# Zachary del Rosario

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## Education

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|---|---|---|---|
| PhD | Stanford University | Aeronautical and Astronautical Engineering | 2020 |
| | *Co-advisors:* | *Gianluca Iaccarino and Art B. Owen* | |
| MS | Stanford University | Aeronautical and Astronautical Engineering | 2018 |
| BS | Olin College of Engineering | Mechanical Engineering | 2014 |

## PhD Thesis

"Precision Margin: Rigorous Tools and Strategies for Aircraft Design Under Uncertainty"

Competitive aircraft design walks a fine line, balancing weight reduction with aircraft safety. Design tends to lean conservative, with cascaded margins to address uncertainties. This thesis introduces design margins that *provably* yield minimal weight penalties at desired levels of safety. Comparisons against industry standards, tractable approximations, and ramifications for both conceptual and detailed design are considered.

## Grants and Fellowships

| Source | For | Size | |
|---|---|---|---|
| DIF Grant, Vice Provost for Graduate Education<br>*Grant to support outreach activities, Stanford internal* | SeeME | $1,500 | 2019 |
| Teaching Advancement Grant, Vice Provost for Teaching and Learning<br>*Travel grant to attend NABI summit 2019, Stanford internal* | SeeME | ~$470 | 2019 |
| SPICE Grant, Vice Provost for Graduate Education<br>*Grant to support club activities, Stanford internal* | ASEE | $2,500 | 2018 |
| Teaching Advancement Grant, Vice Provost for Teaching and Learning<br>*Travel grant to attend ASEE Annual Conference 2018, Stanford internal* | ASEE | ~$800 | 2018 |
| Diversifying Academia, Recruiting Excellence (DARE) Fellowship<br>*Competitive fellowship for promising faculty candidates, Stanford internal* | - | ~$116,000 | 2018 |
| Statistical Perspectives on UQ (SPUQ) travel award<br>*Travel grant to attend SPUQ 2017, SAMSI-funded* | - | $500 | 2017 |
| Stanford Speaker's Bureau Co-sponsorship<br>*Pitch-based funding for ASEE Colloquium 2017, Stanford internal* | ASEE | $1,500 | 2017 |
| NSF Graduate Research Fellowship | - | ~$300,000 | 2015 |

## Honors and Awards

Stanford MECON Oral Presentation award, 1st place 2017
*Mechanical Engineering Department-sponsored speaker competition*

AIAA Jefferson Goblet Best Student Paper 2017
*Highest honor for student papers at AIAA SciTech annual conference*

## Publications

### Peer-reviewed research papers

1. del Rosario, Z., R. Fenrich, and G. Iaccarino (2019). Cutting the Double Loop: Theory and Algorithms for Reliability-Based Design Optimization with Parametric Uncertainty. *International Journal for Numerical Methods in Engineering*. eprint: https://doi.org/10.1002/nme.6035.
2. del Rosario, Z., G. Iaccarino, and R. W. Fenrich (2019). Fast Precision Margin with the First-Order Reliability Method. *AIAA Journal*. eprint: https://doi.org/10.2514/1.J058345.
3. del Rosario, Z., M. Lee, and G. Iaccarino (2019). Lurking Variable Detection via Dimensional Analysis. *SIAM / ASA Journal on Uncertainty Quantification*. eprint: https://doi.org/10.1137/17M1155508.

### Papers in conference proceedings

4. del Rosario, Z., R. W. Fenrich, and G. Iaccarino (2020). When are Design Allowables Conservative? In: *AIAA SciTech 2020 Forum*.

