controls Conference, organizing committee, 1978-1979

ASEE New Engineering Educator, 1973

Session Chair at numerous other Conferences

University Service (University of Colorado)

Chair, Department of the Aerospace Engineering Sciences, 1989-1995

Associate Director, Colorado Center for Astrodynamics Research, 1985-2002

Associate Director, Academic Programs, Colorado Space Grant Consortium, 1989-1995

Administration Streamlining Project, 1996-1999

University Budget Committee, 1995-1997

University Faculty Senate member

Boulder Faculty Assembly, 1986-1988

Advisory Board, Undergraduate Research Opportunity Program, 1980-1999

Department ABET Accreditation leader four times, most recently in 1999, all of which received "next general review" accreditation, the highest level.

Department Curriculum and Teaching Chair during the development of the Aerospace Curriculum 2000, the new curriculum following the ABET Century XXI guidelines.

Chair, Departmental Self Study, Program Review, 1996-1998

Chair, Internal Review Committee, Program Review, Electrical and Computer Engineering Department, 1995-1996

Numerous other University, College, and Departmental committees, chair of many.

SELECTED PUBLICATIONS:

ARTICLES

“Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies”, Final Report, coauthors: Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, Space Studies Board, Aeronautics and Space Engineering Board, Division on Engineering and Physical Sciences, the National Research Council of the National Academies; The National Academies Press, Washington, D.C., 134 + xviii pp., June, 2010.

“Space Debris”, organized and chaired invited session, Guidance and Control 2010, Volume 137, Advances in the Astronautical Sciences, The American Astronautical Society, Shawn C. McQuerry, editor, Univelt, Inc., San Diego, CA, 2010, pp. 1 – 74.

“Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies”, Final Report, Prepublication Release, coauthors: Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, Space Studies Board, Aeronautics and Space Engineering Board, Division on Engineering and Physical Sciences, the National Research Council of the National Academies; The National Academies Press, Washington, D.C., 134 + xv pp., January 22, 2010.

“Photometric Detection of Known Sun-Occcluding Satellites”, Brian J. Poller and Robert D. Culp, Journal of Spacecraft and Rockets, Vol. 46, No. 3, pp 728-732, May-June 2009.

“Near-Earth Object Surveys and Hazard Mitigation Strategies Interim Report”, coauthors: Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, Space Studies Board, Aeronautics and Space Engineering Board, Division on Engineering and Physical Sciences, the National Research Council of the National Academies; The National Academies Press, Washington, D.C., 22pp., August 12, 2009.

“Aerospace Engineering Science at the University of Colorado at Boulder”, Brian Argrow and Robert D. Culp, Chapter 34, Aerospace Engineering During the First Century of Flight, edited by Barnes McCormick, Conrad Newberry, Eric Jumper, American Institute of Aeronautics and Astronautics, Inc., Reston Virginia, pp 442-451, 2004

“Improved Angular Observations in Geosynchronous Orbit Determination”, Chris Sabol and Robert D. Culp, AIAA Journal of Guidance, Control, and Dynamics, Vol. 24, No. 1, pp 123-130, January-February, 2001.

“Using Spectroscopy to Characterize Orbiting Space Debris”, Robert D. Culp and Kira Jorgensen, The Richard H. Battin Symposium, Advances in the Astronautical Sciences, American Astronautical Society, Vol. 106, Junkins and Alfriend, editors, pp. 279-287, September, 2000.

“Use of Optical Characteristics to Identify Orbit Material,” coauthors: K. Jorgensen, I. Gravseth, and J. Lambert, Space Debris, Vol. 1, No. 2, 1999, Kluwer Academic Publications, The Netherlands, pp. 113-125, appeared in 2000.

“On Spectroscopy Applied to Space Debris,” coauthor: K. Jorgensen, Proceedings, 38th Aerospace Sciences Meeting, Paper 2000-0759, January, 2000.

“Study of Perturbation Effects on Space Debris in Supersynchronous Orbits,” coauthors: K.Luu and C. Sabol, Spaceflight Mechanics 1999, Advances in the Astronautical Sciences, Vol 102, Part 2, pp 1053-1072, American Astronautical Society, Univelt, San Diego, CA, 1999.

“Improved Angular Observations in Geosynchronous Orbit determination,” coauthor: C. Sabol, Proceedings of the AIAA Astrodynamics Specialists Conference, Paper 98-4281, August, 1998.

“Estimating the Area of Artificial Space Debris,” coauthors: R.A. Madler, K. Jorgensen, D.B. Spencer; Proceedings of the Second European Conference on Space Debris, European Space Agency Publications Division, SP-393, May, 1997, pp. 297-302.

“Implications of Collisions in Supersynchronous Orbits,” coauthor: K.K. Luu; Proceedings of the Second European Conference on Space Debris, European Space Agency Publications Division, SP-393, May, 1997, pp. 637-642.

"Protecting the Space Station from Meteoroids and Orbital Debris," coauthors: Committee on International Space Station Meteoroid/Debris Risk Management, Aeronautics and Space Engineering Board, Commission on Engineering and Technical Systems, National Research Council; National Academy Press, Washington, D.C., 1997, 50+ix pp.

"An Optical Analysis of the 6470 Hypervelocity Debris Fragments," coauthor: Ian Gravseth; Astrodynamics 1995, Vol. 90, Part I, Advances in the Astronautical Sciences; Univelt, Inc., publisher, 1996, pp. 771-779.

"The Investigation of Space Debris Generation and Associated Long-term Effects in the Geosynchronous Region," coauthor: R.P. McNamara; Astrodynamics 1995, Vol. 90, Part I, Advances in the Astronautical Sciences; Univelt, Inc., publisher, 1996, pp. 791-807.

"Determination of the Sizes and Masses of Debris Objects," coauthor: Ian Gravseth; Spaceflight Mechanics 1996; Advances in the Astronautical Sciences, Vol. 93, Part I; Univelt, Inc., 1996, pp. 221-229.

"Initiatives in Guidance, Navigation, and Control Education at the University of Colorado," Guidance and Control 1996, Vol. 92, Advances in the Astronautical Sciences, 1996, pp. 299-310.

"Determination of Debris Sizes and Masses Using Radar and Optical Data," coauthor: Ian Gravseth; Proceedings, SPIE International Symposium on Optical Science, Engineering, and Instrumentation, Vol. 2813, Characteristics and Consequences of Orbital Debris and Natural Space Impactors, 1996, 15 pp.

