JPL Publication 05-07

Summer Student Research Presentations

August 17 and 18, 2005

JPL Seminar Days

(SURF, MURF, NASA USRP, NASA Space Grant, PGGURP)

Carol Casey, Editor
Caltech Student-Faculty Programs Office, Pasadena, CA

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

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Abstract

In 2005, over 150 undergraduate students and first-year graduate students participated in a variety of research programs coordinated by the Jet Propulsion Laboratory Education Office in conjunction with the Caltech Student-Faculty Programs Office. The programs give students the opportunity to conduct research under the guidance of an experienced mentor for a 10-week period. Students gain valuable experience while contributing to the ongoing goals of JPL. Students are required to submit progress reports and an abstract, and to give an oral presentation of their projects to an audience of JPL staff and other students. This set of abstracts provides brief descriptions of the projects that were conducted by these students and their mentors. A schedule of student talks is also included.

Students presenting their work have come to JPL through one of the following programs: SURF – Summer Undergraduate Research Fellowships, MURF – MURF Undergraduate Research Fellowships, NASA USRP – Undergraduate Student Research Program, NASA Space Grant Work Force Development Program, and NASA PGGURP – Planetary Geology and Geophysics Undergraduate Research Program.

Acknowledgments

The authors wish to thank the following for their contributions to the success of the summer programs documented in this volume: Carolyn Ash, Caltech Student-Faculty Programs Office; Carol Hix, Linda Rodgers, and William M. Whitney, JPL Education Office; and Tracy K.P. Gregg, University at Buffalo.

Division 31

Session **A**

Date: Wednesday, August 17
Room: 126-225
Session Chair: Craig Peterson

1:40 - 2:00 PM	***Kelly A. Wallenstein*** Wellesley College	Team X Spacecraft Instrument Database Consolidation	Theresa M. Anderson *Member of the Technical Staff*
2:00 - 2:20 PM	***Shanna E. Andrew*** * University of Mississippi	Development of a New Approach to Instrument Model Design Used by Team X	Theresa M. Anderson *Member of the Technical Staff*
2:20 - 2:40 PM	***Brandon N. Huelman*** * University of Minnesota	Relevant Parameter Evolution in Team X Mission Concept Designs	Theresa M. Anderson *Member of the Technical Staff*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Chester Ong*** * Georgia Institute of Technology	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
3:10 - 3:30 PM	***Jennifer M. Needham*** * Rice University	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
3:30 - 3:50 PM	***Rashmi K. Sahai*** University of California, Los Angeles	Aerogel Development	Daniel E. Goods *Artist in Residence* Steven M. Jones *Scientist*
3:50 - 4:10 PM	***Matthew R. Otterstatter*** * University of Minnesota	Tools of the Future: How Decision Tree Analysis Will Impact Mission Planning	Elisabeth Lamassoure *Staff Systems Engineer*

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Division 31

Session **B**

Date: Wednesday, August 17
Room: 126-346
Session Chair: John Elliott

1:40 - 2:00 PM	***Katrina M. Hay*** * Oregon State University	A Perfect View of Vesta: Creating Pointing Observations for the Dawn Spacecraft on Asteroid 4 Vesta	Carol Polanskey *Dawn Science Systems Engineer*
2:00 - 2:20 PM	***Joseph M. Moholt*** * Montana State University, Bozeman	Asynchronous Messaging and Data Transfer in a Spacecraft: An Implementation	Amalaye Oyake *Member of the Technical Staff*
2:20 - 2:40 PM	***David C. Wang*** * Massachusetts Institute of Technology	BEAM Technology Flight Demonstration	Ryan M. Mackey *Senior Member of the Technical Staff*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Stephen C. Savin*** Princeton University	Analyzing MER Uplink Reports	Deborah Bass *Member of the Technical Staff* Roxana Wales *Research Scientist, NASA Ames Research Center*
3:10 - 3:30 PM	***Timothy M. Schriener*** * Oregon State University	Utilizing Radioisotope Power Systems for Human Lunar Exploration	John O. Elliott *Senior Engineer*
3:30 - 3:50 PM	***Greg M. Goldgof*** Stanford University	Designing and Implementing a Distributed System Architecture for the Mars Rover Mission Planning Software (Maestro)	Jeffrey S. Norris *Member of the Technical Staff* I-Hsiang Shu *Member of the Technical Staff*
3:50 - 4:10 PM	***Lucy Abramyan*** Harvey Mudd College	Activity Scratchpad Prototype: Simplifying the Rover Activity Planning Cycle	Jeffrey S. Norris *Member of the Technical Staff*

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Division 32 Session C

Date: Wednesday, August 17
Room: 171-118
Session Chair: Steve Ostro

1:20 - 1:40 PM	***James E. Hansen*** Black Hills State University	Pressures in Tumuli: A Study of Tumuli Formation	Suzanne Smrekar *Research Scientist*
1:40 - 2:00 PM	***Sarah F. Newman**** * Massachusetts Institute of Technology	Photometric and Spectral Study of the Saturnian Satellites	Bonnie J. Buratti *Principal Research Scientist*
2:00 - 2:20 PM	***Michael W. Busch**** * University of Minnesota	Asteroid Shape Reconstruction From Radar Observations	Steven J. Ostro *Senior Research Scientist*
2:20 - 2:40 PM	***Benjamin J. Pollard**** * University of Idaho	Irregular Wavelike Structure in Saturn's Rings	Linda J. Spilker *Principal Research Scientist*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Lyndsey D. Earl*** Reed College	Stable Isotope Characteristics of Jarosite: The Acidic Aqueous History of Mars	Max Coleman *Senior Research Scientist* Benjamin Brunner *Postdoctoral Scholar in Astrobiology*
3:10 - 3:30 PM	***Ellen R. Harju**** * University of Washington	Optical Characterization of Cryptoendolithic Chemical Biosignatures on Antarctic Sandstone Surfaces	Pamela G. Conrad *Member of the Technical Staff*
3:30 - 3:50 PM	***Erica R. Pantel*** Caltech	Effects of Cryogenic Temperatures on LEDs and Optical Fiber	Arthur L. Lane *Research Scientist*
3:50 - 4:10 PM	***Sara S. Van Nortwick*** University of Washington	Investigation of Solar Radiation Properties at the Battleship Promontory Area, Antarctica	Arthur L. Lane *Research Scientist*
4:10 - 4:30 PM	***Aditi Sharma**** * Louisiana State University	Distribution and Diversity of Organic and Biological Signatures in Soils From the Atacama Desert	Alexandre Tsapin *Research Scientist*

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Division 32

Session **D**

Date: Wednesday, August 17
Room: 202-230B
Session Chair: Joseph Carson

1:40 - 2:00 PM	***Rudra A. Roy*** Caltech	Satellite Validation: A Project to Create a Data-Logging System to Monitor Lake Tahoe	Simon Hook *Research Scientist* Ali A. Abtahi *Member of the Technical Staff*
2:00 - 2:20 PM	***Jeffrey J. Smith*** * University of California, Berkeley *JPLUS SURF Fellow*	A Population Study of Wide-Separation Brown Dwarf Companions to Main-Sequence Stars	Joseph C. Carson *Postdoctoral Scholar* Karl R. Stapelfeldt *Research Scientist*
2:20 - 2:40 PM	***Matthew A. Ferry*** * University of California, Berkeley	Building the Case for SNAP: Creation of Multi-Band, Simulated Images With Shapelets	Jason D. Rhodes *Scientist*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Lauren A. Porter*** Caltech	Determining the Locations of Brown Dwarfs in Young Star Clusters	Amanda K. Mainzer *Research Scientist*
3:10 - 3:30 PM	***Jonathan D. Hiller*** * University of Washington	Satellite Calibration With LED Detectors at Mud Lake	Carol J. Bruegge *Senior Scientist*
3:30 - 3:50 PM	***Jeffrey L. Sadino*** * Montana State University, Bozeman	Automating Radiometer Calibration Procedures	Simon Hook *Research Scientist*

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Division 33

Session **E**

Date: Wednesday, August 17
Room: 301-376
Session Chairs: Hamid Hemmati/Richard Alvidrez

1:20 - 2:00 pm	***Charles E. Scott*** * Boise State University	Actuation of Deformable Mirrors Using Laser Controlled Pistons	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
1:20 - 2:00 pm	***Adam S. Lint*** * University of Idaho	Adaptive Optics: Arroyo Simulation Tool and Deformable Mirror Actuation Using Golay Cells	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
2:00 - 2:20 PM	***Collin W. Petersen*** * University of Idaho	Various Analyses of Structures and Systems Pertaining to Optical Communications	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
2:20 - 2:40 PM	***Christoffer J. Renner*** * Montana State University, Bozeman	Mitigation of Laser Beam Scintillation in Free-Space Optical Communication Systems Through Coherence-Reducing Optical Materials	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Jessica L. Malecha*** * University of Idaho	The Different Wavelengths of Radio Science	Sami W. Asmar *Group Supervisor*
3:10 - 3:30 PM	***Karl W. Janich*** Harvey Mudd College	At-Least Version of the Generalized Minimum Spanning Tree Problem: Optimization Through Ant Colony System and Genetic Algorithms	Payman Arabshahi *Member of the Technical Staff* Andrew Gray *Group Supervisor*
3:30 - 3:50 PM	***Jiajing Xu*** * Caltech	Reconfigurable Advanced Receiver Design and Implementation	Andrew Gray *Group Supervisor* Kourosh Rahnamai *Senior Systems Engineer*
3:50 - 4:10 PM	***Andrew P. Riha*** * Iowa State University	An Advanced Orbiting Systems Approach to Quality of Service in Space-Based Intelligent Communication Networks	Clayton M. Okino *Senior Member of the Technical Staff*
4:10 - 4:30 PM	***Mark S. Haynes*** * University of Michigan	Dual-Band Deramp Radar Design for Ocean Current Measurements	Alina Moussessian *Senior Member of the Engineering Staff*

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Division 31

Session **F**

Date: Wednesday, August 17
Room: 198-102
Session Chair: Craig Peterson

10:30 AM - 12:30 PM	***Bing Huo*** * Caltech	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
10:30 AM - 12:30 PM	***Chester Ong*** * Georgia Institute of Technology	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
10:30 AM - 12:30 PM	***Ben S. Bieber*** University of North Dakota	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
10:30 AM - 12:30 PM	***Angela C. Magee*** * Caltech	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
10:30 AM - 12:30 PM	***Jennifer M. Needham*** * Rice University	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
10:30 AM - 12:30 PM	***Craig S. Montuori*** Caltech	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*

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Division 34

Session **G**

Date: Thursday, August 18
Room: 156-219
Session Chair: Chris Assad

1:20 - 1:40 PM	***Matthew D. King**** New Mexico State University	Environmental Considerations in a Mobile Computing Facility	Chris Assad *Senior Member of the Technical Staff*
1:40 - 2:00 PM	***John M. Lacy**** University of Idaho	Small Dog-Like Quadruped Robot Powered With McKibben Air Muscles	Chris Assad *Senior Member of the Technical Staff*
2:00 - 2:20 PM	***Nikhil R. Kumar**** University of Florida	Temperature Tolerant Evolvable Systems Utilizing FPGA Boards and Bias-Controlled Amplifiers	Didier Keymeulen *Senior Research Engineer*
2:20 - 2:40 PM	***Steven P. Sandoval**** New Mexico State University	Upper Torso Control for HOAP-2 Using Neural Networks	Didier Keymeulen *Senior Research Engineer*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Quan Gan**** University of California, Berkeley	Humanoid Locomotion: An Experimental Study on Signal Processing and Dynamic Approaches to Humanoid Walk Generation	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*
3:10 - 3:30 PM	***Jeffrey D. Moore*** Massachusetts Institute of Technology	Vision and "Hand-Eye" Coordination for the Fujitsu HOAP-2 Humanoid Robot	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*
3:30 - 3:50 PM	***Ambrus Csaszar*** Caltech	Standardized Action Modules for Humanoid Robot Control	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*
3:50 - 4:10 PM	***Jason E. Newton*** Riverside Community College *JPLUS SURF Fellow*	Humanoid Robotics: Real-Time Object Oriented Programming	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*
4:10 - 4:30 PM	***Nicholas J. Zola**** Franklin W. Olin College of Engineering	Equipping an FPGA-Based Mars Rover With an LN-200 IMU	Robert K. Watson *Senior Member of the Technical Staff*