5. del Rosario, Z., R. W. Fenrich, and G. Iaccarino (2019). Beyond Basis Values: Fast Precision Margin with FORM. In: 21st AIAA Non-Deterministic Approaches Conference.
6. del Rosario, Z., R. W. Fenrich, and G. Iaccarino (2019). Margin as Model: Some Answers to "How Many Tests Should I Perform?". In: *AIAA Aviation 2019 Forum*.
7. del Rosario, Z., A. Towne, and G. Iaccarino (2018). Dimension Reduction for Shape Design Insight. In: 20th AIAA Non-Deterministic Approaches Conference.
8. del Rosario, Z., P. Constantine, and G. Iaccarino (2017). Developing Design Insight Through Active Subspaces. In: 19th AIAA Non-Deterministic Approaches Conference.

### Pre-prints and Submissions

9. del Rosario, Z., Y. Kim, M. Rupp, E. Antono, and J. Ling (2019). Assessing the Frontier: Active Learning, Model Accuracy, and Multi-objective Materials Discovery and Optimization. *arXiv preprint arXiv:1911.03224*. Submission Imminent.
10. Jofre-Cruanyes, L., Z. del Rosario, and G. Iaccarino (2019). Data-driven dimensional analysis of heat transfer in irradiated particle-laden turbulent flow. *International Journal of Multiphase Flow*. Submitted.
11. Constantine, P. G., Z. del Rosario, and G. Iaccarino (2017). Data-driven dimensional analysis: algorithms for unique and relevant dimensionless groups. *arXiv preprint arXiv:1708.04303*. Forthcoming in JCP.
12. Constantine, P. G., Z. del Rosario, and G. Iaccarino (2016). Many physical laws are ridge functions. *arXiv preprint arXiv:1605.07974*.

## Presentations

### Invited talks

13. del Rosario, Z. (2019). Aircraft Design Under Uncertainty. In: Harvey Mudd College Seminar.
14. del Rosario, Z. (2019). The Curse of Dimensionality: Problems and Strategies. In: NATO/STO Lecture Series: Uncertainty Quantification in Computational Fluid Dynamics. https://we.stanford.edu/LSUQ.
15. del Rosario, Z., R. Fenrich, and G. Iaccarino (2019). Principled Margin. In: Arevo, Inc.
16. del Rosario, Z. (2018). Lost in Hyperspace: The Curse of Dimensionality. In: Wellesley College student seminar.
17. del Rosario, Z. (2018). The Curse of Dimensionality: Problems and Strategies. In: von Karman Institute: Uncertainty Quantification in Computational Fluid Dynamics (STO-AVT 326).
18. del Rosario, Z., A. Towne, and G. Iaccarino (2018). Dimension Reduction for Shape Design Insight. In: Aerospace Computational Design Lab (ACDL) seminar, MIT.

### Conference talks

19. del Rosario, Z. (2019). Machine Learning for Materials Property Prediction. In: North American Solid State Chemistry Conference.
20. del Rosario, Z. (2019). Stanford SeeME: Student-driven research within an R1 institution. In: National Alliance for Broader Impacts (NABI) Summit.
21. del Rosario, Z., A. Banko, A. Horwitz, and G. Iaccarino (2018). Data-Driven Physical Inquiry: Discovering Relevant Dimensionless Numbers With Physics-Constrained Machine Learning. In: 71th Annual Meeting of the American Physical Society, Division of Fluid Dynamics.
22. del Rosario, Z., A. Towne, and G. Iaccarino (2018). Dimension Reduction for Shape Design Insight. In: Thermal, Fluid science Sponsors, and Affiliates conference (TFSA).
23. del Rosario, Z., P. Constantine, and G. Iaccarino (2017). Algorithm-Driven Insight. In: Thermal and Fluid Science Affiliates Conference.
24. del Rosario, Z., P. Constantine, and G. Iaccarino (2017). Data-Driven Dimensional Analysis. In: CompFest.
25. del Rosario, Z., M. Lee, and G. Iaccarino (2017). Discovering Hidden Controlling Parameters using Data Analytics and Dimensional Analysis. In: 70th Annual Meeting of the American Physical Society, Division of Fluid Dynamics.
26. del Rosario, Z., A. Towne, and G. Iaccarino (2017). Handling Classes of Variables in Dimension Reduction. In: SIAM Workshop on Parameter Space Dimension Reduction (DR17).