"Mass-Diameter and Characteristic-Length Ratio Functions for Orbital Debris," coauthors: Ian J. Gravseth and Timothy D. Maclay; Journal of Spacecraft and Rockets, Vol. 33, No. 3, May-June, 1996, pp. 433-437.

"Space-Debris Identification Using Optical Calibration of Common Spacecraft Materials," coauthor: Ian J. Gravseth; Journal of Spacecraft and Rockets, Vol. 33, No. 2, March-April, 1996, pp. 262-266.

"Optical Calibration of Common Spacecraft Materials," coauthor: Ian Gravseth; Spaceflight Mechanics 1995, Vol. 89, Advances in the Astronautical Sciences; Univelt, Inc., publisher, 1995, pp. 1619-1627.

"Sensitivity of the LEO Orbital Debris Environment to Satellite Breakup Parameters," coauthor: Ronald A. Madler; Spaceflight Mechanics 1995, Vol. 89, Advances in the Astronautical Sciences; Univelt, Inc., publisher, 1995, pp. 1587-1599.

"Investigation of an RBAR/CUSP Approach for Russian Rendezvous to Space Station Alpha," coauthor: Rodolfo Gonzalez; Spaceflight Mechanics 1995, Vol. 89, Advances in the Astronautical Sciences; Univelt, Inc., publisher, 1995, pp. 979-998.

"Designing Continuous-Thrust Low Earth to Geosynchronous Earth Orbit Transfers," coauthor: D.A. Spencer; J. of Spacecraft and Rockets, Vol. 32, No. 6, Nov.-Dec., 1995, pp. 1033-1038.

"The Impact of Satellite Breakup Parameters on Long-Term Orbital Debris Environment Evolution," coauthor: R.A. Madler; Proceedings, AeroSense, SPIE International Symposium on Aerospace/Defense Sensing and Control and Dual-Use Photonics, Vol. 2483, Orlando, FL, April, 1995, pp. 64-76.

"Mass-Diameter Function for the Entire Size Regime of Orbital Debris," coauthors: Ian J. Gravseth and Timothy D. Maclay; Proceedings, AeroSense, SPIE International Symposium on Aerospace/Defense Sensing and Control and Dual-Use Photonics, Vol. 2483, Orlando, FL, April, 1995, pp. 21-30.

"An Analytical Approach for Continuous-Thrust LEO-GEO Transfers," Proceedings, AIAA/AAS Astrodynamics Conference, Scottsdale, Arizona, Orbital Mechanics, pp. 421-430, August, 1994.

"ODERACS Pre-flight Optical Calibration," coauthors: R.A. Madler, T.D. Maclay; J. of SPIE, Vol. 1951: Space Debris Detection and Mitigation, 1993, pp. 37-47.

"Orbital Debris Studies at the University of Colorado," coauthors: M.B. Hinga, R.A. Madler, T.D. Maclay; ESA SD-01, Proceedings of the First European Conference on Space Debris, April 1993, pp. 263-267.

"Debris Hazard for the Earth Observing System," coauthors: R.A. Madler, T.D. Maclay, R.P. McNamara; Astrodynamics 1991, Vol. 76, Part 1, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., March 1992, pp. 311-322.

"Defining the Background Status of a Debris Cloud," coauthors: T.D. Maclay, R.A. Madler, R.P. McNamara; Astrodynamics 1991, Vol. 76, Part 1, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., March, 1992, pp. 279-286.

"Trajectory Analysis and Issues Associated with the EXCALIBIR Mission," (Abstract), coauthors: R.S. Klucz and M.R. Dickey; Astrodynamics 1991, Vol. 76, Part 1, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., March, 1992, p. 358.

"Orbital Debris Hazard Analysis for Long-Term Space Assets," coauthors: T.D. Maclay, R.A. Madler, R.P. McNamara; Proceedings of the 1991 Workshop on Hypervelocity Impacts in Space, University of Canterbury at Kent, U.K., 1992, pp. 262 - 276.

"On the Subject of Mass Distributions from Catastrophic Hypervelocity Impacts, or MAD CHIMP'S" coauthors: T.D. Maclay and R.A. Madler; Proceedings, 1992 AIAA/AAS Astrodynamics Conference, Hilton Head Island, SC, August, 1992, pp. 143-148.

"Topographically Modified Bumper Concepts for Spacecraft Shielding," coauthors: T.D. Maclay, L. Bareiss, T.G. Gillespie, and F.M. Kustas; Proceedings, 1992 Hypervelocity Impact Symposium, Austin, Texas, November, 1992, 13 pp.

"EXCALIBIR: A Space Experiment in Orbital Debris Lethality," coauthor: M.R. Dickey; Spaceflight Mechanics 1991, Vol. 75, Advances in the Astronautical Sciences, AAS, Univelt, 1991, pp. 897-909.

"Orbital Debris," Guidance and Control 1991, Vol. 74, Advances in the Astronautical Sciences, AAS, Univelt, 1991, pp. 629-648.

"Absolute Accuracy Limits of a High Eccentricity Orbit Propagator," coauthors: W.E. Frazier, G.W. Rosborough; J. of the Astronautical Sciences, Vol. 39, No. 2, April - June, 1991, pp. 155-172.

"Volumetric Imaging of Space Debris Using Sun Microsystem's TAAC-1 Application Accelerator Board," coauthors: K. Luetkemeyer, T. Maclay, R. Madler, AIAA-90-2877, Proceedings, AIAA/AAS Astrodynamics Conference, Portland, Oregon, August 20-22, 1990, pp. 847-855.

"The Orbital Debris Issue: A Status Report," coauthors: D. McKnight, M. Wolfe, V. Chobotov, D. Cooke, M. Michaud, K. Schwetje, L. Taff; Space Technology, Vol. 10, No. 3, 1990, pp. 175-184.

"Estimating and Modeling the Background Orbital Debris Population," coauthors: T.D. Maclay, R.A. Madler, Astrodynamics 1989, Volume 71, Part 1, Advances in the Astronautical Sciences, Univelt, Inc., San Diego, CA, 1990, pp. 365-376.

