

# Stanford

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## Ilan Kroo

Thomas V. Jones Professor in the School of Engineering  
Aeronautics and Astronautics

### CONTACT INFORMATION

- **Administrator**

Corinna Haussecker - Administrative Associate

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### Bio

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#### BIO

Professor Kroo's research involves work in three general areas: multidisciplinary optimization and aircraft synthesis, unconventional aircraft, and low-speed aerodynamics. Current research in the field of aircraft synthesis, sponsored by NASA and industry, includes the development of a new computational architecture for aircraft design, and its integration with numerical optimization. Studies of unconventional configurations employ rapid turnaround analysis methods in the design of efficient subsonic and supersonic commercial aircraft. Recent research has included investigation of configurations such as joined wings, oblique wings, and tailless aircraft. Nonlinear low-speed aerodynamics studies have focused on vortex wake roll-up, refined computation of induced drag, the design of wing tips, and the aerodynamics of maneuvering aircraft.

#### ACADEMIC APPOINTMENTS

- Professor, Aeronautics and Astronautics

#### BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Elected Member, National Academy of Engineering (2013 - present)

#### PROFESSIONAL EDUCATION

- PhD, Stanford University (1983)

#### LINKS

- <http://aero.stanford.edu/People/kroo.html>: <http://aero.stanford.edu/People/kroo.html>

### Teaching

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#### COURSES

##### 2021-22

- Aircraft Design: AA 146A (Win)
- Aircraft Design Laboratory: AA 146B (Spr)
- Applied Aerodynamics: AA 200 (Win)

- Atmospheric Flight: AA 141 (Aut)

#### 2020-21

- Aircraft Design Laboratory: AA 146B, AA 246X (Spr)
- Applied Aerodynamics: AA 200 (Win)
- Atmospheric Flight: AA 141 (Aut)

#### 2019-20

- Aircraft Design: AA 146A (Win)
- Aircraft Design Laboratory: AA 146B (Spr)
- Atmospheric Flight: AA 141 (Aut)
- Case Studies in Aircraft Design: AA 294 (Spr)

#### 2018-19

- Applied Aerodynamics: AA 200 (Win)
- Atmospheric Flight: AA 141 (Aut)
- Autonomous Aircraft: Design/Build/Fly: AA 241X (Spr)
- Case Studies in Aircraft Design: AA 294 (Spr)

## STANFORD ADVISEES

### Doctoral Dissertation Reader (AC)

Matthew Clarke, Racheal Erhard, Jason Qian

### Orals Evaluator

Matthew Clarke, Jason Qian

### Doctoral Dissertation Advisor (AC)

Loren Newton, Jean de Becdelievre

### Master's Program Advisor

Karthik Anantharaman, Yamaan Atiq, Alvin Lee, Walter Manuel, Tan-Duc Nguyen, Anna Wahl, Michael Ye

## Publications

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### PUBLICATIONS

- **Control of Multiple UAVs for Persistent Surveillance: Algorithm and Flight Test Results** *IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY*  
Nigam, N., Bieniawski, S., Kroo, I., Vian, J.  
2012; 20 (5): 1236-1251
- **Metric for Comparing Lifetime Average Climate Impact of Aircraft** *AIAA JOURNAL*  
Dallara, E. S., Kroo, I. M., Waitz, I. A.  
2011; 49 (8): 1600-1613
- **Aerodynamic Performance of Extended Formation Flight** *48th AIAA Aerospace Sciences Meeting and Exhibit Including the New Horizons Forum and Aerospace Exposition*  
Ning, S. A., Flanzer, T. C., Kroo, I. M.  
AMER INST AERONAUT ASTRONAUT.2011: 855-65
- **Multidisciplinary Considerations in the Design of Wings and Wing Tip Devices** *AIAA 26th Applied Aerodynamics Conference*  
Ning, S. A., Kroo, I.  
AMER INST AERONAUT ASTRONAUT.2010: 534-43