### Poster presentations

27. del Rosario, Z. and G. Iaccarino (2017). Hidden Parameter Hypothesis Testing. In: Statistical Perspectives on Uncertainty Quantification.

28. Torres, H., Z. del Rosario, and G. Iaccarino (2017). MCRT. In: WEST Conference.

## Teaching Experience

### Course Instruction

Uncertainty Quantification, (ME 470) Stanford — Spring 2019
*Designed, implemented, and delivered graduate-level elective course for 9 advanced students. Taught using a mixture of lecture and evidence-based methods. Sought professional consultation for mid-quarter feedback and implemented changes.*

Uncertainty Quantification, (ME 470) (Two lectures) Stanford — Winter 2018
*Guest lecturer. Developed two lectures plus supporting notes, and designed a homework to reinforce content. Iterated on this content in 2019.*

### Academic Workshops

Materials Informatics Workshop, (Citrine Informatics) Georgia Tech — 2019
*Designed and facilitated a two-day workshop on materials informatics at Georgia Tech, sponsored by the Institute for Materials. Led a team of 7 TA's to teach ∼ 15 participants.*
https://citrineinformatics.github.io/ga-tech-workshop/

Teacher Workshops, (SeeME) Stanford — 2019
*Developed and delivered workshops on the fundamentals of teaching, including lessons on learning goals and The 5E Model. Ran workshops for audiences of ∼ 10.*

Groupwork Workshop, (VPTL Consultant) Stanford — 2018-2019
*Co-developed and delivered workshop on evidence-based best-practices for groupwork in the classroom. Digested, summarized, and applied education literature, designed hands-on activities, co-facilitated workshop on several occasions for audiences of ∼ 16.*

### External Outreach

Intro to Exploratory Data Analysis, (SeeME) Stanford — 2016
*Introductory hands-on class to introduce students to principles of visualization, exploring data, understanding trends, and basic causal reasoning.*
https://github.com/zdelrosario/teaching-eda

"What the heck is engineering?", (Splash) Stanford — 2014-2015
*Introductory discussion-based class meant to introduce middle- and high-school aged students to engineering as a profession.*

### Assistantships

Applied Aerodynamics, (AA 200) Stanford — 2016
*Held office hours, graded homeworks and exams.*

Partial Differential Equations, Olin College — 2014
*Held office hours, graded homeworks and exams.*

Machine Shop Instructor, Olin College — 2014
*Taught basic machine shop operations, milling, turning, shop safety.*

Transport Phenomena, Olin College — 2013
*Heat transfer and fluid mechanics; held office hours, graded homeworks and exams.*

Linearity, Olin College — 2012
*Introductory linear algebra; held office hours, graded homeworks and exams.*

## Teaching Competencies

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|---|---|
| Mathematics | Linear Algebra, Ordinary/Partial Differential Equations, Numerical Analysis, Optimization |
| Statistics | Probability, Estimation, (Multivariate) Regression, EDA, Machine Learning |
| Engineering | Fluid Dynamics, Solid Mechanics, Aerodynamics, Human-centered Design |
| Languages | Python (Numpy/Scipy, Pandas, Matplotlib), R (Tidyverse) |