"Semianalytic Study of High-Eccentricity Orbit Evolution," coauthors: W.E. Frazier, G.W. Rosborough, Astrodynamics 1989, Volume 71, Part II, Advances in the Astronautical Sciences, Univelt, Inc., San Diego, CA, 1990, pp. 1251-1264.

"Simplified Semianalytic Method for High-Eccentricity Mission Preliminary Design," coauthors: W.E. Frazier, G.W. Rosborough; AIAA 90-0475, Proceedings, 28th Aerospace Sciences Meeting, Reno, Nevada, January 8-11, 1990.

"Determining Characteristic Mass for Low Earth-Orbiting Debris Objects," coauthor: M. Dickey, Journal of Spacecraft and Rockets, Vol. 26, No. 6, 1989, pp. 460-464.

"Space Debris Environment Definition," OAST Technology for the Future, Vol. II, "Critical Technologies," Themes 1-4, NASA, 1989, pp. 151-156.

"Modeling Untrackable Orbital Debris Associated with a Tracked Space Debris Cloud," coauthor: R. Madler, Astrodynamics 1987, Vol. 65, Advances in the Astronautical Sciences, AAS, Univelt, Inc., 1988, pp. 775-790.

"Correlation Between Radar Cross Section and Ballistic Coefficient for Orbiting Objects," coauthor: M. Dickey, Astrodynamics 1987, Vol. 65, Advances in the Astronautical Sciences, AAS, Univelt, Inc., 1988, pp. 809-824.

- "Techniques for Determining Size and Mass for Debris Size Low Earth Satellites," coauthor: M. Dickey, AIAA/AAS Astrodynamics Conference Proceedings, August, 1988, pp. 723-728.
- "The Orbital Debris Issue: A Status Report," co-authors: D.S. McKnight, *et al*, IAF 39th Congress, Bangalore, India, Proceedings, 10 pp, October, 1988.
- "Tuned Earth Gravity Field for Propagation of Resonant High Eccentricity Orbits," coauthors: W. Frazier, G. Rosborough, AIAA/AAS Astrodynamics Conference Proceedings, August, 1988, pp. 197-203.
- "Use of Solar Lyman-Alpha and 1-8 A X-Rays as EUV Flux Indices," coauthors: W. Tobiska, C. Barth, AIAA/AAS Astrodynamics Conference Proceedings, August, 1988, pp. 588-597.
- "Predicted Solar Cycle Twenty-two 10.7cm Flux and Satellite Orbit Decay," coauthors: W.K. Tobiska and C.A. Barth, J. of the Astronautical Sciences, Vol. 35, No. 4, Oct-Dec., 1987, pp. 367-381.
- "Preliminary Orbit Determination Using Satellite-to-Satellite Limited Range and Range-Rate Data," coauthor: L.S. Jin, Acta Astronautica, Vol. 15, No. 11, November, 1987, pp. 807-811.
- "Meter-level Orbit Determination of Geosynchronous Satellites by an Economical Tracking System," coauthor: T.H. Wang, Journal of Guidance, Control, and Dynamics, Vol. 10, No. 1, January-February, 1987, pp. 45-52.
- "Distinguishing between Collision-Induced and Explosion-Induced Satellite Breakup through Debris Analysis," coauthor: D.S. McKnight, Astrodynamics 1985, Advances in the Astronautical Sciences, Vol. 58, Part I, 1986, pp. 739-758.
- "Time-Dependent Model of the Martian Atmosphere for Use in Orbit Lifetime and Sustainment Studies," coauthor: A.I. Stewart, Journal of the Astronautical Sciences, Vol. 32, No. 3, July-Sept., 1984, pp. 329-341.
- "Analytical Theory of Orbit Contraction Due to Atmospheric Drag," coauthors: N.X. Vinh, J.M. Longuski, and A. Busemann; Acta Astronautica, Vol. 6, No. 5-6, May-June, 1979, pp. 697-723.
- "Flight with Lift Modulation Inside a Planetary Atmosphere," coauthors: A. Busemann, N.X. Vinh, and N.A. Bletsos; American Institute for Aeronautics and Astronautics Journal, Vol. 15, No. 11, November 1977, pp. 1617-1623.
- "Optimum Three-Dimensional Atmospheric Entry," coauthors: N.X. Vinh and A. Busemann, Acta Astronautica, Vol. 2, No. 7-8, July-August, 1975, pp. 592-611.
- "Synthesis of the Types of Optimal Transfers between Hyperbolic Asymptotes," coauthors: J.M. Walton and C. Marchal, AIAA Journal, Vol. 13, No. 8, August 1975, pp. 980-988.
- "Optimal Impulsive Transfers between Real Planetary Orbits," coauthors: J.P. Gravier and C. Marchal; Journal of Optimization Theory and Applications, Vol. 15, No. 5, May 1975, pp. 587-604.
- "Effects of Inclination and Eccentricity on Optimal Trajectories between Earth and Venus," coauthors: J.P. Gravier and C. Marchal, Astronautica Acta, Vol. 18, No. 4, Oct. 1973, pp. 273-279.
- "Optimum Altitude for Coasting Flight of a Hypervelocity Vehicle," coauthors: A. Busemann and N.X. Vinh; Journal of Astronautical Sciences, Vol. XXI, No. 1, July-Aug. 1973, pp. 32-48.
- "Optimal Trajectories between Earth and Mars in Their True Planetary Orbits," coauthors: J.P. Gravier and C. Marchal; Journal of Optimization Theory and Applications, Vol. 9, No. 2, Feb. 1972, pp. 120-136.
- "Optimal Transfer between Hyperbolic Asymptotes with Turn Angle Less than the Maximum Natural Turn Angle," coauthors: J.M. Walton and C. Marchal; Journal of the Astronautical Sciences, Vol. XXIX, No. 3, Nov.-Dec. 1971, pp. 205-231.
- "Optimal Switching in Coplanar Orbit Transfer," coauthor: N.X. Vinh; Journal of Optimization Theory and Applications, Vol. 7, No. 3, Mar. 1971, pp. 197-208.
- "A Technique for Obtaining Optimal Interplanetary Transfers in the Real Case," coauthors: J.P. Gravier and C. Marchal; Journal of the Astronautical Sciences, Vol. XVIII, No. 2, Sept.-Oct., 1970, pp. 107-117.

"Contensou-Busemann Conditions for Optimal Coplanar Orbit Transfer," American Institute of Aeronautics and Astronautics Journal, Vol. 5, No. 2, Feb. 1967, pp. 371-372.

