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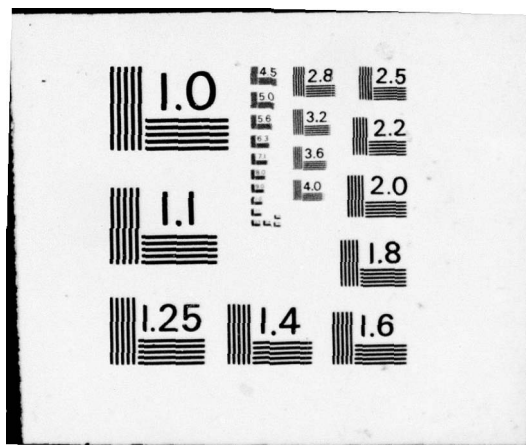
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1965-76

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E.C. WILSON

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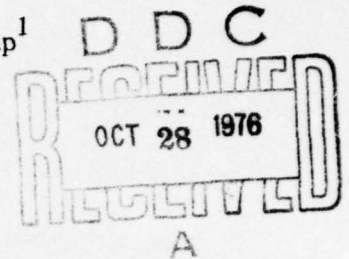
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Publications of the Aero-Astronautics Group¹

1965-76

by

E.C. WILSON²

Abstract. This document summarizes the research performed by the Aero-Astronautics Group of Rice University during the period 1965-76 under several AFOSR, NSF, and NASA grants. This research has been reported in 133 Aero-Astronautics Reports and 91 papers published in the open literature. It has spanned the following mathematical areas: (i) nonlinear equations, (ii) differential equations, (iii) two-point and multipoint boundary-value problems, (iv) mathematical programming, (v) optimal control, and (vi) calculus of variations. In these areas, it has led to the development of several new analytical and computational techniques.

Concerning applications, the research reported here is of interest in several areas of engineering, science, and economics. With particular regard to aerospace engineering, it applies to the following problem areas: (i) optimum atmospheric flight trajectories, (ii) optimum extra-atmospheric flight trajectories, (iii) optimum aerodynamic shapes, and (iv) optimum structures.

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² Secretary, Department of Mechanical Engineering and Materials Science, Rice University, Houston, Texas.

Key Words. Nonlinear equations, differential equations, two-point boundary-value problems, multipoint boundary-value problems, mathematical programming, optimal control, calculus of variations.

Numerical analysis, numerical methods, computing methods, computing techniques.

Systems theory, engineering systems, aerospace engineering, economics.

Optimum systems, optimum atmospheric flight trajectories, optimum extra-atmospheric flight trajectories, optimum aerodynamic shapes, optimum structures.

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I. Introduction

This document summarizes the research performed by the Aero-Astro-nautics Group of Rice University during the period 1965-76. This research has been supported through the following US Government Grants:

Air Force Office of Scientific Research

AFOSR Grant No. AF-AFOSR-828-65, 1965-66

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NASA Grant No. NGR-44-006-063, 1967-68

NASA-Johnson Research Center

NASA Grant No. NGR-44-006-089, 1968-70

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Prof. H.Y. Huang

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Mr. A. Esterle
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Mr. R.E. Pritchard
Mr. J.L. Tietze
Mr. K.H. Well
Mr. W.L. Wilson
Mr. A.K. Wu

As a partial result of research performed under the above grants, the following advanced degrees were awarded:

MS Degrees

A.K. Aggarwal
J.W. Cantrell
J.P. Chambliss
J.R. Cloutier
G.M. Coggins
E.E. Cragg

J.C. Heideman
H.Y. Huang
A.V. Levy
S. Naqvi
W.L. Wilson
A.K. Wu

PhD Degrees

A.K. Aggarwal
J.R. Cloutier
E.E. Cragg
J.N. Damoulakis
J.C. Heideman
H.Y. Huang
D.G. Hull
R.R. Iyer

A.V. Levy
A.H. Lusty, Jr.
P.E. Moseley
S. Naqvi
R.E. Pritchard
J.L. Tietze
K.H. Well

Over the period 1965-76, the research of the Aero-Astronautics Group has been concerned with the following mathematical areas: (i) nonlinear equations, (ii) differential equations, (iii) two-point and multipoint boundary-value problems, (iv) mathematical programming, (v) optimal control, and (vi) calculus of variations. In these areas, it has led to the development of several new analytical and computational techniques.