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Division 34

Session **H**

Date: Thursday, August 18
Room: 198-102
Session Chair: Richard Alvidrez

1:20 - 1:40 PM	***David C. Foor**** Texas A&M University, Kingsville	A Hexapod Robot to Demonstrate Mesh Walking in a Microgravity Environment	Alberto E. Behar *Senior Member of the Technical Staff*
1:40 - 2:00 PM	***Cesar R. Rivadeneyra**** University of California, Irvine	Hydrothermal Vent Sampler: Does Life Exist In High Temperature Environments?	Jaret B. Matthews *Member of the Technical Staff* Alberto E. Behar *Senior Member of the Technical Staff*
2:00 - 2:20 PM	***Brandon M. Jones**** Southern University and A&M College	Camera Image Transformation and Registration for Safe Spacecraft Landing and Hazard Avoidance	Ayanna Howard *Senior Member of the Technical Staff* Edward W. Tunstel *Senior Member of the Engineering Staff*
2:20 - 2:40 PM	***Gerardo E. Cruz**** University of Florida	Modeling Leadership Styles in Human-Robot Team Dynamics	Ayanna Howard *Senior Member of the Technical Staff* Edward W. Tunstel *Senior Member of the Engineering Staff*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:30 PM	***Shawn S. Catron**** New Mexico State University	Approach and Instrument Placement Validation	Won Kim *Senior Member of the Technical Staff*
2:50 - 3:30 PM	***Danielle E. Ator**** University of Idaho	Approach and Instrument Placement Validation	Won Kim *Senior Member of the Technical Staff*
3:30 - 3:50 PM	***John D. Wason**** Rensselaer Polytechnic Institute	SHERPA Electromechanical Test Bed	J. Balaram *Member of the Technical Staff* Brett A. Kennedy *Staff Engineer*
3:50 - 4:10 PM	***Nathan A. Wood**** University of Nebraska, Lincoln	Crewbot Suspension Design	Brett A. Kennedy *Staff Engineer*

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Division 34

Session I

Date: Thursday, August 18
Room: 202-230B
Session Chair: Jeff Snyder

1:40 - 2:00 PM	***Ben T. Meuer**** University of Wyoming	Verifying Correct Functionality of Avionics Subsystems	Martin Le *Avionics Senior Engineer*
2:00 - 2:20 PM	***Kent R. Crossin**** University of Idaho	MSAP Hardware Verification: Testing Multi-Mission System Architecture Platform Hardware Using Simulation and Bench Test Equipment	Martin Le *Avionics Senior Engineer*
2:20 - 2:40 PM	***John M. Sartori**** University of North Dakota	Multi-Mission System Architecture Platform: Design and Verification of the Remote Engineering Unit	Christen J. Buchanan *Technical Group Supervisor, ASIC Design Group*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***King Yi Heung**** Caltech	A Study of the Measurement of Seebeck Coefficient of SiGe	G. Jeffrey Snyder *Senior Member of the Technical Staff*
3:10 - 3:30 PM	***Amado S. Guloy**** University of Texas at Austin *Howard Hughes Medical Institute MURF Fellow*	Synthesis, Structure, and Transport Properties of $YbSb_2Te_4$ and $YbSb_4Te_7$ for Thermoelectric Applications	G. Jeffrey Snyder *Senior Member of the Technical Staff*
3:30 - 3:50 PM	***Vicky V. Doan-Nguyen**** Yale University	Synthesis and Optimization of Thermoelectric Properties of Zn_xSb_3	G. Jeffrey Snyder *Senior Member of the Technical Staff* Franck Gascoin *Postdoctoral Scholar in Materials Science*
3:50 - 4:10 PM	***John L. Ziegler**** Rensselaer Polytechnic Institute	A Unifying Multibody Dynamics Algorithm Development Workbench	Abhinandan Jain *Principal Member of the Technical Staff*

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Division 35

Session J

Date: Thursday, August 18
Room: 249-114
Session Chair: Brett Williams

1:40 - 2:00 PM	***Peter K. Koo**** University of California, Berkeley *JPLUS SURF Fellow*	A PdMn Based High Resolution Thermometer for the Temperature Range of 0.7–1 K	Melora Larson *Senior Member of the Technical Staff*
2:00 - 2:20 PM	***Jeremy M. Morales**** University of Washington	A Study in HRT Resolution: Seeking Maximum Sensitivity Among Variations in Sensing Element Material	Melora Larson *Senior Member of the Technical Staff*
2:20 - 2:40 PM	***Nicholas B. Galitzki*** Caltech	Lunar Seismic Detector to Advance the Search for Strange Quark Matter	Talso Chui *Principal Member of the Technical Staff* Konstantin I. Penanen *Scientist*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Erinna M. Chen**** Princeton University	Design, Fabrication, and Testing of Emissive Probes to Determine the Plasma Potential of the Plumes of Various Electric Thrusters	Lee K. Johnson *Research Scientist*
3:10 - 3:30 PM	***Gretchen P. Joyce**** Montana State University, Bozeman	Qualifying a Bonding Process for Space Interferometry Mission	Stephanie E. Buck *Member of the Technical Staff*
3:30 - 3:50 PM	***Ashley Moore**** University of Colorado, Boulder	A Method for Assessing the Accuracy of a Photogrammetry System for Precision Deployable Structures	Gregory Agnes *Senior Engineer, Science and Technology Development* Robert B. Williams *Member of the Technical Staff*

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Division 38

Session **K**

Date: Thursday, August 18
Room: 303-401
Session Chair: Xenia Amashukeli, SURF '96

1:40 - 2:00 PM	***Glenda H. Arik**** University of Arizona	Design and Construction of a Field Capable Snapshot Hyperspectral Imaging Spectrometer	Gregory H. Bearman *Member of the Technical Staff* William R. Johnson *Staff Optical Engineer*
2:00 - 2:20 PM	***Matthew W. Wright*** University of Maine	Characterization of Unimorph-Membrane Microactuators and Error-Analysis of the Characterization Process	Eui-Hyeok Yang *Task Manager*
2:20 - 2:40 PM	***Viola Fucsko**** University of Idaho	Optimization of Aluminum Anodization Conditions for the Fabrication of Nanowires by Electrodeposition	Eui-Hyeok Yang *Task Manager*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Wing H. To**** University of California, Santa Barbara *JPLUS SURF Fellow*	Analysis of Quantum Information Test-bed by Parametric Down Converted Photons Interference Measurement	Deborah J. Jackson *Senior Researcher* George M. Hockney *Senior Software Engineer*
3:10 - 3:30 PM	***Asahi A. Okada*** University of California, Berkeley	Optimization of Polycyclic Aromatic Hydrocarbon (PAH) Extraction Efficiency Parameters for Sub- and Supercritical Water Extraction (SCWE) Instrument	Xenia Amashukeli *Postdoctoral Scholar in Environmental Science and Engineering*
3:30 - 3:50 PM	***Karl P. Ostmo**** University of North Dakota	Miniature Instrumentation for SIPR (Subsurface Ice PRobe)	Miles Smith *Postdoctoral Scholar*
3:50 - 4:10 PM	***Erik J. Tollerud**** University of Puget Sound	MECA TECP Testing and Experimentation	Michael Hecht *Project Manager*

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Division 38

Session **L**

Date: Thursday, August 18
Room: 306-300
Session Chair: Dominic Mazzoni

1:40 - 2:00 PM	***Heidi E. Bostic*** Wofford College	Characterization of an Electroanalytical Instrument Suite Searching for Water and Life on Mars	Suresh Seshadri *Senior Engineer*
2:00 - 2:40 PM	***Paul B. Gardner*** * University of Central Florida	Compact Micro-Imaging Spectrometer (CMIS): Investigation of Imaging Spectroscopy and Its Application to Mars Geology and Astrobiology	R. Glenn Sellar *Senior Optical Engineer*
2:00 - 2:40 PM	***Paul W. Staten*** * Weber State University	Compact Micro-Imaging Spectrometer (CMIS): Investigation of Imaging Spectroscopy and Its Application to Mars Geology and Astrobiology	R. Glenn Sellar *Senior Optical Engineer*
2:40 - 2:50 PM	***BREAK***		
2:50 - 3:10 PM	***Michael J. Kocurek*** Caltech	The Optimization of Trained and Untrained Image Classification Algorithms for Use on Large Spatial Datasets	Kiri Wagstaff *Research Staff* Dominic M. Mazzoni *Member of the Technical Staff*
3:10 - 3:30 PM	***Alexander E. Garbutt*** * University of California, Davis	Parallel Rendering of Large Time-Varying Volume Data	Peggy Li *Principal Technical Staff*

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Division 38

Session **M**

Date: Thursday, August 18
Room: 168-427
Session Chair: Barbara McGuffie

1:00 - 3:00 PM	***Alison M. Brown**** College of the Holy Cross	Solar System Visualizations	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
1:00 - 3:00 PM	***Ben Lickly*** Harvey Mudd College	3DRT-MPASS	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
1:00 - 3:00 PM	***Nathan D. Scharfe**** Stanford University	Three Dimensional Rover/Lander/Orbiter Mission-Planning (3D-ROMPS) System: A Modern Approach to Mission Planning	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
1:00 - 3:00 PM	***Daniel P. O'Connor*** College of the Holy Cross	Weather Satellite Thermal IR Responses Prior to Earthquakes	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
1:00 - 3:00 PM	***Jennifer L. Jones**** Portland State University	Geographic Information Systems and Martian Data: Compatibility and Analysis	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
1:00 - 3:00 PM	***Jessica L. Todd**** University of Wyoming	Solar System Visualization (SSV) Project	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*

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Division 35

Session **N**

Date:	**Thursday, August 18**
Room:	**299 Conference Room**
Session Chair:	**Greg Agnes**

12:00 PM	***Alexander R. Murray*** * University of Michigan	Precision Deployable Structures Testbed	Gregory Agnes *Senior Engineer, Science and Technology Development*

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Presentation Schedule

Session B - Division 31 126-346 Wednesday, August 17 3:50 - 4:10 PM	***Lucy Abramyan*** Harvey Mudd College	Activity Scratchpad Prototype: Simplifying the Rover Activity Planning Cycle	Jeffrey S. Norris *Member of the Technical Staff*
Session A - Division 31 126-225 Wednesday, August 17 2:00 - 2:20 PM	***Shanna E. Andrew**** * University of Mississippi	Development of a New Approach to Instrument Model Design Used by Team X	Theresa M. Anderson *Member of the Technical Staff*
Session K - Division 38 303-401 Thursday, August 18 1:40 - 2:00 PM	***Glenda H. Arik*** * University of Arizona	Design and Construction of a Field Capable Snapshot Hyperspectral Imaging Spectrometer	Gregory H. Bearman *Member of the Technical Staff* William R. Johnson *Staff Optical Engineer*
Session H - Division 34 198-102 Thursday, August 18 2:50 - 3:30 PM	***Danielle E. Ator*** * University of Idaho	Approach and Instrument Placement Validation	Won Kim *Senior Member of the Technical Staff*
Session F - Division 31 198-102 Wednesday, August 17 10:30 AM - 12:30 PM	***Ben S. Bieber*** University of North Dakota	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
Session L - Division 38 306-300 Thursday, August 18 1:40 - 2:00 PM	***Heidi E. Bostic*** Wofford College	Characterization of an Electroanalytical Instrument Suite Searching for Water and Life on Mars	Suresh Seshadri *Senior Engineer*
Session M - Division 38 168-427 Thursday, August 18 1:00 - 3:00 PM	***Alison M. Brown*** * College of the Holy Cross	Solar System Visualizations	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
Session C - Division 32 171-118 Wednesday, August 17 2:00 - 2:20 PM	***Michael W. Busch*** * University of Minnesota	Asteroid Shape Reconstruction From Radar Observations	Steven J. Ostro *Senior Research Scientist*
Session H - Division 34 198-102 Thursday, August 18 2:50 - 3:30 PM	***Shawn S. Catron*** * New Mexico State University	Approach and Instrument Placement Validation	Won Kim *Senior Member of the Technical Staff*
Session J - Division 35 249-114 Thursday, August 18 2:50 - 3:10 PM	***Erinna M. Chen*** * Princeton University	Design, Fabrication, and Testing of Emissive Probes to Determine the Plasma Potential of the Plumes of Various Electric Thrusters	Lee K. Johnson *Research Scientist*