- **Two-Level Multifidelity Design Optimization Studies for Supersonic Jets** *AIAA 43rd Aerospace Sciences Meeting and Exhibit*  
Choi, S., Alonso, J. J., Kroo, I. M.  
AMER INST AERONAUT ASTRONAUT.2009: 776–90
- **ENHANCED COLLABORATIVE OPTIMIZATION: A DECOMPOSITION-BASED METHOD FOR MULTIDISCIPLINARY DESIGN** *ASME International Design Engineering Technical Conferences/Computers and Information in Engineering Conference*  
Roth, B. D., Kroo, I. M.  
AMER SOC MECHANICAL ENGINEERS.2009: 927–936
- **Persistent surveillance using multiple unmanned air vehicles** *2008 IEEE Aerospace Conference*  
Nigam, N., Kroo, I.  
IEEE.2008: 88–101
- **A Multifidelity Gradient-Free Optimization Method and Application to Aerodynamic Design**  
Rajnarayan, D., Haas, A., Kroo, I.  
2008
- **Theoretical and Experimental Investigation of Energy Extraction from Atmospheric Turbulence**  
Patel, C., Kroo, I.  
2008
- **Control and Design of Multiple Unmanned Air Vehicles for a Persistent Surveillance Task**  
Nigam, N., Kroo, I.  
2008
- **Tip Extensions, Winglets, and C-wings: Conceptual Design and Optimization**  
Ning, S., A., Kroo, I.  
2008
- **Extracting Energy from Atmospheric Turbulence**  
Patel, C., Lee, H., Kroo, I.  
2008
- **Multi-Objective Aircraft Optimization for Minimum Cost and Emissions over Specific Route Networks**  
Geoffrey, C., Bower, Kroo, Ilan, M.  
2008
- **Enhanced Collaborative Optimization: Application to an Analytic Test Problem and Aircraft Design**  
Roth, B., D., Kroo, I., M.  
2008
- **Multifidelity Optimization Methodology for Incorporating Advanced Technologies into Conceptual Design**  
Fidkowski, K., Kroo, I., Willcox, K.  
2008
- **Multifidelity Design Optimization of Low-Boom Supersonic Jets** *Journal of Aircraft* 0021-8669  
Choi, S., Alonso, J. J., Kroo, I., M., Wintzer, M.  
2008; 45 (1): 106-118
- **Multifidelity design optimization of low-boom supersonic sets** *AIAA/ISSMO 10th Multidisciplinary Analysis and Optimization Conference*  
Choi, S., Alonso, J. J., Kroo, I. M., Wintzer, M.  
AMER INST AERONAUT ASTRONAUT.2008: 106–18
- **Stanford University, Stanford, CA, Neutral Energy Cycles for a Vehicle in Sinusoidal and Turbulent Vertical Gusts**  
Kroo, I., Lissaman, P., Ventures, D. V., Santa Fe, N. M., Patel, C.  
2007
- **NASA Ames Research Center, Probability Collectives for Optimization of Computer Simulations**  
Rajnarayan, D., Kroo, I.  
2007

- **Aircraft Family Design Using Decomposition-based Methods**  
Allison, J., Roth, B., Kokkolaras, M., Kroo, I., Papalambros, P. Y.  
2006
- **Control Law Design for Improving UAV Performance Using Wind Turbulence**  
Patel, C. K., Kroo  
2006
- **Optimization Under Uncertainty Using Probability Collectives**  
Rajnarayan, D., Wolpert, D., Kroo, I.  
2006
- **Robust Objective Functions for Sonic-Boom Minimization** *Journal of Aircraft*, 0021-8669  
Makino, Y., Kroo, Ilan, M.  
2006; 43 (5): 1301-1306
- **Conceptual Design of Conventional and Oblique Wing Configurations for Small Supersonic Aircraft**  
Wintzer, M., Sturdza, P., Kroo, I.  
2006
- **Two Dimensional Unsteady Aerodynamics of Miniature Trailing Edge Effectors**  
Lee, H., Kroo, I. M.  
2006
- **Framework for aircraft conceptual design and environmental performance studies** *AIAA/ISSMO 10th Multidisciplinary Analysis and Optimization Conference*  
Antoine, N. E., Kroo, I. M.  
AMER INST AERONAUT ASTRONAUT.2005: 2100-2109
- **Unconventional Configurations for Efficient Supersonic Flight**  
Kroo, I.  
2005
- **Flight Control with Distributed Effectors**  
Bieniawski, S., Kroo, I., Wolpert, D.  
2005
- **Nonplanar Wing Concepts for Increased Aircraft Efficiency**  
Kroo, I.  
2005
- **Two-Level Multi-Fidelity Design Optimization Studies for Supersonic Jets**  
Choi, S., Alonso, J. J., Kim, S., Kroo, I. M., Wintzer, M.  
2005
- **Aircraft optimization for minimal environmental impact** *AIAA Aircraft Technology, Integration, and Operations Technical Forum (ATIO 2002)*  
Antoine, N. E., Kroo, I. M.  
AMER INST AERONAUT ASTRONAUT.2004: 790-97
- **Fleet Assignment Using Collective Intelligence**  
Antoine, N., Bieniawski, S., Kroo, I.  
2004
- **Aeronautical Applications of Evolutionary Design**  
Kroo, I.  
2004
- **Computational Investigation of Airfoils with Miniature Trailing Edge Control Surfaces**  
Lee, H., Kroo, I.  
2004