BOOKS

Hypersonic and Planetary Entry Flight Mechanics, coauthors: N.X. Vinh and A. Busemann, University of Michigan Press, Ann Arbor, 1980, 357+xii pp.

Guidance and Control 1979, editor, Vol. 39, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1979.

Guidance and Control 1982, editor, Vol. 48, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1982.

Guidance and Control 1984, editor, Vol. 55, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1984.

Guidance and Control 1985, editor, Vol. 57, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1985.

Guidance and Control 1986, editor, Vol. 61, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1986

Guidance and Control 1987, editor, Vol. 63, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1987, 622+xvi pp.

Guidance and Control 1988, editor, Vol. 66, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1988.

Guidance and Control 1989, editor, Vol. 68, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1989.

Guidance and Control 1990, editor, Vol. 72, Advances in the Astronautical Science, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1990.

Guidance and Control 1991, editor, Vol. 74, Advances in the Astronautical Science, the American Astronautical Society, Univelt, Inc., publisher, San Diego, 1991.

Guidance and Control 1992, editor, Vol. 78, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., San Diego, CA, 1992, 736+xvii pp.

Guidance and Control 1993, editor, Vol. 81, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., San Diego, CA, 1993, 630+xvii pp.

Guidance and Control 1994, editor, Vol. 86, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., San Diego, CA, 1994, 678+xxi pp.

Guidance and Control 1995, editor, Vol. 88, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., San Diego, CA, 1995, 580+xv pp.

Guidance and Control 1996, editor, Vol. 92, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., San Diego, CA, 1996, 724+xix pp.

Protecting the Space Station from Meteoroids and Orbital Debris, coauthors: Paul Shawcross, George Gleghorn, et al, National Research Council, National Academy Press, Washington, D.C., 1997, 53+ix pp.

Guidance and Control 1997, editor, Vol. 94, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., San Diego, CA, 1997, 442+xvi pp.

Guidance and Control 1998, editor, Vol. 98, Advances in the Astronautical Sciences, The American Astronautical Society, Univelt, Inc., San Diego, CA, 1998, 690 pp. + xvi.

Guidance and Control 1999, editor, Vol. 101, Advances in the Astronautical Sciences, The American Astronautical Society, Univelt, Inc., San Diego, CA, 1999, 511 pp., + xvi.

Spaceflight Mecanics 1999, Part 1, coeditor, Vol. 102, Part 1, Advances in the Astronautical Sciences, The American Astronautical Society, Univelt, Inc., San Diego, CA, 1999, 802 pp. +xix.

Spaceflight Mechanics 1999, Part 2, coeditor, Vol. 102, Part 2, Advances in the Astronautical Sciences, the American Astronautical Society, Univelt, Inc., San Diego, CA, 1999, 772 pp. + xix.

Guidance and Control 2000, editor, Vol.104, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 2000, 723pp + xiv.

Guidance and Control 2001, editor, Vol. 107, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 2001, 722pp + xvi.

Guidance and Control 2002, editor, Vol. 111, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 2002, 522pp + xxii.

Guidance and Control 2003, I. Gravseth and R. D. Culp, editors, Vol. 113, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 2003, 648pp + xiv.

Guidance and Control 2004, Jim D. Chapel and Robert D. Culp, editors, Vol118, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 2004, 668pp+ xvi

Guidance and Control 2005, William Frazier and Robert D. Culp, editors, Volume 121, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 598+xx pages, 2005.

Guidance and Control 2006, Steven Jolly and Robert D. Culp, editors, Volume 124, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 598+xx pages, 2006.

Guidance and Control 2007, edited by Heidi E. Hollowell and Robert D. Culp, Volume 128, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 1110 + xxii pages, 2007.

Guidance and Control 2008, edited by Michael E. Drews and Robert D. Culp, Volume 131, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 796 + xxi pages, 2008.

Guidance and Control 2009, edited by Edward J. Friedman and Robert D. Culp, Volume 133, Advances in the Astronautical Sciences, American Astronautical Society, Univelt, Inc., San Diego, CA, 692 + xx pages, 2009.

"Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies", Final Report, coauthors: Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies, Space Studies Board, Aeronautics and Space Engineering Board, Division on Engineering and Physical Sciences, the National Research Council of the National Academies; The National Academies Press, Washington, D.C., 134 + xviii pp., June, 2010

RECENT PAPERS PRESENTED

"Using Spectroscopy to Characterize Orbiting Space Debris," coauthor: K. Jorgensen, The Richard H. Battin Astrodynamics Conference, College Station, TX, Paper No. AAS 00-265, March, 2000.

"On Spectroscopy Applied to Space Debris," coauthor: K. Jorgensen, 38th Aerospace Sciences Meeting, Reno, NV, Paper No. AIAA 2000-0759, January, 2000.

"Study of Perturbation Effects on Space Debris in Supersynchronous Orbits," coauthors: K. Luu and C. Sabol, AAS/AIAA Space Flight Mechanics Meeting, Breckenridge, CO, Paper No. AAS 99-173, February, 1999,

"Improved Angular Observations in Geosynchronous Orbit Determination," coauthor: C. Sabol, AIAA Astrodynamics Specialists Conference, Boston, MA, Paper No. 98-4281, August, 1998.

"Implications of Collisions in Supersynchronous Orbits," coauthor: K. Kim Luu; Risk Analysis and Damage Assessment, Second European Conference on Space Debris, ESOC, Darmstadt, Germany, organized by the European Space Agency, March 17-19, 1997.

"Estimating the Area of Artificial Space Debris," coauthors: R.A. Madler, K. Jorgensen, D.B. Spencer; Modeling of Space Debris and Meteoroids, Second European Conference on Space Debris, ESOC, Darmstadt, Germany, organized by the European Space Agency, March 17-19, 1997.

"Determination of Debris Sizes and Masses Using Radar and Optical Data," coauthor: Ian Gravseth; SPIE International Symposium on Optical Science, Paper No. 2813-10, Engineering, and Instrumentation, Denver, Colorado, August 4-9, 1996.

"Determination of the Sizes and Masses of Debris Objects," coauthor: Ian Gravseth; AAS/AIAA Space Flight Mechanics Meeting, Paper AAS 96-114, Austin, Texas, February 12-15, 1996.