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Session I - Division 34 202-230B Thursday, August 18 2:00 - 2:20 PM	***Kent R. Crossin**** University of Idaho	MSAP Hardware Verification: Testing Multi-Mission System Architecture Platform Hardware Using Simulation and Bench Test Equipment	Martin Le *Avionics Senior Engineer*
Session H - Division 34 198-102 Thursday, August 18 2:20 - 2:40 PM	***Gerardo E. Cruz**** University of Florida	Modeling Leadership Styles in Human-Robot Team Dynamics	Ayanna Howard *Senior Member of the Technical Staff* Edward W. Tunstel *Senior Member of the Engineering Staff*
Session G - Division 34 156-219 Thursday, August 18 3:30 - 3:50 PM	***Ambrus Csaszar*** Caltech	Standardized Action Modules for Humanoid Robot Control	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*
Session I - Division 34 202-230B Thursday, August 18 3:30 - 3:50 PM	***Vicky V. Doan-Nguyen**** Yale University	Synthesis and Optimization of Thermoelectric Properties of Zn_xSb_3	G. Jeffrey Snyder *Senior Member of the Technical Staff* Franck Gascoin *Postdoctoral Scholar in Materials Science*
Session C - Division 32 171-118 Wednesday, August 17 2:50 - 3:10 PM	***Lyndsey D. Earl*** Reed College	Stable Isotope Characteristics of Jarosite: The Acidic Aqueous History of Mars	Max Coleman *Senior Research Scientist* Benjamin Brunner *Postdoctoral Scholar in Astrobiology*
Session D - Division 32 202-230B Wednesday, August 17 2:20 - 2:40 PM	***Matthew A. Ferry**** University of California, Berkeley	Building the Case for SNAP: Creation of Multi-Band, Simulated Images With Shapelets	Jason D. Rhodes *Scientist*
Session H - Division 34 198-102 Thursday, August 18 1:20 - 1:40 PM	***David C. Foor**** Texas A&M University, Kingsville	A Hexapod Robot to Demonstrate Mesh Walking in a Microgravity Environment	Alberto E. Behar *Senior Member of the Technical Staff*
Session K - Division 38 303-401 Thursday, August 18 2:20 - 2:40 PM	***Viola Fucsko**** University of Idaho	Optimization of Aluminum Anodization Conditions for the Fabrication of Nanowires by Electrodeposition	Eui-Hyeok Yang *Task Manager*
Session J - Division 35 249-114 Thursday, August 18 2:20 - 2:40 PM	***Nicholas B. Galitzki*** Caltech	Lunar Seismic Detector to Advance the Search for Strange Quark Matter	Talso Chui *Principal Member of the Technical Staff* Konstantin I. Penanen *Scientist*

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Session G - Division 34 156-219 Thursday, August 18 2:50 - 3:10 PM	***Quan Gan*** * University of California, Berkeley	Humanoid Locomotion: An Experimental Study on Signal Processing and Dynamic Approaches to Humanoid Walk Generation	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*
Session L - Division 38 306-300 Thursday, August 18 3:10 - 3:30 PM	***Alexander E. Garbutt*** * University of California, Davis	Parallel Rendering of Large Time-Varying Volume Data	Peggy Li *Principal Technical Staff*
Session L - Division 38 306-300 Thursday, August 18 2:00 - 2:40 PM	***Paul B. Gardner*** * University of Central Florida	Compact Micro-Imaging Spectrometer (CMIS): Investigation of Imaging Spectroscopy and Its Application to Mars Geology and Astrobiology	R. Glenn Sellar *Senior Optical Engineer*
Session B - Division 31 126-346 Wednesday, August 17 3:30 - 3:50 PM	***Greg M. Goldgof*** Stanford University	Designing and Implementing a Distributed System Architecture for the Mars Rover Mission Planning Software (Maestro)	Jeffrey S. Norris *Member of the Technical Staff* I-Hsiang Shu *Member of the Technical Staff*
Session I - Division 34 202-230B Thursday, August 18 3:10 - 3:30 PM	***Amado S. Guloy*** * University of Texas at Austin *Howard Hughes Medical Institute MURF Fellow*	Synthesis, Structure, and Transport Properties of $YbSb_2Te_4$ and $YbSb_4Te_7$ for Thermoelectric Applications	G. Jeffrey Snyder *Senior Member of the Technical Staff*
Session C - Division 32 171-118 Wednesday, August 17 1:20 - 1:40 PM	***James E. Hansen*** Black Hills State University	Pressures in Tumuli: A Study of Tumuli Formation	Suzanne Smrekar *Research Scientist*
Session C - Division 32 171-118 Wednesday, August 17 3:10 - 3:30 PM	***Ellen R. Harju*** * University of Washington	Optical Characterization of Cryptoendolithic Chemical Biosignatures on Antarctic Sandstone Surfaces	Pamela G. Conrad *Member of the Technical Staff*
Session B - Division 31 126-346 Wednesday, August 17 1:40 - 2:00 PM	***Katrina M. Hay*** * Oregon State University	A Perfect View of Vesta: Creating Pointing Observations for the Dawn Spacecraft on Asteroid 4 Vesta	Carol Polanskey *Dawn Science Systems Engineer*
Session E - Division 33 301-376 Wednesday, August 17 4:10 - 4:30 PM	***Mark S. Haynes*** * University of Michigan	Dual-Band Deramp Radar Design for Ocean Current Measurements	Alina Moussessian *Senior Member of the Engineering Staff*
Session I - Division 34 202-230B Thursday, August 18 2:50 - 3:10 PM	***King Yi Heung*** * Caltech	A Study of the Measurement of Seebeck Coefficient of SiGe	G. Jeffrey Snyder *Senior Member of the Technical Staff*

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Session D - Division 32 202-230B Wednesday, August 17 3:10 - 3:30 PM	***Jonathan D. Hiller*** * University of Washington	Satellite Calibration With LED Detectors at Mud Lake	Carol J. Bruegge *Senior Scientist*
Session A - Division 31 126-225 Wednesday, August 17 2:20 - 2:40 PM	***Brandon N. Huelman*** * University of Minnesota	Relevant Parameter Evolution in Team X Mission Concept Designs	Theresa M. Anderson *Member of the Technical Staff*
Session F - Division 31 198-102 Wednesday, August 17 10:30 AM - 12:30 PM	***Bing Huo*** * Caltech	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
Session E - Division 33 301-376 Wednesday, August 17 3:10 - 3:30 PM	***Karl W. Janich*** Harvey Mudd College	At-Least Version of the Generalized Minimum Spanning Tree Problem: Optimization Through Ant Colony System and Genetic Algorithms	Payman Arabshahi *Member of the Technical Staff* Andrew Gray *Group Supervisor*
Session H - Division 34 198-102 Thursday, August 18 2:00 - 2:20 PM	***Brandon M. Jones*** * Southern University and A&M College	Camera Image Transformation and Registration for Safe Spacecraft Landing and Hazard Avoidance	Ayanna Howard *Senior Member of the Technical Staff* Edward W. Tunstel *Senior Member of the Engineering Staff*
Session M - Division 38 168-427 Thursday, August 18 1:00 - 3:00 PM	***Jennifer L. Jones*** * Portland State University	Geographic Information Systems and Martian Data: Compatibility and Analysis	Barbara McGuffie *Member of the Technical Staff*
Session J - Division 35 249-114 Thursday, August 18 3:10 - 3:30 PM	***Gretchen P. Joyce*** * Montana State University, Bozeman	Qualifying a Bonding Process for Space Interferometry Mission	Stephanie E. Buck *Member of the Technical Staff*
Session G - Division 34 156-219 Thursday, August 18 1:20 - 1:40 PM	***Matthew D. King*** * New Mexico State University	Environmental Considerations in a Mobile Computing Facility	Chris Assad *Senior Member of the Technical Staff*
Session L - Division 38 306-300 Thursday, August 18 2:50 - 3:10 PM	***Michael J. Kocurek*** Caltech	The Optimization of Trained and Untrained Image Classification Algorithms for Use on Large Spatial Datasets	Kiri Wagstaff *Research Staff* Dominic M. Mazzoni *Member of the Technical Staff*
Session J - Division 35 249-114 Thursday, August 18 1:40 - 2:00 PM	***Peter K. Koo*** * University of California, Berkeley *JPLUS SURF Fellow*	A PdMn Based High Resolution Thermometer for the Temperature Range of 0.7–1 K	Melora Larson *Senior Member of the Technical Staff*

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Session G - Division 34 156-219 Thursday, August 18 2:00 - 2:20 PM	***Nikhil R. Kumar*** * University of Florida	Temperature Tolerant Evolvable Systems Utilizing FPGA Boards and Bias-Controlled Amplifiers	Didier Keymeulen *Senior Research Engineer*
Session G - Division 34 156-219 Thursday, August 18 1:40 - 2:00 PM	***John M. Lacy*** * University of Idaho	Small Dog-Like Quadruped Robot Powered With McKibben Air Muscles	Chris Assad *Senior Member of the Technical Staff*
Session M - Division 38 168-427 Thursday, August 18 1:00 - 3:00 PM	***Ben Lickly*** Harvey Mudd College	3DRT-MPASS	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
Session E - Division 33 301-376 Wednesday, August 17 1:20 - 2:00 pm	***Adam S. Lint*** * University of Idaho	Adaptive Optics: Arroyo Simulation Tool and Deformable Mirror Actuation Using Golay Cells	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
Session F - Division 31 198-102 Wednesday, August 17 10:30 AM - 12:30 PM	***Angela C. Magee*** * Caltech	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
Session E - Division 33 301-376 Wednesday, August 17 2:50 - 3:10 PM	***Jessica L. Malecha*** * University of Idaho	The Different Wavelengths of Radio Science	Sami W. Asmar *Group Supervisor*
Session I - Division 34 202-230B Thursday, August 18 1:40 - 2:00 PM	***Ben T. Meuer*** * University of Wyoming	Verifying Correct Functionality of Avionics Subsystems	Martin Le *Avionics Senior Engineer*
Session B - Division 31 126-346 Wednesday, August 17 2:00 - 2:20 PM	***Joseph M. Moholt*** * Montana State University, Bozeman	Asynchronous Messaging and Data Transfer in a Spacecraft: An Implementation	Amalaye Oyake *Member of the Technical Staff*
Session F - Division 31 198-102 Wednesday, August 17 10:30 AM - 12:30 PM	***Craig S. Montuori*** Caltech	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
Session J - Division 35 249-114 Thursday, August 18 3:30 - 3:50 PM	***Ashley Moore*** * University of Colorado, Boulder	A Method for Assessing the Accuracy of a Photogrammetry System for Precision Deployable Structures	Gregory Agnes *Senior Engineer, Science and Technology Development* Robert B. Williams *Member of the Technical Staff*
Session G - Division 34 156-219 Thursday, August 18 3:10 - 3:30 PM	***Jeffrey D. Moore*** Massachusetts Institute of Technology	Vision and "Hand-Eye" Coordination for the Fujitsu HOAP-2 Humanoid Robot	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*

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Session J - Division 35 249-114 Thursday, August 18 2:00 - 2:20 PM	***Jeremy M. Morales**** * University of Washington	A Study in HRT Resolution: Seeking Maximum Sensitivity Among Variations in Sensing Element Material	Melora Larson *Senior Member of the Technical Staff*
Session N - Division 35 299 Conference Room Thursday, August 18 12:00 PM	***Alexander R. Murray**** * University of Michigan	Precision Deployable Structures Testbed	Gregory Agnes *Senior Engineer, Science and Technology Development*
Session F - Division 31 198-102 Wednesday, August 17 10:30 AM - 12:30 PM	***Jennifer M. Needham**** * Rice University	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
Session A - Division 31 126-225 Wednesday, August 17 3:10 - 3:30 PM	***Jennifer M. Needham**** * Rice University	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
Session C - Division 32 171-118 Wednesday, August 17 1:40 - 2:00 PM	***Sarah F. Newman**** * Massachusetts Institute of Technology	Photometric and Spectral Study of the Saturnian Satellites	Bonnie J. Buratti *Principal Research Scientist*
Session G - Division 34 156-219 Thursday, August 18 3:50 - 4:10 PM	***Jason E. Newton*** Riverside Community College *JPLUS SURF Fellow*	Humanoid Robotics: Real-Time Object Oriented Programming	Adrian Stoica *Principal Engineer* Didier Keymeulen *Senior Research Engineer*
Session M - Division 38 168-427 Thursday, August 18 1:00 - 3:00 PM	***Daniel P. O'Connor*** College of the Holy Cross	Weather Satellite Thermal IR Responses Prior to Earthquakes	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
Session K - Division 38 303-401 Thursday, August 18 3:10 - 3:30 PM	***Asahi A. Okada*** University of California, Berkeley	Optimization of Polycyclic Aromatic Hydrocarbon (PAH) Extraction Efficiency Parameters for Sub- and Supercritical Water Extraction (SCWE) Instrument	Xenia Amashukeli *Postdoctoral Scholar in Environmental Science and Engineering*
Session F - Division 31 198-102 Wednesday, August 17 10:30 am - 12:30 pm	***Chester Ong**** * Georgia Institute of Technology	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*
Session A - Division 31 126-225 Wednesday, August 17 2:50 - 3:10 PM	***Chester Ong**** * Georgia Institute of Technology	CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design	Craig E. Peterson *Senior Engineer*

