

# Gabriel J. Soto

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## Research Interests

Modeling and simulation, systems engineering, nuclear energy, energy systems, optimization techniques, software development and design

## Education

**2015-2020**    PhD in Aerospace Engineering - [Cornell University](#)

Thesis: "Orbital Design Tools and Scheduling Techniques for Optimizing Space Science and Exoplanet-Finding Missions"

*Committee* - Dmitry Savransky, Richard Rand, Philip Nicholson

*Major Area* - Dynamics, System and Controls

*Minor Area* - Astrophysics

**2015-2018**    Master of Science in Aerospace Engineering - [Cornell University](#)

"Orbital Design and Scheduling Techniques for Space Science and Exoplanet-Finding Missions"

**2011-2015**    Bachelor of Science - [University of Miami](#)

Senior Project: "CANESat: Customizable Apparatus for Nano-Experimentation Satellite"

*Aerospace Engineering*            GPA: 3.97

*Dual Major in Physics*            GPA: 4.00

## Research and Professional Experience

**Oct 2020 - Present**    [Optimization of Integrated Energy Systems, University of Wisconsin-Madison, Madison, WI](#)

*Post-Doctoral Research Associate*

- Augmented existing C++ codebase (SSC) with combined lead-cooled fast reactor (LFR) and molten salt thermal energy storage (TES) model
- Added modeling capabilities for coupled concentrated solar plant, LFR and TES to codebase
- Planned addition of multi-effect desalination model to SSC
- Implemented mixed-integer programming optimization scheme to maximize production and profitability of coupled systems
- Developed mixed-mode debugging utilities in Linux
- Designed Python architecture to interface between SAM, Pyomo and RAVEN calls

**Software Used:** Python, C++, Pyomo, SAM/SSC, RAVEN, Linux, Bash, CMake, Sphinx

**Funded By:** United States Department of Energy

**Collaborators:** Idaho National Laboratory (INL), National Renewable Energy Laboratory (NREL), Westinghouse Electric Company

- Feb 2021 - Present** - [Prognostic Health Monitoring of Nuclear Plant, University of Wisconsin-Madison, Madison, WI](#)  
*Post-Doctoral Research Associate*
- Developed Python code for extracting control rod and reactor vessel fluence from VERA runs
  - Created database for reduced-order models of rod and vessel remaining usable life (RUL) as a function of operating modes
  - Designed optimization scheme for flexible power operation of small-modular reactors with regards to RUL and fuel burnup
- Technologies:** VERAView, Python  
**Funded By:** United States Department of Energy  
**Collaborators:** NuScale Power Plant, University of Tennessee-Knoxville, University of Michigan, Idaho National Laboratory (INL)
- Sep 2016 - Aug 2020** - [Starshade Observation Scheduling, Cornell University, Ithaca, NY](#)  
*Lead Graduate Researcher*
- Solved boundary value problems between occulter positions relative to halo orbit
  - Parameterized  $\Delta v$  expended between transfers and transfer time to maximize number of exoplanet observations
  - Optimally scheduled observations for a starshade direct imaging telescope mission
  - Developed fuel consumption heuristics for use in end-to-end mission simulations
  - Investigated the impedance of starshade station-keeping burns during observations
  - Proposed a framework for determining the optimal stars and times for the least interrupted and most fuel conservative observations
- Technologies:** Python  
**Funded By:** NASA Roses XRP - "Science Yield Modeling for the WFIRST-AFTA Coronagraph" Imaging Mission"  
 NASA JPL SURP - "Advanced Simulation and Modeling for Starshade-based Exoplanet Imaging Missions"
- Jun 2018 - Apr 2019** - [Solar Sail Self-Assembling Space Telescope, Cornell University, Ithaca, NY](#)  
*Lead Graduate Researcher*
- Developed numerical techniques for solving optimal control of solar sail-powered spacecraft
  - Created tools for studying design space of solar sails and payloadmass in these missions
  - Generated Lissajous orbits in the Sun-Earth L2 vicinity
  - Aided an MEng student in generating rendezvous trajectories for the spacecraft
- Technologies:** Python  
**Funded By:** NASA NIAC Grant - "Modular Active Self-assembling Space Telescope Swarms"
- Oct 2015 - Aug 2017** - [Zodiacal Light Imaging Mission, Cornell University, Ithaca, NY](#)  
*Lead Graduate Researcher*
- Created CONOPS and orbital requirements for a high inclination SmallSat mission to image zodiacaldust in our solar system
  - Developed an algorithm to maximize orbital height above ecliptic plane after a planetary flyby creating a 1:1 resonant orbit with the Earth
  - Minimized fuel required for corrective orbital maneuvers in heliocentric frame to achieve planetary flyby
- Technologies:** MATLAB, NASA Spice Toolkit  
**Funded By:** NASA JPL SURP - "Formulation of a Zodiacal Light Imaging Mission"
- Oct 2014 - May 2015** - [NASA Robotic Mining Competition, NASA Kennedy Space Center, Cape Canaveral, FL](#)  
*Robotic Mining Team Systems Engineer*
- Coordinated interdisciplinary team in collaboration with IEEE, ASME, and AIAA UM chapters
  - Led team of 10 engineering and computer science students in designing a remotely operated robotic craft
  - Developed an Arduino program for remote operation of wheel motors and linear actuators
- Technologies:** Arduino, SolidWorks, MATLAB