Concerning applications, the research reported here is of interest in several areas of engineering, science, and economics. With particular regard to aerospace engineering, it applies to the following problem areas: (i) optimum atmospheric flight trajectories, (ii) optimum extra-atmospheric flight trajectories,

(iii) optimum aerodynamic shapes, and (iv) optimum structures.

A list of the research reports of the Aero-Astronautics Group is given in Section II. In turn, Section III contains a list of the papers published in the open literature by members of the Aero-Astronautics Group.

Remark. Aero-Astronautics Report (AAR) and Aero-Astronautics Papers (AAP) can be obtained by writing to the following address:

Dr. Angelo Miele
Aero-Astronautics Group
230 Ryon Building
Rice University
Houston, Texas 77001

II. Reports of the Aero-Astronautics Group

- AAR-1. MIELE, A., Extremal Problems in Aerodynamics, Rice University, Aero-Astronautics Report No. 1, 1965.
- AAR-2. MIELE, A., Generalized Approach to the Calculus of Variations in Two Independent Variables, Rice University, Aero-Astronautics Report No. 2, 1965.
- AAR-3. HULL, D.G., and MIELE, A., Three-Dimensional Wings of Minimum Total Drag in Newtonian Flow, Rice University, Aero-Astronautics Report No. 3, 1965.
- AAR-4. MIELE, A., Similarity Laws for Optimum Hypersonic Bodies, Rice University, Aero-Astronautics Report No. 4, 1965.
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- AAR-6. HULL, D.G., and MIELE, A., Three-Dimensional Hypersonic Shapes of Minimum Total Drag, Rice University, Aero-Astronautics Report No. 6, 1965.
- AAR-7. MIELE, A., and PRITCHARD, R.E., Optimum Slender Bodies in Free-Molecular Flow, Rice University, Aero-Astronautics Report No. 7, 1965.
- AAR-8. MIELE, A., Optimum Transversal Contour of a Nonlifting Body in Newtonian Flow, Rice University, Aero-Astronautics Report No. 8, 1965.

- AAR-9. MIELE, A., Lift-to-Drag Ratios of Slender Bodies at Hypersonic Speeds, Rice University, Aero-Astronautics Report No. 9, 1965.
- AAR-10. MIELE, A., and HULL, D.G., Maximum Lift-to-Drag Ratios of Slender, Flat-Top, Hypersonic Bodies, Part 1, Rice University, Aero-Astronautics Report No. 10, 1965.
- AAR-11. MIELE, A., Similarity Laws for Lifting Bodies of Minimum Drag at Hypersonic Speeds, Rice University, Aero-Astronautics Report No. 11, 1965.
- AAR-12. MIELE, A., Extremization of Products of Powers of Functionals, Rice University, Aero-Astronautics Report No. 12, 1966.
- AAR-13. MIELE, A., Lift-to-Drag Ratios of Slender Wings at Hypersonic Speeds, Rice University, Aero-Astronautics Report No. 13, 1966.
- AAR-14. MIELE, A., One-Dimensional Approach to the Maximum Lift-to-Drag Ratio of a Slender, Flat-Top, Hypersonic Wing, Rice University, Aero-Astronautics Report No. 14, 1966.
- AAR-15. MIELE, A., Two-Dimensional Approach to the Maximum Lift-to-Drag Ratio of a Slender, Flat-Top, Hypersonic Wing, Rice University, Aero-Astronautics Report No. 15, 1966.
- AAR-16. MIELE, A., Similarity Laws for Lifting Wings of Minimum Drag at Hypersonic Speeds, Rice University, Aero-Astronautics Report No. 16, 1966.
- AAR-17. MIELE, A., Maximum Lift-to-Drag Ratio of a Nonslender, Flat-Top, Hypersonic Wing, Rice University, Aero-Astronautics Report No. 17, 1966.