"Space Debris Research at the University of Colorado," invited lecture, European Space Agency, European Space Operations Center, Darmstadt, Germany, October 12, 1995.

"The Investigation of Space Debris Generation and Associated Long-Term Effects in the Geosynchronous Region," coauthor: Roger McNamara; Paper No. AAS 95-347, AAS/AIAA Astrodynamics Specialist Conference, Halifax, Nova Scotia, Canada, August 14-17, 1995, 18 pp.

"An Optical Analysis of the 6470 Hypervelocity Debris Fragments," coauthor: Ian Gravseth; Paper No. AAS 95-345, AAS/AIAA Astrodynamics Specialist Conference, Halifax, Nova Scotia, Canada, August 14-17, 1995, 10 pp.

"Investigation of an RBAR/CUSP Approach for Russian Rendezvous to Space Station Alpha," coauthor: Rodolfo Gonzalez; Paper No. AAS 95-123, AAS/AIAA Space Flight Mechanics Conference, Albuquerque, New Mexico, February 12-16, 1995, 23 pp.

"Optical Calibration of Common Spacecraft Materials," co-author: Ian J. Gravseth; Paper No. AAS 95-203, AAS/AIAA Space Flight Mechanics Conference, Albuquerque, NM, February 12-16, 1995, 9 pp.

"Sensitivity of the LEO Orbital Debris Environment to Satellite Breakup Parameters," coauthor: Ronald A. Madler; Paper No. AAS 95-201, AAS/AIAA Space Flight Mechanics Conference, Albuquerque, New Mexico, February 12-16, 1995, 13 pp.

"The Impact of Satellite Breakup Parameters on Long-Term Orbital Debris Environment Evolution," coauthor: Ronald A. Madler; Paper No. 2483-08, AeroSense, SPIE's International Symposium on Aerospace/Defense Sensing and Control and Dual-Use Photonics, Orlando, Florida, April 17-21, 1995, 13 pp.; also, SPIE Proceedings Vol. 2483, Space Environmental, Legal, and Safety Issues, Orbital Debris Modeling Session.

"Mass-Diameter Function for the Entire Size Regime of Orbital Debris," coauthors: Ian J. Gravseth and Timothy D. Maclay; Paper No. 2483-04, AeroSense, SPIE's International Symposium on Aerospace/Defense Sensing and Control and Dual-Use Photonics, Orlando, FL, April 17-21, 1995, 9 pp.; also, SPIE Proceedings, Vol. 2483, Space Environmental, Legal, and Safety Issues, Environments and Effects Session.

"An Analytical Approach for Continuous-Thrust LEO-GEO Transfers," AIAA Paper No. 94-3760, AIAA/AAS Astrodynamics Conference, Scottsdale, Arizona, August, 1994.

"Calculating Collision Rates, Intersection Angles, and Relative Velocities between Intersecting Orbits," AIAA Paper 94-3740, AIAA/AAS Astrodynamics Conference, Scottsdale, Arizona, August, 1994.

"Optical Calibration for the ODERACS Mission," coauthors: R.A. Madler, T.D. Maclay, I. Gravseth; invited paper, DOD/NASA Conference on Debris, September 1-3, 1993, Colorado Springs, CO.

"An Analytical Solution Method for Near-Optimal, Continuous-Thrust Orbit Transfers," coauthor: D.B. Spencer, AAS/AIAA Astrodynamics Specialist Conference, Paper No. AAS 93-663; Victoria, British Columbia, Canada; August 16-19, 1993.

"Trajectory and Analysis Issues Associated with the EXCALIBIR Mission," coauthors: M.R. Dickey, M.M. Briggs, and W. Sonntag; AAS/AIAA Astrodynamics Specialist Conference, Paper No. AAS 93-632; Victoria, British Columbia, Canada; August 16-19, 1993.

"Modeling Design for Aerobraking Orbit Transfer Problem with Simulation Analysis and Study," coauthor: H.L. Fu; Paper No. AIAA-93-3586, AIAA/Aerospace America/Flight International Flight Simulation Technologies Conference, Monterey, California; August 9-13, 1993.

"Guidance, Navigation, and Control Education at the University of Colorado in the Next Decade," Challenges to GN&C Education for the Next Decade, Session 25-GNC-14, AIAA Guidance, Navigation, and Control Conference, Monterey, California; August 11-13, 1993.

"ODERACS Pre-flight Optical Calibration," coauthors: R.A. Madler, T.D. Maclay, Paper No. 1951-06, 1993 SPIE (International Society for Optical Engineering), Aerospace and Remote Sensing Conference, Orlando, FL, April 12-16, 1993.

"Orbital Debris Studies at the University of Colorado," coauthors: M.B. Hinga, R.A. Madler, T.D. Maclay, Paper No. 6.03, First European Conference on Space Debris, Darmstadt, Germany, April 5-7, 1993.

"On the Subject of Mass Distributions from Catastrophic Hypervelocity Impacts, or MAD CHIMP'S," coauthors: T.D. Maclay and R.A. Madler, Paper AIAA-92-4438, AIAA/AAS Astrodynamics Conference, Hilton Head Island, South Carolina, August 10-12, 1992.

"Topographically Modified Bumper Concepts for Spacecraft Shielding," coauthors: T.D. Maclay, *et al*, in Debris Generation and Effects - Shield Design and Analysis Session, Hypervelocity Impact Symposium, Institute for Advanced Technology, University of Texas, Austin, November 16-19, 1992.

"Debris Hazard for the Earth Observing System," with R.A. Madler, T.D. Maclay, R.P. McNamara; Paper No. AAS 91-370, AAS/AIAA Astrodynamics Specialist Conference, Durango, Colorado, August 19-22, 1991.

"Defining the Background Status of A Debris Cloud," with T.D. Maclay, R.A. Madler, R.P. McNamara; Paper No. AAS 91-365, AAS/AIAA Astrodynamics Specialist Conferences, Durango, Colorado, August 19-22, 1991.

"Orbital Debris Hazard Analysis for Long-Term Space Assets," with T.D. Maclay, R.A. Madler, R.P. McNamara; Workshop on Hypervelocity Impacts in Space, University of Canterbury at Kent, U.K., July 1-5, 1991.