**Aug 2014 -** [Senior Capstone Project, University of Miami, Miami FL](#)  
**May 2015** *Structures and Thermal Design Team*

- Created three alternate chassis designs to accommodate electrical, attitude, and heat shield components
- Integrated heat shield and re-entry module with a standard 1U CubeSat design
- Developed concept of operations and framework for Command and Data Handling subsystem

**Technologies:** SolidWorks, MATLAB

**May 2014 -** [ThermoFluids Lab, George Washington University, Washington, D.C.](#)  
**Aug 2014** *Undergraduate Research Assistant*

- Assembled large acrylic and stainless steel tanks and structural supports
- Fabricated structures in acrylic and stainless steel using a drill press, vertical mill, and lathe
- Modeled camera mounts to withstand vibrations on the GW-NSF Shake table
- Measured refractive index of p-cymene and cinnamaldehyde sample for index matching in PIV measurements
- Designed experiments to measure density and viscosity of various p-cymene and cinnamaldehyde mixtures

**Technologies:** Pro-Engineer, MATLAB

**Sep 2013 -** [FUNSAT Competition, Florida Space Grant Consortium, Cape Canaveral, FL](#)  
**May 2014** *Structures and Thermal Design Team*

- Designed the chassis and arrangement of inner components using SolidWorks
- Analyzed potential stress and vibrational loads through launch to ensure safety of spacecraft
- Determined thermal conditions in LEO for thermal failure modes

**Technologies:** SolidWorks, MATLAB

## Teaching Experience

**Jan 2018 -** Cornell University, Ithaca, NY  
**May 2018** *Lead Teaching Assistant*

- Coordinated recitation sections focused on problem solving techniques
- Taught introductory lecture on MATLAB and programming
- Designed dynamics problems for recitations sections

**Jan 2016 -** Cornell University, Ithaca, NY  
**May 2016** *Teaching Assistant*

- Led two recitation sections a week which focused on problem solving techniques in an active teaching environment
- Provided two office hours a week, answered students' questions on the subject of Dynamics
- Constructed fair and effective rubrics for grading both homework assignments as well as examinations

**Jan 2015 -** Academic Resource Center, University of Miami, Miami, FL  
**May 2015** *Lead Tutor*

- Tutored 15-17 students a week in the same mathematics, physics, and engineering topics
- Led two review sessions for University Physics II and Calculus II during finals week
- Served as a mentor for students as well as new tutors in engineering, physics, and mathematics

**Sep 2013 -** Academic Resource Center, University of Miami, Miami, FL

**Dec 2014** *Peer Tutor*

- Aided 8-10 students a week in understanding topics and study skills in Calculus, Physics, and Mechanical Engineering
- Led a review session for Calculus I during finals week

## Publications

### ■ Peer-Reviewed Journal Articles

**Soto, G.,** Savransky, D., Morgan, R., (2021) "Analytical Model for Starshade Formation Flying with Applications to Exoplanet Direct Imaging Observation Scheduling" *Journal of Astronomical Telescopes, Instruments, and Systems*. [Link](#).

**Soto, G.,** Savransky, D., Garrett, D., Delacroix, C. (2019) "Parameterizing the Search Space of Starshade Fuel Costs for Optimal Observation Schedules" *Journal of Guidance, Control, and Dynamics*. [Link](#).

### ■ Conference Proceedings

**Soto, G.,** Gustafson, E., Savransky, D., Shapiro, J., Keithly, D. (2019) "Solar Sail Trajectories and Orbit Phasing of Modular Spacecraft for Segmented Telescope Assembly About Sun-Earth L2" *Proceedings of the 2019 AAS/AIAA Astrodynamics Specialists Meeting*

**Soto, G.,** Keithly, D., Garrett, D., Delacroix, C., Savransky, D. (2018) "Optimal Starshade Observation Scheduling" *Proceedings of the SPIE Space Telescopes and Instrumentation 2018: Optical, Infrared, and Millimeter Wave*; doi: 10.1117/12.2311771. [Link](#).