## Mentoring

| Mentee | Project advised | |
|---|---|---|
| Gitanjali Bhattacharjee | Former student (ME 470) used sensitivity analysis to study transit network reliability and bridge retrofitting. Focused on modeling decision processes and uncertainty arising from bridge fragility. Connected student to experts on sensitivity analysis. | 2019 |
| Sita Syal | Former student (ME 470) performed soft cost analysis for solar farm leasing. Focused on modeling cost uncertainties and advised student on how to strategically leverage her NREL contacts in her research agenda. | 2019 |
| Mark Benjamin | Rotation student investigated reliability-based design optimization strategies, focusing on comparing various density-matching approaches. | 2018 |

| Writing Consultee | Outcome | |
|---|---|---|
| Cindy Nguyen | NSF GRFP; Stanford, Electrical Engineering | 2019 |
| Larissa Little | NDSEG; Harvard, Materials Science | 2018 |
| Mason del Rosario | NSF GRFP Honorable Mention; UC Davis, Electrical Engineering | 2018 |
| Rongfei Lu | Stanford, Aeronautics and Astronautics | 2018 |
| Emma (Zeyan) Xu | NSF GRFP; Columbia, Material Science | 2017 |

## Employment

**Statistical Consultant** (Citrine Informatics) October 2019-Present

*Supporting government-funded research projects with numerical and graphical statistical analyses. Co-author on resulting publications.*

**Instructional Designer and Data Scientist** (Citrine Informatics) Summer 2019

*Developed and delivered 2-day workshop at Georgia Tech on Materials Informatics. Developed novel strategies for active learning in support of materials discovery.*

**Teaching Consultant** (Stanford VPTL) 2018-Present

*Professional teaching consultant, employed by the office of the Vice Provost for Teaching and Learning (VPTL). Used training in pedagogy and mentorship to carry out consultations with fellow graduate students. Co-facilitated various workshops, and co-developed novel workshop material on Groupwork.*

**Research intern** (Northrop Grumman Corporation) Summer 2017

*Developed statistical methods to identify anomalies in time series data. Supported exoplanet detection research team.*

## Service and Leadership

**Co-Chair** (ASEE, Task Force on Graduate Student Affairs) 2019-Present

*Appointed by the president of the American Society for Engineering Education (ASEE) national organization to co-chair a task force studying how our professional society can serve graduate students.*

**President** (American Society for Engineering Education, Stanford Chapter) 2018-2019

*Led and served on a 5-person organizing team. Organized a seminar sequence with internal and external speakers. Directed a Colloquium event attended by 70 persons, featuring workshops on "The Fundamentals of Teaching."*

**Founder and Director of Curriculum** (SeeME) 2017-Present

*Co-founded Stanford Mechanical Engineering's student-run research outreach program SeeME. Developed and delivered workshops to train grad student instructors. Wrote grants to support operations and conference travel. Served as program leader and interfaced with the Department Chair.*

**Financial Officer** (American Society for Engineering Education, Stanford Chapter) 2017-2018

*Served on 4-person organizing team. Wrote and won grants to fund speaker series and Colloquium. Point person on organizing seminar sequence.*

**Chair of Teacher Development** (Stanford Splash) 2014-2016

*Served on 20-person organizing team serving thousands of high school students. Owned our teacher training program; co-facilitated workshops to introduce Stanford students to the basics of teaching. Enhanced teacher evaluations by introducing new survey system.*

**Robotics Mentor** (FIRST Robotics, Team 751) 2014-2016

*Volunteered on 3-mentor team for a high-school robotics program. Taught machine shop operations (milling and turning), mechanical design and drawing, coordinated travel logistics for away competitions.*

## Media Appearances

- ASEE Prism, October 2019
- Stanford Daily, January 2019
- Stanford News, April 2018

## Licenses and Certifications

- Private Pilot, Single engine land, Certificate Number 3386055
- Amateur radio operator, Technician Class, call sign KC3HMT

## Skills

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|---|---|
| Academic | Linear Algebra, Aerodynamics, Optimization, Statistics, User-Centered Design |
| Computer | Python, R/Tidyverse, c++, MATLAB, MPI, Legion/Regent, Unix, SolidWorks, LaTeX |
| Machine Shop | Manual and CNC milling, Manual turning, Laser cutting |

The Analyst's Entreaty:
"Grant me the insight to neglect the terms I do not need,
Tenacity to understand strange interactions,
And wisdom to know the (significant) difference."