"EXCALIBIR: A Space Experiment in Orbital Debris Lethality," with Michael R. Dickey, paper No. AAS 91-167, AAS/AIAA Spaceflight Mechanics Meeting, Houston, Texas, February 11-13, 1991.

"Orbital Debris" A Tutorial in the Space Environment Series, invited paper, paper No. AAS 91-012, 14th Annual Guidance and Control Conference, Keystone, Colorado, February 2-6, 1991.

"Volumetric Imaging of Space Debris Using Sun Microsystem's TAAC-1 Application Accelerator Board," with K. Luetkemeyer, T. Maclay, R. Madler, paper No. AIAA 90-2977, AIAA/AAS Astrodynamics Conference, Portland, Oregon, August 20-22, 1990

"Simplified Semianalytic Method for High-Eccentricity Mission Preliminary Design," with W. Frazier, G.

Rosborough, paper No. AIAA 90-0475, 28th Aerospace Sciences Meeting, Reno, Nevada, January 8-11, 1990.

"Semianalytic Study of High-Eccentricity Orbit Evolution," with W. Frazier, G. Rosborough, paper No. AAS 89-452, AAS/AIAA Astrodynamics Specialist Conference, Stowe, Vermont, August 7-10, 1989.

"Absolute Accuracy Limits of a Transfer Orbit Propagator," with W. Frazier, G. Rosborough, paper No. AIAA 89-0453, 27th Aerospace Sciences Meeting, Reno, Nevada, January 9-12, 1989.

"Estimating and Modeling the Background Orbital Debris Population," with T. Maclay, R. Madler, paper No. AAS 89-376, AAS/AIAA Astrodynamics Specialist Conference, Stowe, Vermont, August 7-10, 1989.

Invited survey paper on "The Orbital Debris Issue," 39th Congress of IAF, Bangalore, India, October, 1988.

Invited presentation on defining space debris environment, IN-STEP '88, NASA OAST, Atlanta, Georgia, December, 1988.

"Techniques for Determining Size and Mass for Debris-Size Low Earth Satellites," with M. Dickey, paper No. AIAA-88-4311-CP, AIAA/AAS Astrodynamics Conference, Minneapolis, Minnesota, August 15-17, 1988.

"Use of Solar Lyman-Alpha and 1-8 Angstrom X-Rays as EUV Flux Indices," with W. Tobiska, C. Barth, paper No. AIAA-88-4293, AIAA/AAS Astrodynamics Conference, Minneapolis, Minnesota, August 15-17, 1988.

"Tuned Earth Gravity Field for Propagation of Resonant High-Eccentricity Orbits," with W. Frazier, G. Rosborough, paper No. AIAA-88-4237-CP, AIAA/AAS Astrodynamics Conference, Minneapolis, Minnesota, August 15-17, 1988.

"Modeling Untrackable Orbital Debris Associated with a Tracked Space Debris Cloud," coauthor: R.A. Madler, Paper No. AAS 87-472, AAS/AIAA Astrodynamics Specialist Conference, Kalispell, Montana, August 10-13, 1987.

"The Correlation between Radar Cross Section and Ballistic Coefficient for Orbiting Objects," coauthor: M.R. Dickey, Paper No. AAS 87-474, AAS/AIAA Astrodynamics Specialist Conference, Kalispell, Montana, August 10-13, 1987.

"Minimum Altitude Variation Arcs," coauthor: Richard C. Murrow; Paper 9SC2; SAE 1986 Aerospace Technology Conference and Exposition, Long Beach, California, October 13-16, 1986. Selected as one of the outstanding SAE papers of 1986.

"Simulation of Satellite Breakups," coauthor: D.S. McKnight; Paper No. AIAA-86-2220-CP; AIAA/AAS Astrodynamics Conference, Williamsburg, Virginia, August 20, 1986.

"Prediction of Orbit Decay through Next Solar Cycle: Solar Mesosphere Explorer," coauthors: W.K. Tobiska, C.A. Barth; Paper No. AIAA-86-2223-CP; AIAA/AAS Astrodynamics Conference, Williamsburg, Virginia; August 20, 1986.

"Distinguishing between Collision-Induced and Explosion-Induced Satellite Breakup through Debris Analysis," coauthor: D.S. McKnight; Paper no. AAS-85-370, AAS/AIAA Astrodynamics Conference, Vail, Colorado, August, 1985.

"Meter-level Orbit Determination of Geosynchronous Satellites by an Economical Tracking System," coauthor: T.H. Wang; Paper No. 85-1919-CP, AIAA Guidance and Control Conference, Snowmass, Colorado, August 1985.

"Aerospace Guidance and Control in the University: Anticipated Trends," Paper AAS 85-001A, AAS Guidance and Control Conference, Keystone, Colorado, February, 1985.

"Long-Lifetime Martian Orbit Selection Using a Time-Dependent Model of the Martian Atmosphere," coauthors: A.I. Stewart, C.C. Chow, and C. Uphoff, AIAA/AAS Astrodynamics Conference, Seattle, August, 1984.

"Satellite-to-Satellite Orbit Determination Using Minimum Discrete Range and Range-Rate Data Only,"

DIRECTED RESEARCH:

PH.D. THESES DIRECTED:

1. Jean-Paul Gravier, "Absolute Optimum and Two-Impulse Optimal Interplanetary Transfers with Applications to Earth-Mars and Earth-Venus," 1970.
2. Ching-Yew Yang, "On the Use of Aerodynamic Forces to Effect Maneuvers of Orbiting Vehicles," 1972.
3. James Michael Walton, "Optimum Transfer Between Hyperbolic Asymptotes About a Planet of Finite Size," 1973.
4. Jerry Neill Mason, "Determination of Optimal Initial Conditions for an Orbital Launch Facility," 1973.
5. James Pryor Hauser, "An Analysis of the Effects of Systematic Errors in the Lunar Ranging Experiment," (with P. Bender), 1974.
6. Wu-Torng Chen, "Satellite Orbits Under the Influence of Air Drag, Rotating Oblate Atmosphere, and Planet's Oblateness," 1977.
7. Shean-Teh Han, "Determination and Maintenance of Earth Orbits With Arcs of Minimum Altitude Variation," 1980.
8. Chia-Chuan Chow, "Satellite-to-Satellite Orbit Determination Using Minimum Range and Range-Rate Data Only," 1984.
9. Ting-hua Wang, "Meter-level Orbit Determination of Geosynchronous Satellites by and Economical Tracking System," 1985.
10. Lin-sheng Jin, "Preliminary Orbit Determination Using Satellite-to-Satellite Limited Range and Range-Rate Data," 1986.
11. Douglas R. Tighe, "Orbit Determination for Low Earth Orbit Spacecraft Based on Satellite-to-Satellite Tracking Techniques Via a Unique Very High Altitude Relay Constellation," 1986.
12. Richard C. Murrow, "Frozen Orbits - Near Constant or Beneficially Varying Orbital Parameters," 1986.
13. Darren S. McKnight, "Simulation of On-Orbit Satellite Fragmentations," 1986.
14. Rodney D. Bain, "Ten Year Lifetime Orbits About the Planet Mars," 1988.
15. W. Kent Tobiska, "A Solar Extreme Ultraviolet Flux Model," 1988.
16. Donald L. Mackison, "Guaranteed Cost Control of Flexible Space Structures," (with P. Dorato) 1988.
17. William E. Frazier, "Semianalytic Study of High-Eccentricity Orbit Stability and Evolution," 1989.
18. Ho-ling Fu, "On the High Eccentricity Aerobraking Orbit Transfer Problem, with Parametric Analysis and Numerical Study", 1992.
19. Timothy D. Maclay, "Untrackable Orbital Debris Hazard Assessment and Shield Design for Satellites Operating in Low Earth Orbit", 1993.
20. David B. Spencer, "An Analytical Solution Method for Near-Optimal, Continuous-Thrust

Orbit Transfers," 1994.

21. Ronald A. Madler, "Evolution of the Near-Earth Man-Made Orbital Debris Environment," 1994.
22. Roger P. McNamara, "The Investigation of Space Debris Generation and Associated Long-Term Effects in the Geosynchronous Region," 1995.
23. Ian J. Gravseth, "Determination of the Physical Properties of Artificial Debris Via Remote Observations," 1996.
24. Christopher A. Sabol, "A Role for Improved Angular Observations in Geosynchronous Orbit Determination", 1998.
25. Khanh Kim Luu, "Effects of Perturbations on Space Debris in Supersynchronous Storage Orbits", 1998.
26. Scott R. Dahlke, "Investigation of Lunar Ballistic Capture Transfer Trajectories", 1998.
27. Maria J. Evans, "Optimization of Satellite Constellations for Partial Coverage", 1999.
28. Kira Michelle Jorgensen, "Using Reflectance Spectroscopy to Determine Material Type of Orbital Debris", 2000.
29. Kenneth Stephen Crumpton, "The Effects of Filter and Coordinate Frame Selection on the Accuracy and Efficiency of Tactical Ballistic Missile Parameter Estimation and Prediction", 2000.
30. Brian J. Poller, "The Photometric Detection of Known Sun Occluding Orbital Debris", 2009

M.S. THESES DIRECTED:

1. Jean Leon Cendral, "Evaluation of an Attitude and Position Control System for a Geostationary Communication Satellite Using the Possibilities of Ion Propulsion," 1971.
2. William Kent Tobiska, "Predictive Model of the Orbit Decay of the Solar Mesosphere Explorer," 1985.
3. H. Allan Foster, Jr., "The Effect of Albedo on the Attitude Knowledge of a Spacecraft," 1985.
4. Eric H. Seale, "Attitude Algebra Package," 1988.
5. Nicholas G. Smith, "Mars Rover Sample Return Mission Study," 1988.
6. Christopher E. Casar, "Atmospheric Density Variations and the Effects on Spacecraft in Low Earth Orbit," 1989.

PH.D. Graduates and their careers:

- Jean-Paul Gravier, "Absolute Optimum and Two-Impulse Optimal Interplanetary Transfers with Applications to Earth-Mars and Earth-Venus," 1970. *Returned to France, worked in the Nuclear Program there and in Brazil.*
- Ching-Yew Yang, "On the Use of Aerodynamic Forces to Effect Maneuvers of Orbiting Vehicles," 1972. *In the Republic of China (Taiwan) rose to be Director of Chung Shan Institute of Science and Technology (CSIST) with more than 1500 PhD's under his direction.*
- James Michael Walton, "Optimum Transfer Between Hyperbolic Asymptotes About a Planet of Finite Size," 1973. *Rose to Colonel in the USAF, directed several major programs, and directed the AFWL at Albuquerque.*
- Jerry Neill Mason, "Determination of Optimal Initial Conditions for an Orbital

- Launch Facility," 1973. *Rose to Colonel in the USAF, and directed a major satellite program.*
- James Pryor Hauser, "An Analysis of the Effects of Systematic Errors in the Lunar Ranging Experiment," (with P. Bender), 1974. *Served on the faculty at the Naval Postgraduate School, and started his own consulting company.*
 - Wu-Torng Chen, "Satellite Orbits Under the Influence of Air Drag, Rotating Oblate Atmosphere, and Planet's Oblateness," 1977. *Returned to the Republic of China and served as research scientist at Chung Shan Institute of Science and Technology (CSIST).*
 - Shean-Teh Han, "Determination and Maintenance of Earth Orbits With Arcs of Minimum Altitude Variation," 1980. *Returned to the Republic of China and served as research scientist at Chung Shan Institute of Science and Technology (CSIST).*
 - Chia-Chuan Chow, "Satellite-to-Satellite Orbit Determination Using Minimum Range and Range-Rate Data Only," 1984. *Returned to Republic of China and became Chairman of the Department of Aerospace Engineering at the Military University, then joined the Industrial Technology Research Institute (ITRI). Now Professor, Kainan University, Taiwan.*
 - Ting-hua Wang, "Meter-level Orbit Determination of Geosynchronous Satellites by and Economical Tracking System," 1985. *Returned to the Republic of China, as research scientist at Chung Shan Institute of Science and Technology (CSIST).*
 - Lin-sheng Jin, "Preliminary Orbit Determination Using Satellite-to-Satellite Limited Range and Range-Rate Data," 1986. *Returned to the Republic of China, served as research scientist at Chung Shan Institute of Science and Technology (CSIST).*
 - Douglas R. Tighe, "Orbit Determination for Low Earth Orbit Spacecraft Based on Satellite-to-Satellite Tracking Techniques Via a Unique Very High Altitude Relay Constellation," 1986. *Has continued with Lockheed Martin Corporation at the Denver, Bethesda, Vandenburg, and Houston facilities. Rose to a high managerial position in Lockheed Martin.*
 - Richard C. Murrow, "Frozen Orbits - Near Constant or Beneficially Varying Orbital Parameters," 1986.
 - Darren S. McKnight, "Simulation of On-Orbit Satellite Fragmentations," 1986. *Joined the faculty of the USAF Academy, then played a key role in the SOCIT tests, and joined Kaman Sciences, then Senior Vice President and Director of Science and Technology Strategy, SAIC, McLean, Virginia. Now Technical Director at Integrity Applications Incorporated, Chantilly, VA.*
 - Rodney D. Bain, "Ten Year Lifetime Orbits About the Planet Mars," 1988. *Rose to Colonel in the USAF and joined the faculty of AFIT in Dayton, Ohio. After a decade there he retired.*
 - W. Kent Tobiska, "A Solar Extreme Ultraviolet Flux Model," (with Charles Barth), 1988. *Served at JPL for a decade. Now...*
 - Donald L. Mackison, "Guaranteed Cost Control of Flexible Space Structures," (with P. Dorato) 1988. *Served at Ball Corp as their Kalman filter guru among other things. After a decade there joined the University of Colorado's Aerospace Engineering Science Department as a Lecturer and consults and teaches short courses. Retired in 2009.*
 - William E. Frazier, "Semianalytic Study of High-Eccentricity Orbit Stability and Evolution," 1989. *At Ball Corporation, Ball Aerospace, since graduating. Served*