**Soto, G.,** Sinha, A., Savransky, D., Delacroix, C., Garrett, D. (2017) "Starshade Orbital Maneuver Study for WFIRST." *Proceedings of the SPIE Techniques and Instrumentation for Detection of Exoplanets VIII Conference*; doi: 10.1117/12.2273568. [Link](#).

**Soto, G.,** Lloyd, J., Savransky, D., Grogan, K., Sinha, A. (2017) "Optimization of high-inclination orbits using planetary flybys for a zodiacal light-imaging mission." *Proceedings of the SPIE Techniques and Instrumentation for Detection of Exoplanets VIII Conference*; doi: 10.1117/12.2274069. [Link](#).

■ **Contributing Author**

Keithly, D. R., Savransky, D., Garrett, D., Delacroix, C., **Soto, G.**, (2020) “Optimal scheduling of exoplanet direct imaging single-visit observations of a blind search survey” *Journal of Astronomical Telescopes, Instruments, and Systems*; doi:10.1117/1.JATIS.6.2.027001 [Link](#).

Morgan, R., Savransky, D., Stark, C., Nielsen, E., Cady, E., Dula, W., Dulz, S., Horning, A., Mamajek, E., Mennesson, B., Newman, P., Plavchan, P., Robinson, T., Ruane, G., Sirbu, D., **Soto, G.**, Turmon, M., Turnbull, M., (2019) “The Standard Definitions and Evaluation Team Final Report: A Common Comparison of Exoplanet Yield” *NASA Jet Propulsion Laboratory* [Link](#).

Morgan, R., Savransky, D., Turmon, M., Mennesson, B., Mamajek, E., Shaklan, S., **Soto, G.**, Stapelfeldt, K., Dula, W., Keithly, D., (2019) “Standard Exoplanet Yield Evaluation for the LUVOIR and HabEx Concept Studies” *Proceedings of SPIE Techniques and Instrumentation for Detection of Exoplanets IX*; doi: 10.1117/12.2530668 [Link](#).

Shapiro, J., Keithly, D., **Soto, G.**, Savransky, D., Gustafson, E. , (2019) “Optical Design of a Modular Segmented Space Telescope” *Proceedings of SPIE Astronomical Optics: Design, Manufacture, and Test of Space and Ground Systems II*; doi: 10.1117/12.2529816 [Link](#).

D. Savransky, D. Keithly, J. Shapiro, **G. Soto**, E. Gustafson, K. Liu, and C. Della Santina, (2019) “Modular Active Self-Assembling Space Telescope Swarms” *NASA NIAC Final Report* [Link](#).

## Leadership Experience

**Jun 2019 -** SiGMA, Cornell University, Ithaca, NY  
**Jun 2020** *President*

**Nov 2018 -** Sibley Graduate Research Symposium (SGRS), Cornell University, Ithaca, NY  
**Jun 2019** *Marketing Director*

**Aug 2018 -** SiGMA, Cornell University, Ithaca, NY  
**Jun 2019** *Vice President*

**Aug 2017 -** SiGMA, Cornell University, Ithaca, NY  
**Jul 2018** *Social Committee Chair*

**Aug 2016 -** Sibley Graduate Research Symposium (SGRS), Cornell University, Ithaca, NY  
**Jan 2017** *Marketing Director*

**Oct 2014 -** Students for the Exploration and Development of Space (SEDS), University of Miami, Miami, FL  
**May 2015** *Co-founder*

**Aug 2014 -** Society of Hispanic Professional Engineers (SHPE), University of Miami, Miami, FL  
**May 2015** *Fundraising Chair*

**Aug 2014 -** American Institute of Aeronautics and Astronautics (AIAA), University of Miami, Miami, FL  
**May 2015** *Vice President*

## Awards and Honors

<b>Travel Award for 2nd Starshade SIP Forum</b>	February 2020
<b>McMullen Aerospace Fellowship</b>	August 2019
<b>AAS 233rd Meeting Honorable Mention for Poster Presentation</b>	January 2019
<b>Sibley Prize for Excellence in Graduate Teaching Assistance</b>	May 2018
<b>AAS 231st Meeting Honorable Mention for Poster Presentation</b>	January 2018
<b>Outstanding Lead Tutor Award</b>	April 2015
<b>Georgia Institute of Technology FOCUS Scholar</b>	January 2015
<b>Florida Space Grant Consortium FUNSAT Competition - Second Place in Florida</b>	May 2014

## Technical Strengths

- Python 2 and 3, LaTeX, C++
- MATLAB, Inkscape, SolidWorks
- Fluent in Spanish, Conversational German