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- AAR-20. MIELE, A., and HUANG, H.Y., Power-Law Bodies of Maximum Lift-to-Drag Ratio in Hypersonic Flow, Rice University, Aero-Astronautics Report No. 20, 1966.
- AAR-21. LUSTY, A.H., Jr., Lifting Bodies of Minimum Drag in Hypersonic Flow, Rice University, Aero-Astronautics Report No. 21, 1966.
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- AAR-23. MIELE, A., and WILSON, W.L., Two-Dimensional, Power-Law Wings of Maximum Lift-to-Drag Ratio in Hypersonic Flow, Rice University, Aero-Astronautics Report No. 23, 1966.
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- AAR-32. MIELE, A., and HUANG, H.Y., Missile Shapes of Minimum Ballistic Factor, Rice University, Aero-Astronautics Report No. 32, 1967.
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- AAR-37. MIELE, A., On a Modification of the Classical Isoperimetric Problem, Rice University, Aero-Astronautics Report No. 37, 1968.
- AAR-38. MIELE, A., Bodies of Maximum Lift at Hypersonic Speeds, Rice University, Aero-Astronautics Report No. 38, 1968.
- AAR-39. MIELE, A., and HEIDEMAN, J.C., The Restoration of Constraints in Holonomic Problems, Rice University, Aero-Astronautics Report No. 39, 1968.
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- AAR-43. MIELE, A., and DAMOULAKIS, J.N., Optimum Airfoils at Moderate Supersonic Speeds, Part 3, Maximum Lift-to-Drag Ratio for Given Thickness, Rice University, Aero-Astronautics Report No. 43, 1968.
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- AAR-58. CRAGG, E.E., and LEVY, A.V., Gradient Methods in Mathematical Programming, Part 3, Supermemory Gradient Method, Rice University, Aero-Astronautics Report No. 58, 1969.
- AAR-59. MIELE, A., and HEIDEMAN, J.C., Mathematical Programming for Constrained Minimal Problems, Part 1, Sequential Gradient-Restoration Algorithm, Rice University, Aero-Astronautics Report No. 59, 1969.
- AAR-60. MIELE, A., Gradient Methods in Control Theory, Part 1, Ordinary Gradient Method, Rice University, Aero-Astronautics Report No. 60, 1969.
- AAR-61. MIELE, A., HUANG, H.Y., and HEIDEMAN, J.C., Mathematical Programming for Constrained Minimal Problems, Part 2, Sequential Conjugate Gradient-Restoration Algorithm, Rice University, Aero-Astronautics Report No. 61, 1969.
- AAR-62. MIELE, A., and PRITCHARD, R.E., Gradient Methods in Control Theory, Part 2, Sequential Gradient-Restoration Algorithm, Rice University, Aero-Astronautics Report No. 62, 1969.
- AAR-63. MIELE, A., and IYER, R.R., General Technique for Solving Nonlinear, Two-Point Boundary-Value Problems via the Method of Particular Solutions, Rice University, Aero-Astronautics Report No. 63, 1969.

- AAR-64. HUANG, H.Y., Unified Approach to Quadratically Convergent Algorithms for Function Minimization, Rice University, Aero-Astronautics Report No. 64, 1969.
- AAR-65. DAMOULAKIS, J.N., Gradient Methods in Control Theory, Part 3, Sequential Gradient-Restoration Algorithm: Numerical Examples, Rice University, Aero-Astronautics Report No. 65, 1969.
- AAR-66. HUANG, H.Y., and LEVY, A.V., Numerical Experiments on Quadratically Convergent Algorithms for Function Minimization, Rice University, Aero-Astronautics Report No. 66, 1969.
- AAR-67. DAMOULAKIS, J.N., Gradient Methods in Control Theory, Part 4, Sequential Gradient-Restoration Algorithm: Further Numerical Examples, Rice University, Aero-Astronautics Report No. 67, 1970.
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- AAR-73. DAMOULAKIS, J.N., Gradient Methods in Control Theory, Part 5, Sequential Gradient-Restoration Algorithm: Additional Numerical Examples, Rice University, Aero-Astronautics Report No. 73, 1970.
- AAR-74. MIELE, A., Gradient Methods in Control Theory, Part 6, Combined Gradient-Restoration Algorithm, Rice University, Aero-Astronautics Report No. 74, 1970.
- AAR-75. MIELE, A., CRAGG, E.E., IYER, R.R., and LEVY, A.V., Use of the Augmented Penalty Function in Mathematical Programming Problems, Part 1, Ordinary Gradient Algorithm, Rice University, Aero-Astronautics Report No. 75, 1970.
- AAR-76. MIELE, A., and LEVY, A.V., Modified Quasilinearization and Optimal Initial Choice of the Multipliers, Part 1, Mathematical Programming Problems, Rice University, Aero-Astronautics Report No. 76, 1970.
- AAR-77. MIELE, A., IYER, R.R., and WELL, K.H., Modified Quasilinearization and Optimal Initial Choice of the Multipliers, Part 2, Optimal Control Problems, Rice University, Aero-Astronautics Report No. 77, 1970.