- **Innovations in Aeronautics – Dryden Lectureship in Research**  
Kroo, I.  
2004
- **Computational Investigation of Wings with Miniature Trailing Edge Control Surfaces**  
Lee, H., Kroo, I.  
2004
- **A Framework for Aircraft Conceptual Design and Environmental Performance Studies**  
Antoine, N., Kroo, I.  
2004
- **Discrete, Continuous, and Constrained Optimization Using Collectives**  
Bieniawski, S., Kroo, I.  
2004
- **Multi-fidelity Design Optimization of Low-boom Supersonic Business Jets**  
Choi, S., Alonso, J., Kroo, I.  
2004
- **Distributed Multidisciplinary Design and Collaborative Optimization**  
Kroo, I.  
2004
- **Collectives and Complex System Design**  
Kroo, I.  
2004
- **Optimizing Aircraft Design and Fleet Composition for Environmental Compliance**  
Antoine, N., Kroo, I.  
2004
- **Development and Testing of an Experimental Aeroelastic Model with Micro-Trailing Edge Effectors**  
Bieniawski, S., Kroo, I.  
2003
- **NATO Course in Novel Aircraft Design Concepts for the 21st Century** *Instituto Superior Técnico Centro de Congressos, Lisbon PORTUGAL*  
Kroo, I.  
2003
- **Design-Oriented Aerodynamic Analysis for Supersonic Laminar Flow Wings**  
Kroo, I., Sturdza, P.  
2003
- **Aeroelastic design optimization of a two-spar flexible wind-tunnel model** *JOURNAL OF AIRCRAFT*  
Borglund, D., Kroo, I. M.  
2002; 39 (6): 1074-1076
- **Mesoscale flight and miniature rotorcraft development** *Conference on Fixed, Flapping and Rotary Wing Aerodynamics at Very Low Reynolds Numbers*  
Kroo, I., Kunz, P.  
AMER INST AERONAUTICS & ASTRONAUTICS.2002: 503–517
- **Optimizing Aircraft and Operations for Minimum Noise**  
Antoine, N., Kroo, I.  
2002
- **Aircraft Optimization for Minimal Environmental Impact**  
Antoine, N., Kroo, I.  
2002

- **Flutter Suppression for High Aspect Ratio Flexible Wings Using Microflaps**  
Lee, H., Kroo, I., Bieniawski, S.  
2002
- **Analysis and design of airfoils for use at ultra-low Reynolds numbers** *Conference on Fixed, Flapping and Rotary Wing Aerodynamics at Very Low Reynolds Numbers*  
Kunz, P. J., Kroo, I.  
AMER INST AERONAUTICS & ASTRONAUTICS.2002: 35–60
- **Drag due to lift: Concepts for prediction and reduction** *ANNUAL REVIEW OF FLUID MECHANICS*  
Kroo, I.  
2001; 33: 587-617
- **Collaborative optimization using response surface estimation** *AIAA JOURNAL*  
Sobieski, I. P., Kroo, I. M.  
2000; 38 (10): 1931-1938
- **Design and Development of the SWIFT - A Foot-Launched Sailplane**  
Kroo, I.  
2000
- **Supersonic Civil Transport Design Using Collaborative Optimization**  
Kroo, I.  
2000
- **Aeroservoelastic Control Using Redundant Microactuators**  
Kroo, I., Prinz, F., Eaton, J.  
2000
- **Development of the Mesicopter - A miniature autonomous rotorcraft**  
Kroo, I.  
2000
- **A 2D multidisciplinary design method for boundary layer ingesting inlets** Rodriguez  
David, L., Kroo, Ilan, M.  
1999
- **Multidisciplinary optimization of a natural laminar flow supersonic aircraft** Manning  
Valerie, M., Kroo, I.  
1999
- **Boundary layer calculations for preliminary design of wings in supersonic flow** Sturdza, Peter, Manning  
Valerie, M., Kroo, I., Tracy, M., Richard, R.  
1999
- **Aerodynamic Concepts For Future Aircraft**  
Kroo, I.  
1999
- **Test Techniques for Small-Scale Research Aircraft** *AIAA 98-2726*  
Tigner, B., Kroo et. al., I.  
1998
- **Advanced Configurations for Very Large Transport Airplanes** *AIAA 98-0439*  
McMasters, J., Kroo, I.  
1998
- **Small-Scale UAV's for Flight Research**  
Kroo, I., Tigner, B.  
1998