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Session K - Division 38 303-401 Thursday, August 18 3:30 - 3:50 PM	***Karl P. Ostmo*** * University of North Dakota	Miniature Instrumentation for SIPR (Subsurface Ice PRobe)	Miles Smith *Postdoctoral Scholar*
Session A - Division 31 126-225 Wednesday, August 17 3:50 - 4:10 PM	***Matthew R. Otterstatter*** * University of Minnesota	Tools of the Future: How Decision Tree Analysis Will Impact Mission Planning	Elisabeth Lamassoure *Staff Systems Engineer*
Session C - Division 32 171-118 Wednesday, August 17 3:30 - 3:50 PM	***Erica R. Pantel*** Caltech	Effects of Cryogenic Temperatures on LEDs and Optical Fiber	Arthur L. Lane *Research Scientist*
Session E - Division 33 301-376 Wednesday, August 17 2:00 - 2:20 PM	***Collin W. Petersen*** * University of Idaho	Various Analyses of Structures and Systems Pertaining to Optical Communications	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
Session C - Division 32 171-118 Wednesday, August 17 2:20 - 2:40 PM	***Benjamin J. Pollard*** * University of Idaho	Irregular Wavelike Structure in Saturn's Rings	Linda J. Spilker *Principal Research Scientist*
Session D - Division 32 202-230B Wednesday, August 17 2:50 - 3:10 PM	***Lauren A. Porter*** Caltech	Determining the Locations of Brown Dwarfs in Young Star Clusters	Amanda K. Mainzer *Research Scientist*
Session E - Division 33 301-376 Wednesday, August 17 2:20 - 2:40 PM	***Christoffer J. Renner*** * Montana State University, Bozeman	Mitigation of Laser Beam Scintillation in Free-Space Optical Communication Systems Through Coherence-Reducing Optical Materials	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
Session E - Division 33 301-376 Wednesday, August 17 3:50 - 4:10 PM	***Andrew P. Riha*** * Iowa State University	An Advanced Orbiting Systems Approach to Quality of Service in Space-Based Intelligent Communication Networks	Clayton M. Okino *Senior Member of the Technical Staff*
Session H - Division 34 198-102 Thursday, August 18 1:40 - 2:00 PM	***Cesar R. Rivadeneyra*** * University of California, Irvine	Hydrothermal Vent Sampler: Does Life Exist In High Temperature Environments?	Jaret B. Matthews *Member of the Technical Staff* Alberto E. Behar *Senior Member of the Technical Staff*
Session D - Division 32 202-230B Wednesday, August 17 1:40 - 2:00 PM	***Rudra A. Roy*** Caltech	Satellite Validation: A Project to Create a Data-Logging System to Monitor Lake Tahoe	Simon Hook *Research Scientist* Ali A. Abtahi *Member of the Technical Staff*

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Session D - Division 32 202-230B Wednesday, August 17 3:30 - 3:50 PM	***Jeffrey L. Sadino* *** Montana State University, Bozeman	Automating Radiometer Calibration Procedures	Simon Hook *Research Scientist*
Session A - Division 31 126-225 Wednesday, August 17 3:30 - 3:50 PM	***Rashmi K. Sahai*** University of California, Los Angeles	Aerogel Development	Daniel E. Goods *Artist in Residence* Steven M. Jones *Scientist*
Session G - Division 34 156-219 Thursday, August 18 2:20 - 2:40 PM	***Steven P. Sandoval* *** New Mexico State University	Upper Torso Control for HOAP-2 Using Neural Networks	Didier Keymeulen *Senior Research Engineer*
Session I - Division 34 202-230B Thursday, August 18 2:20 - 2:40 PM	***John M. Sartori* *** University of North Dakota	Multi-Mission System Architecture Platform: Design and Verification of the Remote Engineering Unit	Christen J. Buchanan *Technical Group Supervisor, ASIC Design Group*
Session B - Division 31 126-346 Wednesday, August 17 2:50 - 3:10 PM	***Stephen C. Savin*** Princeton University	Analyzing MER Uplink Reports	Deborah Bass *Member of the Technical Staff* Roxana Wales *Research Scientist, NASA Ames Research Center*
Session M - Division 38 168-427 Thursday, August 18 1:00 - 3:00 PM	***Nathan D. Scharfe* *** Stanford University	Three Dimensional Rover/Lander/Orbiter Mission-Planning (3D-ROMPS) System: A Modern Approach to Mission Planning	Barbara McGuffie *Member of the Technical Staff* Eric M. De Jong *Member of the Technical Staff*
Session B - Division 31 126-346 Wednesday, August 17 3:10 - 3:30 PM	***Timothy M. Schriener* *** Oregon State University	Utilizing Radioisotope Power Systems for Human Lunar Exploration	John O. Elliott *Senior Engineer*
Session E - Division 33 301-376 Wednesday, August 17 1:20 - 2:00 pm	***Charles E. Scott* *** Boise State University	Actuation of Deformable Mirrors Using Laser Controlled Pistons	Hamid Hemmati *Technical Group Supervisor and Principal Member of the Technical Staff*
Session C - Division 32 171-118 Wednesday, August 17 4:10 - 4:30 PM	***Aditi Sharma* *** Louisiana State University	Distribution and Diversity of Organic and Biological Signatures in Soils From the Atacama Desert	Alexandre Tsapin *Research Scientist*
Session D - Division 32 202-230B Wednesday, August 17 2:00 - 2:20 PM	***Jeffrey J. Smith* *** University of California, Berkeley *JPLUS SURF Fellow*	A Population Study of Wide-Separation Brown Dwarf Companions to Main-Sequence Stars	Joseph C. Carson *Postdoctoral Scholar* Karl R. Stapelfeldt *Research Scientist*

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Session L - Division 38 306-300 Thursday, August 18 2:00 - 2:40 PM	***Paul W. Staten* *** Weber State University	Compact Micro-Imaging Spectrometer (CMIS): Investigation of Imaging Spectroscopy and Its Application to Mars Geology and Astrobiology	R. Glenn Sellar *Senior Optical Engineer*
Session K - Division 38 303-401 Thursday, August 18 2:50 - 3:10 PM	***Wing H. To* *** University of California, Santa Barbara *JPLUS SURF Fellow*	Analysis of Quantum Information Test-bed by Parametric Down Converted Photons Interference Measurement	Deborah J. Jackson *Senior Researcher* George M. Hockney *Senior Software Engineer*
Session M - Division 38 168-427 Thursday, August 18 1:00 - 3:00 PM	***Jessica L. Todd* *** University of Wyoming	Solar System Visualization (SSV) Project	Barbara McGuffie *Member of the Technical Staff*
Session K - Division 38 303-401 Thursday, August 18 3:50 - 4:10 PM	***Erik J. Tollerud* *** University of Puget Sound	MECA TECP Testing and Experimentation	Michael Hecht *Project Manager*
Session C - Division 32 171-118 Wednesday, August 17 3:50 - 4:10 PM	***Sara S. Van Nortwick*** University of Washington	Investigation of Solar Radiation Properties at the Battleship Promontory Area, Antarctica	Arthur L. Lane *Research Scientist*
Session A - Division 31 126-225 Wednesday, August 17 1:40 - 2:00 PM	***Kelly A. Wallenstein*** Wellesley College	Team X Spacecraft Instrument Database Consolidation	Theresa M. Anderson *Member of the Technical Staff*
Session B - Division 31 126-346 Wednesday, August 17 2:20 - 2:40 PM	***David C. Wang* *** Massachusetts Institute of Technology	BEAM Technology Flight Demonstration	Ryan M. Mackey *Senior Member of the Technical Staff*
Session H - Division 34 198-102 Thursday, August 18 3:30 - 3:50 PM	***John D. Wason* *** Rensselaer Polytechnic Institute	SHERPA Electromechanical Test Bed	J. Balaram *Member of the Technical Staff* Brett A. Kennedy *Staff Engineer*
Session H - Division 34 198-102 Thursday, August 18 3:50 - 4:10 PM	***Nathan A. Wood* *** University of Nebraska, Lincoln	Crewbot Suspension Design	Brett A. Kennedy *Staff Engineer*
Session K - Division 38 303-401 Thursday, August 18 2:00 - 2:20 PM	***Matthew W. Wright*** University of Maine	Characterization of Unimorph-Membrane Microactuators and Error-Analysis of the Characterization Process	Eui-Hyeok Yang *Task Manager*

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Session E - Division 33 301-376 Wednesday, August 17 3:30 - 3:50 PM	***Jiajing Xu*** * Caltech	Reconfigurable Advanced Receiver Design and Implementation	Andrew Gray *Group Supervisor* Kourosh Rahnamai *Senior Systems Engineer*
Session I - Division 34 202-230B Thursday, August 18 3:50 - 4:10 PM	***John L. Ziegler*** * Rensselaer Polytechnic Institute	A Unifying Multibody Dynamics Algorithm Development Workbench	Abhinandan Jain *Principal Member of the Technical Staff*
Session G - Division 34 156-219 Thursday, August 18 4:10 - 4:30 PM	***Nicholas J. Zola*** * Franklin W. Olin College of Engineering	Equipping an FPGA-Based Mars Rover With an LN-200 IMU	Robert K. Watson *Senior Member of the Technical Staff*

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Student Presentation Abstracts

Activity Scratchpad Prototype: Simplifying the Rover Activity Planning Cycle
Lucy Abramyan
Mentor: Jeffrey S. Norris

The Mars Exploration Rover mission depends on the Science Activity Planner as its primary interface to the Spirit and Opportunity Rovers. Scientists alternate between a series of mouse clicks and keyboard inputs to create a set of instructions for the rovers. To accelerate planning by minimizing mouse usage, a rover planning editor should receive the majority of inputted commands from the keyboard. Thorough investigation of the Eclipse platform's Java editor has provided the understanding of the base model for the Activity Scratchpad. Desirable Eclipse features can be mapped to specific rover planning commands, such as auto-completion for activity titles and content assist for target names. A custom editor imitating the Java editor's features was created with an XML parser for experimenting purposes. The prototype editor minimized effort for redundant tasks and significantly improved the visual representation of XML syntax by highlighting keywords, coloring rules, folding projections, and providing hover assist, templates and an outline view of the code.

Development of a New Approach to Instrument Model Design Used by Team X
Shanna Andrew
Mentor: Theresa M. Anderson

The Jet Propulsion Laboratory's Advanced Design Team was formed in April 1995 to improve the quality and reduce the cost of JPL proposals and advanced mission studies. Currently a consolidation attempt is underway to develop a Model Library for use by JPL's Advanced Projects Design Team by collecting existing instrument models for inclusion in the library. This will allow users to readily find models of interest. In addition to this, there is also an attempt underway to develop a new approach to instrument model design used by the Advanced Design Team (Team X). This new approach consists of splitting up the different model parts such as orbital parameters, instrument parameters and instrument outputs into separate searchable parts. The user can then decide between design trades and use the different pieces to construct a model that will fit their needs. As well, this will lead to the opportunity for the large variety of usable instrument models.

Design and Construction of a Field Capable Snapshot Hyperspectral Imaging Spectrometer
Glenda Arik
Mentor: Gregory H. Bearman

The computed-tomography imaging spectrometer (CTIS) is a device which captures the spatial and spectral content of a rapidly evolving scene in a single image frame. The most recent CTIS design is optically all reflective and uses as its dispersive device a state-of the-art reflective computer generated hologram (CGH). This project focuses on the instrument's transition from laboratory to field. This design will enable the CTIS to withstand a harsh desert environment. The system is modeled in optical design software using a tolerance analysis. The tolerances guide the design of the athermal mount and component parts. The parts are assembled into a working mount shell where the performance of the mounts is tested for thermal integrity. An interferometric analysis of the reflective CGH is also performed.

Approach and Instrument Placement Validation
Danielle Ator
Mentor: Won Kim

The Mars Exploration Rovers (MER) from the 2003 flight mission represents the state of the art technology for target approach and instrument placement on Mars. It currently takes 3 sols (Martian days) for the rover to place an instrument on a designated rock target that is about 10 to 20 m away. The objective of this project is to provide an experimentally validated single-sol instrument placement capability to future Mars missions. After completing numerous test runs on the Rocky8 rover under various test conditions, it has been observed that lighting conditions, shadow effects, target features and the initial target distance have an effect on the performance and reliability of the tracking software. Additional software validation testing will be conducted in the months to come.

CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design
Ben Bieber
Mentor: Craig Peterson

New technology in space exploration is often developed without a complete knowledge of its impact. While the immediate benefits of a new technology are obvious, it is harder to understand its indirect consequences, which ripple through the entire system. CoMET is a technology evaluation tool designed to illuminate how specific technology choices affect a mission at each system level. CoMET uses simplified models for mass, power, and cost to analyze performance parameters of technologies of interest. The sensitivity analysis that CoMET provides shows whether developing a certain technology will greatly benefit the project or not. CoMET is an ongoing project approaching a web-based implementation phase. This year, development focused on the models for planetary daughter craft, such as atmospheric probes, blimps and balloons, and landers. These models are developed through research into historical data, well established rules of thumb, and engineering judgment of experts at JPL. The model is validated by corroboration with JPL advanced mission studies. Other enhancements to CoMET include adding launch vehicle analysis and integrating an updated cost model. When completed, CoMET will allow technological development to be focused on areas that will most drastically improve spacecraft performance.