- AAR-78. MIELE, A., NAQVI, S., and LEVY, A.V., Modified Quasilinearization Method for Solving Nonlinear Equations, Rice University, Aero-Astronautics Report No. 78, 1970.
- AAR-79. MIELE, A., and IYER, R.R., Modified Quasilinearization Method for Solving Nonlinear, Two-Point Boundary-Value Problems, Rice University, Aero-Astronautics Report No. 79, 1970.
- AAR-80. MIELE, A., and DAMOULAKIS, J.N., Modifications and Extensions of the Sequential Gradient-Restoration Algorithm for Optimal Control Theory, Rice University, Aero-Astronautics Report No. 80, 1970.
- AAR-81. WELL, K.H., Use of the Method of Particular Solutions in Determining Periodic Orbits of the Earth-Moon System, Rice University, Aero-Astronautics Report No. 81, 1970.
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- AAR-83. WELL, K.H., Note on a Problem by Lance and a Problem by Bellman, Rice University, Aero-Astronautics Report No. 83, 1971.
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- AAR-86. MIELE, A., MOSELEY, P.E., and CRAGG, E.E., A Modification of the Method of Multipliers for Mathematical Programming Problems, Rice University, Aero-Astronautics Report No. 86, 1971.
- AAR-87. HUANG, H.Y., and CHAMBLISS, J.P., Quadratically Convergent Algorithms and One-Dimensional Search Schemes, Rice University, Aero-Astronautics Report No. 87, 1972.
- AAR-88. HUANG, H.Y., Method of Dual Matrices for Function Minimization, Rice University, Aero-Astronautics Report No. 88, 1972.
- AAR-89. HUANG, H.Y., and CHAMBLISS, J.P., Numerical Experiments on Dual Matrix Algorithms for Function Minimization, Rice University, Aero-Astronautics Report No. 89, 1972.
- AAR-90. MIELE, A., COGGINS, G.M., and LEVY, A.V., Updating Rules for the Penalty Constant Used in the Penalty Function Method for Mathematical Programming Problems, Rice University, Aero-Astronautics Report No. 90, 1972.
- AAR-91. MIELE, A., Combined Gradient-Restoration Algorithm for Optimal Control Problems, Rice University, Aero-Astronautics Report No. 91, 1971.
- AAR-94. MIELE, A., TIETZE, J.L., and LEVY, A.V., Comparison of Several Gradient Algorithms for Mathematical Programming Problems, Rice University, Aero-Astronautics Report No. 94, 1972.

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- AAR-96. PRITCHARD, R.E., Comparison between Various Gradient Algorithms in Control Theory, Part 1, Sequential Gradient-Restoration Algorithms, Rice University, Aero-Astronautics Report No. 96, 1971.
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- AAR-98. MIELE, A., Gradient Methods in Optimal Control Theory, Rice University, Aero-Astronautics Report No. 98, 1971.
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) → This document summarizes the research performed by the Aero-Astronautics Group of Rice University during the period 1965-76 under several AFOSR, NSF, and NASA grants. This research has been reported in 133 Aero-Astronautics Reports and 91 papers pub- lished in the open literature. It has spanned the following mathematical areas: (i) non-			

19. KEY WORDS (Continued)

calculus of variations.

Numerical analysis, numerical methods, computing methods, computing techniques.

Systems theory, engineering systems, aerospace engineering, economics.

Optimum systems, optimum atmospheric flight trajectories, optimum extra-atmospheric flight trajectories, optimum aerodynamic shapes, optimum structures.

20. ABSTRACT (continued)

cont. → linear equations; (ii) differential equations; (iii) two-point and multipoint boundary-value problems; (iv) mathematical programming; (v) optimal control; and (vi) calculus of variations. In these areas, it has led to the development of several new analytical and computational techniques.

Concerning applications, the research reported here is of interest in several areas of engineering, science, and economics. With particular regard to aerospace engineering, it applies to the following problem areas: (i) optimum atmospheric flight trajectories; (ii) optimum extra-atmospheric flight trajectories; (iii) optimum aerodynamic shapes; and (iv) optimum structures. ↗

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