in major managerial and technical leadership positions on several high-profile programs.

- Ho-ling Fu, "On the High Eccentricity Aerobraking Orbit Transfer Problem, with Parametric Analysis and Numerical Study", 1992. *Returned to the Republic of China and served as research scientist at Chung Shan Institute of Science and Technology (CSIST).*
- Timothy D. Maclay, "Untrackable Orbital Debris Hazard Assessment and Shield Design for Satellites Operating in Low Earth Orbit", 1993. *Joined OrbComm, subsidiary of Orbital Sciences, and rose to Vice-President in the independent OrbComm. Now...*
- David B. Spencer, "An Analytical Solution Method for Near-Optimal, Continuous-Thrust Orbit Transfers," 1994. *Joined the USAF Phillips Lab in Albuquerque (AFWL) as director of the astrodynamics program. Left to join the faculty of the Department of Aerospace Engineering at Penn State where he is now Professor.*
- Ronald A. Madler, "Evolution of the Near-Earth Man-Made Orbital Debris Environment," 1994. *Joined the faculty of Embry Riddle Aeronautic University where he became professor and chairman of the Aerospace Engineering Department; in 2010 became Dean of Engineering.*
- Roger P. McNamara, "The Investigation of Space Debris Generation and Associated Long-Term Effects in the Geosynchronous Region," 1995. *Continued at Lockheed Martin Corporation, became director of the Large Booster Division, and today has a similar role in advanced launch systems.*
- Ian J. Gravseth, "Determination of the Physical Properties of Artificial Debris Via Remote Observations," 1996. *Continued at Ball Corporation where he is today.*
- Christopher A. Sabol, "A Role for Improved Angular Observations in Geosynchronous Orbit Determination", 1998. *Joined the astronautics group at USAFWL, then transferred to the Air Force Maui Optical and Supercomputing (AMOS) site as a leader of the Optical Program.*
- Khanh Kim Luu, "Effects of Perturbations on Space Debris in Supersynchronous Storage Orbits", 1998. *Joined the astronautics group at USAFWL, then transferred to the Air Force Maui Optical and Supercomputing (AMOS) site as a leader of the Optical Program.*
- Scott R. Dahlke, "Investigation of Lunar Ballistic Capture Transfer Trajectories", 1998. *Joined the faculty of the USAF Academy in the Astronautics Department.*
- Maria J. Evans, "Optimization of Satellite Constellations for Partial Coverage", 1999. *Worked for Orbital Sciences and its subsidiaries, and then formed her own company, Constell Corporation.*
- Kira Michelle (Jorgensen) Abercromby, "Using Reflectance Spectroscopy to Determine Material Type of Orbital Debris", 2000. *Served three years as a National Research Council Postdoctoral Fellow at NASA's Johnson Space Center with the Space Physics Division's Space Debris Program, then in the same position but formally with Jacob Sverdrup in their support group. In 2008 joined the faculty of the Aerospace Engineering Department of Cal Poly in San Luis Obispo as an assistant professor.*
- Kenneth Stephen Crumpton, "The Effects of Filter and Coordinate Frame Selection on the Accuracy and Efficiency of Tactical Ballistic Missile Parameter Estimation and Prediction", (with George Born), 2000. *With Raytheon in their space group in Denver.*
- Brian J. Poller, "The Photometric Detection of Known Sun Occluding Orbital

Debris", 2009. *Joined Logos Technologies, Inc. in Arlington, Virginia, as a research scientist in their R & D group.*

It is gratifying to note that nine of these thirty PhD's became University faculty members at some point in their careers.

Some Special Master's Degree Students:

There have been approximately one hundred Master's Degrees obtained under the direction of Professor Robert D. Culp in the four decades since 1968. Some of these who come to mind are:

Ellison "El" Onisuka, BS and MS, 1969. Astronaut, died on the Challenger in 1986.

James Voss, MS, 1974. Astronaut, became associate Dean, Auburn University College of Engineering, and Lecturer, University of Colorado, Department of Aerospace Engineering Sciences. Now Resident Scholar, Department of Aerospace Engineering Sciences, University of Colorado at Boulder.

Roland H. "Rhip" Worrell, MS, 1984. USAF Colonel, became second in control of the "Star Wars" Program, directed the Brilliant Pebbles Program. Currently with Lockheed Martin, Program Manager, Missile Defense-Warfighter Integration.

Michael Dickey, BS 1987, MS 1988. USAF Colonel. Now Vice President, Sierra Nevada Corporation, Lafayette, Colorado.

Michael Woeste

Kevin Odle

Paul Shattuck

Steve Price

Dave Eagle

Eric Seale

Tom Sparn

All of these could have, and perhaps should have, continued and received the PhD. Primarily because of success in the discipline, they were in demand and could not take time off from exciting careers to spend more time in graduate school. From their successes it is apparent they made the correct decisions.