Characterization of an Electroanalytical Instrument Suite Searching for Water and Life on Mars
Heidi E. Bostic
Mentor: Suresh Seshadri

Seeking the existence of life on other planets is an essential part of NASA's research. Our terrestrial experience suggests that water is a mandatory resource for life to exist and thrive. However, instruments capable of detecting water at the levels likely to be present on Mars are lacking. This project tests the possibility of using electrical measurements of soils, at variable frequencies, as a water detector. Generally, the electrical resistance of soils can be described as a combination of resistance and capacitance, which can be described by a vector including a magnitude and (phase) angle. By specifically studying the impedance measurements and phase angles of different types of soil, spiked with varying concentrations of dissolved ions, measurements can be taken to provide an idea of the behavior of dry Martian soils. The presentation will describe the experimental technique, apparatus and procedures, as well as results conducted to calibrate the instrument and to establish sample preparation protocols.

Solar System Visualizations
Alison M. Brown
Mentors: Barbara McGuffie and Eric M. De Jong

Solar System Visualization products enable scientists to compare models and measurements in new ways that enhance the scientific discovery process, enhance the information content and understanding of the science results for both science colleagues and the public, and create visually appealing and intellectually stimulating visualization products. Missions supported include MER, MRO, and Cassini. Image products produced include pan and zoom animations of large mosaics to reveal the details of surface features and topography, animations into registered multi-resolution mosaics to provide context for microscopic images, 3D anaglyphs from left and right stereo pairs, and screen captures from video footage. Specific products include a three-part context animation of the Cassini Enceladus encounter highlighting images from 350 to 4 meter per pixel resolution; Mars Reconnaissance Orbiter screen captures illustrating various instruments during assembly and testing at the Payload Hazardous Servicing Facility at Kennedy Space Center; and an animation of Mars Exploration Rover Opportunity's 'Rub al Khali' panorama where the rover was stuck in the deep fine sand for more than a month. This task creates new visualization products that enable new science results and enhance the public's understanding of the Solar System and NASA's missions of exploration.

Asteroid Shape Reconstruction From Radar Observations
Michael J. Busch
Mentor: Steven J. Ostro

I estimate near-Earth asteroid 1992 SK's physical properties from radar delay-Doppler images, Doppler-only echo spectra and optical lightcurves. The images are not very strong, but place up to 20 (40 m by 160 m) pixels on the asteroid. The radar tracks are confined to subradar latitudes between 20 and 40 degrees but have complete rotational phase coverage. The echo spectra and optical lightcurves span ~80 degrees of sky motion, providing geometric leverage to constrain the pole direction. The optical lightcurves are essential to accurate determination of the asteroid's shape and spin state. The asteroid is ~1.4 km in maximum extent and mildly asymmetric, with an elongation of ~1.5 and relatively subdued topography. The radar albedo is about 0.13 and the optical albedo about 0.3. The circular polarization ratio for the object is about 0.34, implying typical cm-scale surface roughness. I estimate the asteroid's period to be 7.3182 ±0.0003 hours and its pole direction as (99°±5°, -3°±5°) in ecliptic coordinates. The radar-refined orbital solution accurately predicts planetary close approaches between the years 826 and 2690. I have used my model to predict salient characteristics of radar images and optical lightcurves obtainable during the asteroid's March 2006 approach.

Approach and Instrument Placement Validation
Shawn S. Catron
Mentor: Won Soo Kim

The objectives of this project are to validate the single-sol instrument placement [run_scip] algorithm using the Rocky 8 rover in the mini Mars test bed and to calibrate the arm for the Rocky 8 rover. To accomplish the first goal, the Rocky 8 rover was put through a series of experiments at different times of day, with different target rocks, and different hazards to avoid. It was determined that each of these experimental variables plays a large role in the reliability of the run_scip algorithm and more testing needs to be done to validate it. For arm calibration, the kinematic parameters of the arm were optimized using a Matlab program. These parameters also need to undergo more testing before the arm can be calibrated.

Design, Fabrication, and Testing of Emissive Probes to Determine the Plasma Potential of the Plumes of Various Electric Thrusters

Erinna M. Chen
Mentor: Lee Johnson

A significant problem in the use of electric thrusters in spacecraft is the formation of low-energy ions in the thruster plume. Low-energy ions are formed in the plume via random collisions between high-velocity ions ejected from the thruster and slow-moving neutral atoms of propellant effusing from the engine. The sputtering of spacecraft materials due to interactions with low-energy ions may result in erosion or contamination of the spacecraft. The trajectory of these ions is determined primarily by the plasma potential of the plume. Thus, accurate characterization of the plasma potential is essential to predicting low-energy ion contamination. Emissive probes were utilized to determine the plasma potential. When the ion and electron currents to the probe are balanced, the potential of such probes float to the plasma potential. Two emissive probes were fabricated; one utilizing a DC power supply, another utilizing a rectified AC power source. Labview programs were written to coordinate and automate probe motion in the thruster plume. Employing handshaking interaction, these motion programs were synchronized to various data acquisition programs to ensure precision and accuracy of the measurements. Comparing these experimental values to values from theoretical models will allow for a more accurate prediction of low-energy ion interaction.

MSAP Hardware Verification: Testing Multi-Mission System Architecture Platform Hardware Using Simulation and Bench Test Equipment

Kent R. Crossin
Mentor: Martin Le

The Multi-Mission System Architecture Platform (MSAP) project aims to develop a system of hardware and software that will provide the core functionality necessary in many JPL missions and can be tailored to accommodate mission-specific requirements. The MSAP flight hardware is being developed in the Verilog hardware description language, allowing developers to simulate their design before releasing it to a field programmable gate array (FPGA). FPGAs can be updated in a matter of minutes, drastically reducing the time and expense required to produce traditional application-specific integrated circuits. Bench test equipment connected to the FPGAs can then probe and run Tcl scripts on the hardware. The Verilog and Tcl code can be reused or modified with each design. These steps are effective in confirming that the design operates according specifications.

Modeling Leadership Styles in Human-Robot Team Dynamics

Gerardo E. Cruz
Mentor: Ayanna Howard

The recent proliferation of robotic systems in our society has placed questions regarding interaction between humans and intelligent machines at the forefront of robotics research. In response, our research attempts to understand the context in which particular types of interaction optimize efficiency in tasks undertaken by human-robot teams. It is our conjecture that applying previous research results regarding leadership paradigms in human organizations will lead us to a greater understanding of the human-robot interaction space. In doing so, we adapt four leadership styles prevalent in human organizations to human-robot teams. By noting which leadership style is more appropriately suited to what situation, as given by previous research, a mapping is created between the adapted leadership styles and human-robot interaction scenarios—a mapping which will presumably maximize efficiency in task completion for a human-robot team. In this research we test this mapping with two adapted leadership styles: directive and transactional. For testing, we have taken a virtual 3D interface and integrated it with a genetic algorithm for use in tele-operation of a physical robot. By developing team efficiency metrics, we can determine whether this mapping indeed prescribes interaction styles that will maximize efficiency in the tele-operation of a robot.

Standardized Action Modules for Humanoid Robot Control

Ambrus Csaszar
Mentors: Adrian Stoica and Didier Keymeulen

Humanoid robots could reduce the risks of hazardous work by replacing humans in dangerous environments and they could be useful helpers in environments designed primarily for humans. Currently, no robot is capable enough to fulfill either of these roles for any practical application, and the Humanoid Project at the Jet Propulsion Laboratory's Bio-Inspired Technologies and Systems group is striving to change that. For this summer, our goal was to endow a Fujitsu HOAP 2 humanoid robot with the necessary intelligence and knowledge to autonomously assemble a cubical frame structure from tubular bars and corner joints. Performing such a complicated task requires that the robot have a robust control architecture that allows for a multitude of abilities and operation modes. We have designed and implemented a modular control architecture that allows reusability of existing code and the integration of work by many team members into the larger control system while providing an easy way to implement later improvements. Such a control system has allowed us to achieve important milestones in the humanoid robot assembly task.

Synthesis and Optimization of Thermoelectric Properties of Zn_xSb_3

Vicky Doan-Nguyen

Mentors: Jeffrey Snyder and Franck Gascoin

High-performance thermoelectric materials are studied to investigate their abilities to optimize electrical and minimize thermal conductivities. A stoichiometric range of *p*-type zinc antimonide compounds was synthesized to analyze the trends in their thermoelectric properties. Zn_xSb_3 (x=3.80, 3.85, 3.90, 3.95, 4.00, 4.05, 4.10) was reacted at 750°C and annealed at 300°C for 24 hours at each temperature. Electronic transport properties such as Seebeck and Hall Effect were measured to analyze possible trends in the set of compositions. SEM, EDS, and XRD were used to quantify both ingots and hot-pressed samples to confirm that they were single-phase and of the expected stoichiometries. Recent SEM data indicated that $Zn_{3.90}Sb_3$ and $Zn_{4.00}Sb_3$ samples were actually Zn_3Sb_2. In hopes of further improving the figure-of-merit (ZT) of the binary system, V, Cr, Mn, Fe, Co, In, and Sn were used to dope $(Zn_{0.95}M_{0.05})_{3.95}Sb_3$.

Stable Isotope Characteristics of Jarosite: The Acidic Aqueous History of Mars

Lyndsey D. Earl

Mentors: Max Coleman and Benjamin Brunner

The Mars Rover Opportunity found jarosite (Na^+ or K^+)$Fe_3SO_4(OH)_6$ at the Meridiani Planum site. This mineral forms from the evaporation of an aqueous acidic sulfate brine. Oxygen isotope compositions may characterize formation conditions but subsequent isotope exchange may have occurred between the sulfate and hydroxide of jarosite and water. The rate of oxygen isotope exchange depends on the acidity and temperature of the brine, but it has not been investigated in detail. We performed laboratory experiments to determine the rate of oxygen isotope exchange under varying acidities and temperatures to learn more about this process. Barium sulfate samples were precipitated weekly from acidic sodium sulfate brines. The oxygen isotope composition of the precipitated sulfate was obtained using a Finnigan MAT253 Isotope Ratio Mass-Spectrometer. The results show that water was trapped in barium sulfate during precipitation. Trapped water may exchange with sulfate when exposed to high temperatures, thus changing the isotope composition of sulfate and the observed fractionation factor of oxygen isotope exchange between sulfate and water. The results of our research will contribute to the understanding of oxygen isotope exchange rates between water and sulfate under acidic conditions and provide experimental knowledge for the dehydration of barium sulfate samples.

Building the Case for SNAP: Creation of Multi-Band, Simulated Images With Shapelets

Matthew Ferry

Mentor: Jason Rhodes

Dark energy has simultaneously been the most elusive and most important phenomenon in the shaping of the universe. A case for a proposed space-telescope called SNAP (SuperNova Acceleration Probe) is being built, a crucial component of which is image simulations. One method for this is "Shapelets," developed at Caltech. Shapelets form an orthonormal basis and are uniquely able to represent realistic space images and create new images based on real ones. Previously, simulations were created using the Hubble Deep Field (HDF) as a basis set in one band. In this project, image simulations are created using the 4 bands of the Hubble Ultra Deep Field (UDF) as a basis set. This provides a better basis for simulations because (1) the survey is deeper, (2) they have a higher resolution, and (3) this is a step closer to simulating the 9 bands of SNAP. Image simulations are achieved by detecting sources in the UDF, decomposing them into shapelets, tweaking their parameters in realistic ways, and recomposing them into new images. Morphological tests were also run to verify the realism of the simulations. They have a wide variety of uses, including the ability to create weak gravitational lensing simulations.

A Hexapod Robot to Demonstrate Mesh Walking in a Microgravity Environment

David Foor

Mentor: Michael I. Ferguson

The JPL Micro-Robot Explorer (MRE) Spiderbot is a robot that takes advantage of its small size to perform precision tasks suitable for space applications. The Spiderbot is a legged robot that can traverse harsh terrain otherwise inaccessible to wheeled robots. A team of Spiderbots can network and can exhibit collaborative efforts to successfully complete a set of tasks. The Spiderbot is designed and developed to demonstrate hexapods that can walk on flat surfaces, crawl on meshes, and assemble simple structures. The robot has six legs consisting of two spring-compliant joints and a gripping actuator. A hard-coded set of gaits allows the robot to move smoothly in a zero-gravity environment along the mesh. The primary objective of this project is to create a Spiderbot that traverses a flexible, deployable mesh, for use in space repair. Verification of this task will take place aboard a zero-gravity test flight. The secondary objective of this project is to adapt feedback from the joints to allow the robot to test each arm for a successful grip of the mesh. The end result of this research lends itself to a fault-tolerant robot suitable for a wide variety of space applications.