- **Aeroelastic Design and Control Gain Scheduling of the Blended Wing Using a Collocation Method** *AIAA 98-4831*  
Holden, M., Tigner, B., Kroo, I.  
1998
- **UAV Aeroelastic Control Using Redundant Microactuators**  
Kroo, I., Prinz, F., Eaton, J.  
1998
- **Concurrent Wing Design and Flight Path Optimization Using Optimizer-Based Decomposition** *AIAA 98-4920*  
Altus, S., Kroo, I.  
1998
- **The Challenge and Promise of Blended Wing Body Optimization** *AIAA 98-4736*  
Wakayama, S., Kroo, I.  
1998
- **Response Surface Estimation and Refinement in Collaborative Optimization** *AIAA 98-4753*  
Sobieski, I., Manning, V., Kroo, I.  
1998
- **Collaborative approach to launch vehicle design** *AIAA/USAF/NASA/ISSMO 6th Symposium on Multidisciplinary Analysis and Optimization*  
Braun, R. D., Moore, A. A., Kroo, I. M.  
AMER INST AERONAUT ASTRONAUT.1997: 478-86
- **Induced drag computations on wings with accurately modeled wakes** *JOURNAL OF AIRCRAFT*  
Smith, S. C., Kroo, I. M.  
1997; 34 (2): 253-255
- **MDO for large-scale design** *ICASE/NASA Langley Workshop on Multidisciplinary Design Optimization*  
Kroo, I.  
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- **Induced Drag Computations on Wings with Accurately-Modeled Wakes** *AIAA Journal of Aircraft*  
Smith, S., C., Kroo, I.  
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Kroo, I.  
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- **A genetic algorithm for scheduling and decomposition of multidisciplinary design problems** *JOURNAL OF MECHANICAL DESIGN*  
Altus, S. S., Kroo, I. M., Gage, P. J.  
1996; 118 (4): 486-489
- **Decomposition and Collaborative Optimization for Large Scale Aerospace Design** *In Multidisciplinary Design Optimization: State of the Art*  
Kroo, I.  
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- **Aerodynamic and structural analysis and optimization for conceptual design of supersonic transports**  
Omukai, T., Kroo, I.  
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- **Development and Application of the Collaborative Optimization Architecture in a Multidisciplinary Design Environment** *In Multidisciplinary Design Optimization: State of the Art*  
Braun, R., D., Kroo, I., M.  
edited by Alexandrov, N., Hussaini, M., Y.  
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- **Using Collocation Methods for Aeroelastic Optimization**

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- Holden, M., Kroo, I.  
1996
- **Using Automatic Differentiation with the Quasi-Procedural Method for Multidisciplinary Design Optimization**  
Hovland, P., Altus, S., Kroo, I., Bischof, C.  
1996
  - **Structural Optimization for Joined Wing Synthesis** *Journal of Aircraft*  
Gallman, J., Kroo, I.  
1996; 33 (1): 214-223
  - **A Collocation Method for Aeroelastic Optimization**  
Holden, M., Kroo, I.  
1996
  - **Use of the Collaborative Optimization Architecture for Launch Vehicle Design**  
Braun, R., D., Kroo, I., M., Moore, A., A.  
1996
  - **Implementation and Performance Issues in Collaborative Optimization**  
Braun, R., Gage, P., Kroo, I., Sobieski, I.  
1996
  - **Highly Nonplanar Lifting Systems** *a hypertext version of a paper presented at the Transportation Beyond 2000 workshop at NASA Langley Research Center*  
Kroo, I., McMasters, J., Smith, S., C.  
NASA CP.1996: 331-370
  - **Aircraft Design Using Collaborative Optimization**  
Sobieski, I., P., Kroo, I., M.  
1996
  - **VARIABLE-COMPLEXITY GENETIC ALGORITHM FOR TOPOLOGICAL DESIGN** *AIAA JOURNAL*  
Gage, P. J., Kroo, I. M., Sobieski, I. P.  
1995; 33 (11): 2212-2217
  - **SUBSONIC WING PLANFORM DESIGN USING MULTIDISCIPLINARY OPTIMIZATION** *JOURNAL OF AIRCRAFT*  
Wakayama, S., Kroo, I.  
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  - **COMPARISON OF 2 MULTIDISCIPLINARY OPTIMIZATION STRATEGIES FOR LAUNCH-VEHICLE DESIGN** *JOURNAL OF SPACECRAFT AND ROCKETS*  
Braun, R. D., POWELL, R. W., Lepsch, R. A., STANLEY, D. O., Kroo, I. M.  
1995; 32 (3): 404-410
  - **INTERPLANETARY TRAJECTORY OPTIMIZATION USING A GENETIC ALGORITHM** *JOURNAL OF THE ASTRONAUTICAL SCIENCES*  
Gage, P. J., Braun, R. D., Kroo, I. M.  
1995; 43 (1): 59-75
  - **Comparison of Two Multidisciplinary Optimization Strategies for Launch Vehicle Design** *Journal of Spacecraft & Rockets*  
Braun, R., D., Powell, R., W., Lepsch, R., A., Stanley, D., O., Kroo, I., M.  
1995; 32 (3): 404-410
  - **Use of the Collaborative Optimization Architecture in a Multidisciplinary Design Environment**  
Braun, R., D., Kroo, I., M.  
1995
  - **A Collaborative Approach to Trajectory Optimization**  
Braun, R., D., Kroo, I., M.  
1995