Optimization of Aluminum Anodization Conditions for the Fabrication of Nanowires by Electrodeposition
Viola Fucsko
Mentors: Eui-Hyeok Yang and Daniel Choi

Anodized alumina nanotemplates have a variety of potential applications in the development of nanotechnology. Alumina nanotemplates are formed by oxidizing aluminum film in an electrolyte solution. During anodization, aluminum oxidizes, and, under the proper conditions, nanometer-sized pores develop. A series of experiments was conducted to determine the optimal conditions for anodization. Three-micrometer thick aluminum films on silicon and silicon oxide substrates were anodized using constant voltages of 13–25 V. 0.1–0.3M oxalic acid was used as the electrolyte. The anodization time was found to increase and the overshooting current decreased as both the voltage and the electrolyte concentrations were decreased. The samples were observed under a scanning electron microscope. Anodizing with 25V in 0.3M oxalic acid appears to be the best process conditions. The alumina nanotemplates are being used to fabricate nanowires by electrodeposition. The current-voltage characteristics of copper nanowires have also been studied.

Lunar Seismic Detector to Advance the Search for Strange Quark Matter
Nicholas Galitzki
Mentor: Talso Chui

Detection of small seismic signals on the Moon are needed to study lunar internal structure and to detect possible signals from Strange Quark matter transit events. The immediate objective is to create a prototype seismic detector using a tunnel diode oscillator with a variable capacitor attached to a proof mass. The device is designed to operate effectively on the Moon, which requires a low power consumption to operate through lunar night, while preserving sensitivity. The goal is capacitance resolution of better than 1 part in 10^8 and power consumption of less than 1 watt.

Humanoid Locomotion: An Experimental Study on Signal Processing and Dynamic Approaches to Humanoid Walk Generation
Quan Gan
Mentors: Adrian Stoica and Didier Keymeulen

It is hoped that one day robots will assist in lunar and Martian surface exploration by constructing facilities before their human counterparts arrive; robots with a human form-factor may be desirable since they can potentially use the same set of tools designed for humans. With the goal in mind, locomotion may be one of the biggest challenges for a humanoid since the terrain is most likely uneven and varying. An adjustable walk has been developed for the HOAP-2 robot by gathering motor data from a preprogrammed fixed walk and using signal processing techniques. The result is a basic walk pattern adjustable in the frequency domain that can be used as a central pattern generator (CPG) in which the robot can modify using sensor feedback. Ultimately, the feedback can be applied to have the humanoid walk on various terrains, slopes, and avoid obstacles.

Parallel Rendering of Large Time-Varying Volume Data
Alexander Garbutt
Mentor: Peggy Li

Interactive visualization of large time-varying 3D volume datasets has been and still is a great challenge to the modern computational world. It stretches the limits of the memory capacity, the disk space, the network bandwidth and the CPU speed of a conventional computer. In this SURF project, we propose to develop a parallel volume rendering program on SGI's Prism, a cluster computer equipped with state-of-the-art graphic hardware. The proposed program combines both parallel computing and hardware rendering in order to achieve an interactive rendering rate.

We use 3D texture mapping and a hardware shader to implement 3D volume rendering on each workstation. We use SGI's VisServer to enable remote rendering using Prism's graphic hardware. And last, we will integrate this new program with ParVox, a parallel distributed visualization system developed at JPL. At the end of the project, we will demonstrate remote interactive visualization using this new hardware volume renderer on JPL's Prism system using a time-varying dataset from selected JPL applications.

Compact Micro-Imaging Spectrometer (CMIS): Investigation of Imaging Spectroscopy and Its Application to Mars Geology and Astrobiology
Paul B. Gardner
Mentor: R. Glenn Sellar

Future missions to Mars will attempt to answer questions about Mars' geological and biological history. The goal of the CMIS project is to design, construct, and test a capable, multi-spectral micro-imaging spectrometer for use in such missions. A breadboard instrument has been constructed with a micro imaging camera and several multi-wavelength LED illumination rings. Test samples have been chosen for their interest to spectroscopists, geologists and astrobiologists. Preliminary analysis has demonstrated the advantages of isotropic illumination and micro-imaging spectroscopy over spot spectroscopy.

Designing and Implementing a Distributed System Architecture for the Mars Rover Mission Planning Software (Maestro)
Gregory Goldgof
Mentor: Jeffrey S. Norris

Distributed systems allow scientists from around the world to plan missions concurrently, while being updated on the revisions of their colleagues in real time. However, permitting multiple clients to simultaneously modify a single data repository can quickly lead to data corruption or inconsistent states between users. Since our message broker, the *Java Message Service*, does not ensure that messages will be received in the order they were published, we must implement our own numbering scheme to guarantee that changes to mission plans are performed in the correct sequence. Furthermore, distributed architectures must ensure that as new users connect to the system, they synchronize with the database without missing any messages or falling into an inconsistent state. Robust systems must also guarantee that all clients will remain synchronized with the database even in the case of multiple client failure, which can occur at any time due to lost network connections or a user's own system instability. The final design for the distributed system behind the Mars rover mission planning software fulfills all of these requirements and upon completion will be deployed to MER at the end of 2005 as well as Phoenix (2007) and MSL (2009).

Synthesis, Structure, and Transport Properties of $YbSb_2Te_4$ and $YbSb_4Te_7$ for Thermoelectric Applications
Amado Guloy
Mentors: Jeff Snyder and Franck Gascoin

Very little work has been done in the Yb-Sb-Te system of compounds. Exploratory synthesis of various compounds in the system has been performed in the search for new thermoelectric materials. The compounds in the system were examined due to the fact that the system is known to act as a concentrated Kondo system, a heavy fermion. Heavy fermions are known to possess high densities of state which are useful in thermoelectric applications. Two compounds in the system, $YbSb_2Te_4$ and $YbSb_4Te_7$, have been successfully synthesized in bulk by two methods: low temperature mechanical alloying and high temperature direct synthesis. The Hall mobility, Seebeck coefficient, electrical resistivity, and thermal conductivity were measured on both the unannealed and annealed compounds up to 550°C to determine the dimensionless thermoelectric figure of merit, ZT. The results indicate that both compounds make promising candidates for use in thermoelectric devices.

Pressures in Tumuli: A Study of Tumuli Formation
James Hansen
Mentor: Susanne Smrekar

Tumuli form via localized inflation in surface lava flows. These domed features have widths of 10–20 m, lengths of 10–150 m, and heights of 1–9 m. The axial fracture exposes a brittle crust overlying a ductilely deformed layer. The total crustal thickness is typically less than 1m. Tumuli are observed on both terrestrial and martian lava flow surfaces, and provide insight on the flow formation processes and rates. Past studies have estimated the inflation pressure using a bending model for a circular, thin elastic plate, assuming small deflection (Rossi and Gudmundson, 1996). This formulation results in unrealistic pressures for some tumuli. We thus examine alternative models, including those with different shapes, bending of the ductile crust, large deflection, plastic deformation, and thick plate bending. Using the thickness of the ductile crust in the equations for thin, circular plates reduces most pressures to reasonable values. Alternative plate shapes do not cause a significant reduction in inflation pressure. Although the large deflection equations should be applicable based on the plate thickness to tumuli height ratios, they give even less realistic pressures. Tumuli with unrealistic pressures appear to have exceeded the critical bending moment, and have relatively thick crusts, requiring thick plate bending models.

Optical Characterization of Cryptoendolithic Chemical Biosignatures on Antarctic Sandstone Surfaces
Ellen Harju
Mentor: Pamela Conrad

We have used several non-destructive optical techniques to study the distribution of organic molecules on an Antarctic sandstone sample collected at Battleship Promontory.

Cryptoendolithic microorganisms have been found to inhabit rocks in the dry valleys of Antarctica. These dry deserts are an Earth analog to Mars. Future Mars rovers may search for life in the rocks of Mars with similar instrumentation used in this study. Light microscopy was used to determine five distinct regions and to determine textures on the sample. Deep ultraviolet fluorescence spectroscopy was used to scan the rock for the presence of organic molecules. Organic molecules were present in three of the five regions but not in the crust. There were similarities between each region, but each region presented a unique signature. Raman spectroscopy identified the minerals present and also provided more definitive identifications of the organic molecules. X-ray diffraction was also used to definitively identify the minerals present and corroborate the Raman mineral results.

A Perfect View of Vesta: Creating Pointing Observations for the Dawn Spacecraft on Asteroid 4 Vesta
Katrina M. Hay
Mentors: Carol A. Raymond and Carol A. Polanskey

The Dawn spacecraft has a timely and clever assignment in store. It will take a close look at two intact survivors from the dawn of the solar system (asteroids 4 Vesta and 1 Ceres) to understand more about solar system origin and evolution. To optimize science return, Dawn must make carefully designed observations on approach and in survey orbit, high altitude mapping orbit, and low altitude mapping orbit at each body. In this report, observations outlined in the science plan are modeled using the science opportunity analyzer program for the Vesta encounter. Specifically, I encoded Dawn's flight rules into the program, modeled pointing profiles of the optical instruments (framing camera, visible infrared spectrometer) and mapped their fields of view onto Vesta's surface. Visualization of coverage will provide the science team with information necessary to assess feasibility of alternative observation plans. Dawn launches in summer 2006 and ends its journey in 2016. Instrument observations on Vesta in 2011 will supply detailed information about Vesta's surface and internal structure. These data will be used to analyze the formation and history of the protoplanet and, therefore, complete an important step in understanding the development of our solar system.

Dual-Band Deramp Radar Design for Ocean Current Measurements
Mark Haynes
Mentor: Alina Moussessian

A mission has been proposed to remotely measure ocean surface currents and surface wind velocities. It will provide the highest resolution and repeat time of these measurements to date for ocean current models with scientific and societal applications. A ground-based experimental radar unit is needed for proof of concept. The proposed experiment set up is to mount the radar on an oil rig to imitate satellite data acquisition. This summer, I completed the radar design. The design employs chirp/deramp topology with simultaneous transmit/receive channels. These two properties allow large system bandwidth, extended sample time, close range imaging, and low sampling rate. The radar operates in the Ku and Ka microwave bands, at 13.5 and 35.5 GHz, respectively, with a system bandwidth of 300 MHz. I completed the radar frequency analysis and research on potential components and antenna configurations. Subsequent work is needed to procure components, as well as to build, test, and deploy the radar.

A Study of the Measurement of Seebeck Coefficient of SiGe
King Yi (Fiona) Heung
Mentor: Jeff Snyder

In 1821 German Physicist Thomas J. Seebeck discovered that heat could be converted into electricity when a temperature difference was applied across two points on a material. Theoretically, the generated voltage has a directly proportional relationship with the temperature difference. This relationship is the Seebeck coefficient that scientists always referred to when determining the efficiency of a thermoelectricity convention. In our experiments, however, hysteresis loops appeared when we plotted voltage against temperature difference, and the measured Seebeck appeared differently when the measurements were run under vacuum, air, and helium gas. Measurements were done by using a low-frequency AC measuring method. By simulating the experimental setup into a thermal circuit, we found that the loop and inconsistency in measuring Seebeck coefficient could be explained by studying the behaviors of a RC circuit in a thermal sense. Under vacuum, the gap of the hysteresis loop can be largely eliminated if the time period of the temperature difference increased up to 4800 s. The trend of the variations in measuring Seebeck coefficients in different environments can also be predicted by using different thermal circuit models.

Satellite Calibration With LED Detectors at Mud Lake
Jonathan Hiller
Mentor: Carol Bruegge

Earth-monitoring instruments in orbit must be routinely calibrated in order to accurately analyze the data obtained. By comparing radiometric measurements taken on the ground in conjunction with a satellite overpass, calibration curves are derived for an orbiting instrument. A permanent, automated facility is planned for Mud Lake, Nevada (a large, homogeneous, dry lakebed) for this purpose. Because some orbiting instruments have low resolution (250 meters per pixel), inexpensive radiometers using LEDs as sensors are being developed to array widely over the lakebed. LEDs are ideal because they are inexpensive, reliable, and sense over a narrow bandwidth. By obtaining and averaging widespread data, errors are reduced and long-term surface changes can be more accurately observed.

Relevant Parameter Evolution in Team X Mission Concept Designs
Brandon Huelman
Mentor: Theresa Anderson

The Advanced Projects Design Team, also known as Team X, is a concurrent engineering team that quickly and cheaply designs space mission architectures including the flight system and subsystems, the trajectory, and ground system. Through the use of ICEMaker, an Excel spreadsheet database, the parameters from each subsystem can be shared and used among the other subsystems. This allows for entire missions to be planned with only a few short design team sessions. Based on the results, the feasibility of the mission concept can be determined. Over the years since the team was created, the amount of information being shared among subsystems on the database has increased, however many of the parameters are now obsolete. Removal of these unused parameters will clean up the database and help to streamline the mission design process. By comparing parameter files from previous Team X mission studies, the parameter usage can be determined. As was initially suspected there are more unused parameters on the database than parameters that are actually used.

CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design
Bing Huo
Mentor: Craig Peterson

New technology in space exploration is often developed without a complete knowledge of its impact. While the immediate benefits of a new technology are obvious, it is harder to understand its indirect consequences, which ripple through the entire system. CoMET is a technology evaluation tool designed to illuminate how specific technology choices affect a mission at each system level. CoMET uses simplified models for mass, power, and cost to analyze performance parameters of technologies of interest. The sensitivity analysis that CoMET provides shows whether developing a certain technology will greatly benefit the project or not. CoMET is an ongoing project approaching a web-based implementation phase. This year, development focused on the models for planetary daughter craft, such as atmospheric probes, blimps and balloons, and landers. These models are developed through research into historical data, well established rules of thumb, and engineering judgment of experts at JPL. The model is validated by corroboration with JPL advanced mission studies. Other enhancements to CoMET include adding launch vehicle analysis and integrating an updated cost model. When completed, CoMET will allow technological development to be focused on areas that will most drastically improve spacecraft performance.

At-Least Version of the Generalized Minimum Spanning Tree Problem: Optimization Through Ant Colony System and Genetic Algorithms
Karl Janich
Mentor: Payman Arabshahi

The At-Least version of the Generalized Minimum Spanning Tree Problem (L-GMST) is a problem in which the optimal solution connects all defined clusters of nodes in a given network at a minimum cost. The L-GMST is NP-Hard; therefore, metaheuristic algorithms have been used to find reasonable solutions to the problem as opposed to computationally feasible exact algorithms, which many believe do not exist for such a problem. One such metaheuristic uses a swarm-intelligent Ant Colony System (ACS) algorithm, in which agents converge on a solution through the weighing of local heuristics, such as the shortest available path and the number of agents that recently used a given path. However, in a network using a solution derived from the ACS algorithm, some nodes may move around to different clusters and cause small changes in the network makeup. Rerunning the algorithm from the start would be somewhat inefficient due to the significance of the changes, so a genetic algorithm based on the top few solutions found in the ACS algorithm is proposed to quickly and efficiently adapt the network to these small changes.

Camera Image Transformation and Registration for Safe Spacecraft Landing and Hazard Avoidance
Brandon M. Jones
Mentor: Ayanna Howard

Inherent geographical hazards of Martian terrain may impede a safe landing for science exploration spacecraft. Surface visualization software for hazard detection and avoidance may accordingly be applied in vehicles such as the Mars Exploration Rover (MER) to induce an autonomous and intelligent descent upon entering the planetary atmosphere. The focus of this project is to develop an image transformation algorithm for coordinate system matching between consecutive frames of terrain imagery taken throughout descent. The methodology involves integrating computer vision and graphics techniques, including affine transformation and projective geometry of an object, with the intrinsic parameters governing spacecraft dynamic motion and camera calibration.

Geographic Information Systems and Martian Data: Compatibility and Analysis
Jennifer L. Jones
Mentors: Barbara McGuffie and Eric De Jong

Planning future landed Mars missions depends on accurate, informed data. This research has created and used spatially referenced instrument data from NASA missions such as the Thermal Emission Imaging System (THEMIS) on the Mars Odyssey Orbiter and the Mars Orbital Camera (MOC) on the Mars Global Surveyor (MGS) Orbiter. Creating spatially referenced data enables its use in Geographic Information Systems (GIS) such as ArcGIS. It has then been possible to integrate this spatially referenced data with global base maps and build and populate location based databases that are easy to access.

Qualifying a Bonding Process for the Space Interferometry Mission
Gretchen Joyce
Mentor: Stephanie Buck

The Space Interferometry Mission consists of three parallel Michelson interferometers that will be capable of detecting extrasolar planets with a high degree of accuracy and precision. High levels of stability must be met in order to fulfill the scientific requirements of this mission. To attain successful measurements the coefficient of thermal expansion between optics and bonding material must be minimized without jeopardizing the integrity of the bonds. Optic-to-optic bonds have been analyzed to better understand variables such as the effects of the coefficient of thermal expansion differences between optics and bonding materials, and materials have been chosen for the project based on these analyses. A study was conducted to determine if a reliable, repeatable process for bonding by wicking adhesive could be obtained using a low-viscosity epoxy and ultra-low expansion glass. A process of creating a methodology of bonding fused silica optics with Z-6020 silane primer and Epo-Tek 301 epoxy will be discussed.

Cerebellum Augmented Rover Development
Matthew King
Mentor: Christopher Assad

Bio-Inspired Technologies and Systems (BITS) are a very natural result of thinking about Nature's way of solving problems. Knowledge of animal behaviors can be used in developing robotic behaviors intended for planetary exploration. This is the expertise of the JPL BITS Group and has served as a philosophical model for NMSU *Rio*RoboLab. Navigation is a vital function for any autonomous system. Systems must have the ability to determine a safe path between their current location and some target location. The MER mission, as well as other JPL rover missions, uses a method known as dead-reckoning to determine position information. Dead-reckoning uses wheel encoders to sense the wheel's rotation. In a sandy environment such as Mars, this method is highly inaccurate because the wheels will slip in the sand. Improving positioning error will allow the speed of an autonomous navigating rover to be greatly increased. Therefore, local navigation based upon landmark tracking is desirable in planetary exploration. The BITS Group is developing navigation technology based upon landmark tracking. Integration of the current rover architecture with a cerebellar neural network tracking algorithm will demonstrate that this approach to navigation is feasible and should be implemented in future rover and spacecraft missions.

The Optimization of Trained and Untrained Image Classification Algorithms for Use on Large Spatial Datasets
Michael Kocurek
Mentors: Kiri Wagstaff and Dominic Mazzoni

The HARVIST project seeks to automatically provide an accurate, interactive interface to predict crop yield over the entire United States. In order to accomplish this goal, large images must be quickly and automatically classified by crop type. Current trained and untrained classification algorithms, while accurate, are highly inefficient when operating on large datasets. This project sought to develop new variants of two standard trained and untrained classification algorithms that are optimized to take advantage of the spatial nature of image data. The first algorithm, harvist-cluster, utilizes divide-and-conquer techniques to precluster an image in the hopes of increasing overall clustering speed. The second algorithm, harvistSVM, utilizes support vector machines (SVMs), a type of trained classifier. It seeks to increase classification speed by applying a "meta-SVM" to a quick (but inaccurate) SVM to approximate a slower, yet more accurate, SVM. Speedups were achieved by tuning the algorithm to quickly identify when the quick SVM was incorrect, and then reclassifying low-confidence pixels as necessary. Comparing the classification speeds of both algorithms to known baselines showed a slight speedup for large values of k (the number of clusters) for harvist-cluster, and a significant speedup for harvistSVM. Future work aims to automate the parameter tuning process required for harvistSVM, and further improve classification accuracy and speed. Additionally, this research will move documents created in Canvas into ArcGIS. The launch of the Mars Reconnaissance Orbiter (MRO) will provide a wealth of image data such as global maps of Martian weather and high resolution global images of Mars. The ability to store this new data in a georeferenced format will support future Mars missions by providing data for landing site selection and the search for water on Mars.

A PdMn Based High Resolution Thermometer for the Temperature Range of 0.7–1 K
Peter Koo
Mentor: Melora Larson

EXperiments Along the Coexistence near Tricriticality (EXACT) will test exact predictions made by Renormalization Group theory by mapping the phase diagram of liquid ^3He and ^4He mixtures at the tricritical point, Tcp=0.867 K. A PdMn based High Resolution Thermometer (HRT) will be utilized by EXACT to make accurate measurements with a resolution that has never been attained for the temperature range 0.7–1 K. The basic design of this mini high resolution thermometer comprises a sensing element whose magnetic susceptibility changes with temperature, a thermal connector, magnetic shielding, and some permanent magnets to apply a constant magnetic field. In this study, we will quantitatively determine the resolution of possible sensing element candidates of 0.15%, 0.20%, and 0.25% ppm Mn and compare them with an annealed group of PdMn with the corresponding concentrations to see how this processing technique affects sensitivity.

Temperature Tolerant Evolvable Systems Utilizing FPGA Boards and Bias-Controlled Amplifiers
Nikhil Kumar
Mentor: Didier Keymeulen

Space missions often require radiation and extreme-temperature hardened electronics to survive the harsh environments beyond Earth's atmosphere. Traditional approaches to preserve electronics incorporate shielding, insulation and redundancy at the expense of power and weight. However, a novel way of bypassing these problems is the concept of evolutionary hardware. A reconfigurable device, consisting of several switches interconnected with analog/digital parts, is controlled by an evolutionary processor (EP). When the EP detects degradation in the circuit it sends signals to reconfigure the switches, thus forming a new circuit with the desired output.

This concept has been developed since the mid-1990s, but one problem remains—the EP cannot degrade substantially. For this reason, extensive testing at extreme temperatures (−180 to 120°C) has been done on devices found on FPGA boards (taking the role of the EP), such as the Analog to Digital and the Digital to Analog Converter. The EP is used in conjunction with a bias-controlled amplifier and a new prototype relay board, which is interconnected with 6 G4-FETs, a tri-input transistor-like element developed at JPL. The greatest improvements to be made lie in the reconfigurable device, so future design and testing of the G4-FET chip is required.

Small Dog-Like Quadruped Robot Powered With McKibben Air Muscles
John Lacy
Mentor: Chris Assad

Planetary surface robotic exploration is typically done by wheeled robots, which are limited to traveling on relatively flat terrain. The goal of this project was to design a bio-inspired robot to mimic the movements and agility of animals to navigate in various types of natural terrain, such as found on Mars. My objective for the summer was to design and construct a quadruped robot with a locomotion gait similar to a small dog. The design includes four legs and an actuated flexible spine for added mobility and performance; each leg has three joints—hip, knee, and ankle. I created 3D CAD models and machined the pieces for the assemblies of each part. One of the key areas of concern is weight vs. power issues for the driving force of locomotion. To maximize the power-to-weight ratio, I used McKibben air muscles to drive the motion of the quadruped. The prototype went through several iterations to analyze performance, with adjustments made to each assembly. We expect the final working prototype will be capable of standing unassisted and pronking into the air without active control. It will serve as a research platform for future bio-inspired control algorithms.

3DRT-MPASS
Ben Lickly
Mentor: Barbara McGuffie

Data from all current JPL missions are stored in files called SPICE kernels. At present, animators who want to use data from these kernels have to either read through the kernels looking for the desired data, or write programs themselves to retrieve information about all the needed objects for their animations. In this project, methods of automating the process of importing the data from the SPICE kernels were researched. In particular, tools were developed for creating basic scenes in Maya, a 3D computer graphics software package, from SPICE kernels.

Adaptive Optics: Arroyo Simulation Tool and Deformable Mirror Actuation Using Golay Cells
Adam Lint
Mentor: Hamid Hemmati

The Arroyo C++ libraries, written by Caltech post-doc student Matthew Britton, have the ability to simulate optical systems and atmospheric signal interference. This program was chosen for use in an end-to-end simulation model of a laser communication system because it is freely distributed and has the ability to be controlled by a remote system or "smart agent." Proposed operation of this program by a smart agent has been demonstrated, and the results show it to be a suitable simulation tool.

Deformable mirrors, as a part of modern adaptive optics systems, may contain thousands of tiny, independently controlled actuators used to modify the shape of the mirror. Each actuator is connected to two wires, creating a cumbersome and expensive device. Recently, an alternative actuation method that uses gas-filled tubes known as Golay cells has been explored. Golay cells, operated by infrared lasers instead of electricity, would replace the actuator system thereby creating a more compact deformable mirror. The operation of Golay cells and their ability to move a deformable mirror in excess of the required 20 microns has been demonstrated. Experimentation has shown them to be extremely sensitive to pressure and temperature, making them ideal for use in a controlled environment.

CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design
Angela Magee
Mentor: Craig Peterson

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The Different Wavelengths of Radio Science
Jessica Malecha
Mentor: Sami W. Asmar

Radio Science covers many different avenues. This summer I attempted to work in each of the different avenues to learn the full range of subjects covered by Radio Science. I began my summer by traveling to Greece for the 3rd International Planetary Probe Workshop (IPPW-3). I went as a co-author of the Doppler Wind Experiment (DWE) team paper. My first job when I returned from Greece was to update the Radio Science activities webpage. I then used Fast Fourier Transforms (FFT) to find radio signals in recorded Radio Science experimental data and determine frequencies and powers. I read about and ran Fortran code being used to determine wind measurements on Huygens. I formatted and revised the abstracts and data lengths for the DVD data sets. By performing these tasks, I also learned the Unix operating system as well as a small amount of shell programming.