- **Representation issues for design topological optimization by genetic methods** *8th International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems (IEA/AIE-95)*  
Gage, P. J., Kroo, I. M.  
GORDON AND BREACH SCIENCE PUBL.1995: 383-388
- **Multidisciplinary Optimization Methods for Aircraft Preliminary Design**  
Kroo, I., Altus, S., Braun, R., Gage, P., Sobieski, I.  
1994
- **Multidisciplinary Optimization for Aircraft Preliminary Design** *AIAA 94-4325*  
Kroo, I., Altus, S., Braun, R., Gage, P., Sobieski, I.  
1994
- **Multidisciplinary Optimization Strategies for Launch Vehicle Design**  
Braun, R., D., Powell, R., W., Lepsch, R., A., Stanley, D., O., Kroo, I., M.  
1994
- **Interplanetary Trajectory Optimization Using a Genetic Algorithm**  
Gage, P., J., Braun, R., D., Kroo, I., M.  
1994
- **Post-Optimality Analysis in Aircraft Design**  
Braun, R., D., Kroo, I., M., Gage, P., J.  
1993
- **A Role for Genetic Algorithms in a Preliminary Design Environment**  
Gage, P., Kroo, I.  
1993
- **An Interactive System for Aircraft Design and Optimization** *AIAA Paper #92-1190*  
Kroo, I.  
1992
- **Development of the Quasi-Procedural Method for Use in Aircraft Configuration Optimization**  
Gage, P., Kroo, I.  
1992
- **AERODYNAMIC AND STRUCTURAL STUDIES OF JOINED-WING AIRCRAFT** *JOURNAL OF AIRCRAFT*  
Kroo, I., GALLMAN, J., Smith, S.  
1991; 28 (1): 74-81
- **Development of the SWIFT** *Hang Gliding*  
Kroo, I., Beckman, E., Robbins, B., Morris, S., Porter, B.  
1991
- **AIRCRAFT DESIGN OPTIMIZATION WITH DYNAMIC PERFORMANCE CONSTRAINTS** *JOURNAL OF AIRCRAFT*  
Morris, S. J., Kroo, I.  
1990; 27 (12): 1060-1067
- **A Quasi-Procedural, Knowledge Based System for Aircraft Synthesis**  
Kroo, I., Takai, M.  
1988
- **PROPELLER-WING INTEGRATION FOR MINIMUM INDUCED LOSS** *JOURNAL OF AIRCRAFT*  
Kroo, I.  
1986; 23 (7): 561-565
- **Design and Analysis of Optimally-Loaded Lifting Systems** *an updated version of "A General Approach to Multiple Lifting Surface Analysis and Design," AIAA 84-2507*  
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1984

- **A FUNDAMENTAL COMPARISON OF CANARD AND CONVENTIONAL CONFIGURATIONS** *JOURNAL OF AIRCRAFT*

MCGEER, T., Kroo, I.

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- **A Quasi-Procedural Method for Aircraft Design** *AIAA 88-6502*

Kroo, I., Takai, M.

- **Oblique Wing Bibliography**

Kroo, I.