Verifying Correct Functionality of Avionics Subsystems
Ben Meuer
Mentor: Martin Le

This project focuses on the testing of the telecommunications interface subsystem of the Multi-Mission System Architecture Platform to ensure proper functionality. The Multi-Mission System Architecture Platform is a set of basic tools designed to be used in future spacecraft. The responsibilities of the telecommunications interface include communication between the spacecraft and ground teams as well as acting as the bus controller for the system. The tests completed include bit wise read\write tests to each register, testing of status bits, and verifying various bus controller activities. Testing is accomplished through the use of software-based simulations run on an electronic design of the system. The tests are written in Verilog Hardware Definition Language and they simulate specific states and conditions telecommunication interfaces. Upon successful completion, the output is examined to verify that the system responded appropriately.

Asynchronous Messaging and Data Transfer in a Spacecraft: An Implementation
Joseph M. Moholt
Mentor: Amalaye Oyake

Data transfer and messaging is an important part of a spacecraft. Creating a standard protocol for messaging that can be used for a variety of applications is an extremely beneficial project at the Jet Propulsion Laboratory (JPL). The Asynchronous Messaging Service (AMS) is a protocol outlining how subsystems initialize and conduct communication between each other. There are currently two implementations of AMS in the works. At JPL, my task is to get a working implementation of AMS onto vxWorks as a proof of concept. An Autocoder, a program used to convert visually created state chart diagrams to C++, has also been created to accomplish a part of the implementation. I was assigned to make the program portable on any Unix type environment. Lastly, I was to develop a program to demonstrate messaging between two FireWire cards running vxWorks.

CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design
Craig Montuori
Mentor: Craig Peterson

New technology in space exploration is often developed without a complete knowledge of its impact. While the immediate benefits of a new technology are obvious, it is harder to understand its indirect consequences, which ripple through the entire system. CoMET is a technology evaluation tool designed to illuminate how specific technology choices affect a mission at each system level. CoMET uses simplified models for mass, power, and cost to analyze performance parameters of technologies of interest. The sensitivity analysis that CoMET provides shows whether developing a certain technology will greatly benefit the project or not. CoMET is an ongoing project approaching a web-based implementation phase. This year, development focused on the models for planetary daughter craft, such as atmospheric probes, blimps and balloons, and landers. These models are developed through research into historical data, well established rules of thumb, and engineering judgment of experts at JPL. The model is validated by corroboration with JPL advanced mission studies. Other enhancements to CoMET include adding launch vehicle analysis and integrating an updated cost model. When completed, CoMET will allow technological development to be focused on areas that will most drastically improve spacecraft performance.

A Method for Assessing the Accuracy of a Photogrammetry System for Precision Deployable Structures
Ashley Moore
Mentors: Gregory Agnes and Brett Williams

The measurement techniques used to validate analytical models of large deployable structures are an integral part of the technology development process and must be precise and accurate. Photogrammetry and videogrammetry are viable, accurate, and unobtrusive methods for measuring such large structures. Photogrammetry uses software to determine the three-dimensional position of a target using camera images. Videogrammetry is based on the same principle, except a series of timed images are analyzed. This work addresses the accuracy of a digital photogrammetry system used for measurement of large, deployable space structures at JPL. First, photogrammetry tests are performed on a precision space truss test article, and the images are processed using Photomodeler software. The accuracy of the Photomodeler results is determined through comparison with measurements of the test article taken by an external testing group using the VSTARS photogrammetry system. These two measurements are then compared with Australis photogrammetry software that simulates a measurement test to predict its accuracy. The software is then used to study how particular factors, such as camera resolution and placement, affect the system accuracy to help design the setup for the videogrammetry system that will offer the highest level of accuracy for measurement of deploying structures.

Vision and "Hand-Eye" Coordination for the Fujitsu HOAP-2 Humanoid Robot
Jeffrey D. Moore
Mentor: Adrian Stoica

Software was developed for a Fujitsu HOAP-2 humanoid robot to demonstrate that such "human form" robots can be used to perform useful tasks in an unknown environment; specifically, that they can operate with or in the place of humans to carry out construction operations necessary for space exploration, such as building or maintaining planetary surface habitats for humans. This paper describes the autonomous vision and hand-eye coordination software that enables the HOAP-2 to locate and manipulate objects. Simple vision and pattern detection algorithms including color filtering, noise filtering, image segmentation, orientation filters, and a feedback controlled tracking system enable the robot to locate marked building materials in the workspace. Experimentally determined spatial mappings associate locations in the visual field with the arm joint angles and trajectories necessary to reach these locations, allowing the robot to reach for and manipulate the building materials. These capabilities, when combined with locomotion capabilities, enable the robot to operate autonomously in an unknown workspace.

A Study in HRT Resolution: Seeking Maximum Sensitivity Among Variations in Sensing Element Material
Jeremy Morales
Mentor: Melora Larson

The EXACT (EXperiments Along Coexistence near Tricriticality) project endeavors to perform the most rigorous test to date of Renormalization Group theory. In most cases, the theory gives only approximate solutions, but it offers exact predictions in the case of the ^3He-^4He tricritical point. Currently, the project is focused on maximizing the performance of the low-temperature system's HRT (high resolution thermometer) near the tricritical point. The HRT uses a PdMn sensing element, the qualities of which change based on its Mn concentration and whether or not it is annealed. All sensing element combinations will be catalogued, and through the data, the optimum configuration will be reported.

Test Frame for Gravity Offload Systems
Alex Murray
Mentors: Gregory Agnes and Brett Williams

Advances in space telescope and aperture technology have created a need to launch larger structures into space. Traditional truss structures will be too heavy and bulky to be effectively used in the next generation of space-based structures. Large deployable structures are a possible solution. By packaging deployable trusses, the cargo volume of these large structures greatly decreases. The ultimate goal is to three dimensionally measure a boom's deployment in simulated microgravity. This project outlines the construction of the test frame that supports a gravity offload system. The test frame is stable enough to hold the gravity offload system and does not interfere with deployment of, or vibrations in, the deployable test boom. The natural frequencies and stability of the frame were engineered in FEMAP. The test frame was developed to have natural frequencies that would not match the first two modes of the deployable beam. The frame was then modeled in Solidworks and constructed. The test frame constructed is a stable base to perform studies on deployable structures.

CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design
Jennifer Needham
Mentor: Craig Peterson

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Photometric and Spectral Study of the Saturnian Satellites
Sarah Newman
Mentor: Bonnie Buratti

Photometric and spectral analysis of data from the Cassini Visual and Infrared Mapping Spectrometer (VIMS) has yielded intriguing findings regarding the surface properties of several of the icy Saturnian satellites. Spectral cubes were obtained of these satellites with a wavelength distribution in the IR far more extensive than from any previous observations. Disk-integrated solar phase curves were constructed in several key IR wavelengths that are indicative of key properties of the surface of the body, such as macroscopic roughness, fluffiness (or the porosity of the surface), global albedo and scattering properties of surface particles. Polynomial fits to these phase curves indicate a linear albedo trend of the curvature of the phase functions. Rotational phase functions from Enceladus were found to exhibit a double-peaked sinusoidal curve, which shows larger amplitudes for bands corresponding to water ice and a linear amplitude-albedo trend. These functions indicate regions on the surface of the satellite of more recent geologic activity. In addition, recent images of Enceladus show tectonic features and an absence of impact craters on the Southern latitudes which could be indicative of a younger surface. Investigations into the properties of these features using VIMS are underway.

Humanoid Robotics: Real-Time Object Oriented Programming
Jason Newton
Mentor: Adrian Stoica

Programming of robots in today's world is often done in a procedural oriented fashion, where object oriented programming is not incorporated. In order to keep a robust architecture allowing for easy expansion of capabilities and a truly modular design, object oriented programming is required. However, concepts in object oriented programming are not typically applied to a real time environment. The Fujitsu HOAP-2 is the test bed for the development of a humanoid robot framework abstracting control of the robot into simple logical commands in a real time robotic system while allowing full access to all sensory data. In addition to interfacing between the motor and sensory systems, this paper discusses the software which operates multiple independently developed control systems simultaneously and the safety measures which keep the humanoid from damaging itself and its environment while running these systems. The use of this software decreases development time and costs and allows changes to be made while keeping results safe and predictable.

Weather Satellite Thermal IR Responses Prior to Earthquakes
Daniel O'Connor
Mentor: Barbara McGuffie and Eric M. De Jong

A number of observers claim to have seen thermal anomalies prior to earthquakes, but subsequent analysis by others has failed to produce similar findings. What exactly are these anomalies? Might they be useful for earthquake prediction? It is the purpose of this study to determine if thermal anomalies can be found in association with known earthquakes by systematically co-registering weather satellite images at the sub-pixel level and then determining if statistically significant responses occurred prior to the earthquake event. A new set of automatic co-registration procedures was developed for this task to accommodate all properties particular to weather satellite observations taken at night, and it relies on the general condition that the ground cools after sunset. Using these procedures, we can produce a set of temperature-sensitive satellite images for each of five selected earthquakes (Algeria 2003; Bhuj, India 2001; Izmit, Turkey 2001; Kunlun Shan, Tibet 2001; Turkmenistan 2000) and thus more effectively investigate heating trends close to the epicenters a few hours prior to the earthquake events. This study will lay tracks for further work in earthquake prediction and provoke the question of the exact nature of the thermal anomalies.

Optimization of Polycyclic Aromatic Hydrocarbon (PAH) Extraction Efficiency Parameters for Sub- and Supercritical Water Extraction (SCWE) Instrument
Asahi Okada
Mentor: Xenia Amashukeli

Polycyclic aromatic hydrocarbons are a class of molecules composed of multiple, bonded benzene rings. As PAHs are believed to be present on Mars, positive confirmation of their presence on Mars is highly desirable. To extract PAHs, which have low volatility, a fluid extraction method is ideal, and one that does not utilize organic solvents is especially ideal for *in situ* instrumental analysis. The use of water as a solvent, which at subcritical pressures and temperatures is relatively non-polar, has significant potential. As SCWE instruments have not yet been commercialized, all instruments are individually-built research prototypes: thus, initial efforts were intended to determine if extraction efficiencies on the JPL-built laboratory-scale SCWE instrument are comparable to differing designs built elsewhere. Samples of soil with certified reference concentrations of PAHs were extracted using SCWE as well as conventional Soxhlet extraction. Continuation of the work would involve extractions on JPL's newer, portable SCWE instrument prototype to determine its efficiency in extracting PAHs.

CoMET: Cost and Mass Evaluation Tool for Spacecraft and Mission Design
Chester Ong
Mentor: Craig Peterson

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Miniature Instrumentation for SIPR (Subsurface Ice PRobe)
Karl Ostmo
Mentor: Miles Smith

Ice coring has proved to be a valuable scientific tool for determining climate history on Earth. The goal of the SIPR project is to develop a simple extraterrestrial ice sampling method of comparable value to coring. The SIPR probe works by melting its way through glacial ice, pumping the melt water to the surface for analysis as it descends hundreds of meters. The specific geometry of the probe, along with size and power constraints, requires creative diagnostic instrumentation. A thin, vertically strung heated filament will provide continuous-level monitoring of water in down-hole containers. The filament has an appreciable temperature coefficient to resistance (TCR), so as water cools the wire, its resistance decreases. At a constant electrical current, the voltage across the filament varies linearly with water level.

Tools of the Future: How Decision Tree Analysis Will Impact Mission Planning
Matthew Otterstatter
Mentor: Elisabeth Lamassoure

The universe is infinitely complex; however, the human mind has a finite capacity. The multitude of possible variables, metrics, and procedures in mission planning are far too many to address exhaustively. This is unfortunate because, in general, considering more possibilities leads to more accurate and more powerful results. To compensate, we can get more insightful results by employing our greatest tool, the computer.

The power of the computer will be utilized through a technology that considers every possibility, decision tree analysis. Although decision trees have been used in many other fields, this is innovative for space mission planning. Because this is a new strategy, no existing software is able to completely accommodate all of the requirements. This was determined through extensive research and testing of current technologies.

It was necessary to create original software, for which a short-term model was finished this summer. The model was built into Microsoft Excel to take advantage of the familiar graphical interface for user input, computation, and viewing output. Macros were written to automate the process of tree construction, optimization, and presentation.

The results are useful and promising. If this tool is successfully implemented in mission planning, our reliance on old-fashioned heuristics, an error-prone shortcut for handling complexity, will be reduced. The computer algorithms involved in decision trees will revolutionize mission planning. The planning will be faster and smarter, leading to optimized missions with the potential for more valuable data.

Effects of Cryogenic Temperatures on LEDs and Optical Fiber
Erica Pantel
Mentor: Arthur L. Lane

Light Emitting Diodes (LEDs) may provide a simple, low powered light source for future space missions. However, the effects of cryogenic temperatures on LEDs and optical fibers are largely unknown. Tests were performed on a selection of commercially-available LEDs, with wavelengths varying from 468 nm to 950 nm, as well as "white" LEDs. Dry ice and liquid nitrogen (LN_2) were used to bring the LEDs to the desired temperatures. The optical fibers were tested using a specially-machined brass cylinder that would allow the fibers to be cooled slowly and evenly in an LN_2 dewer. An optical fiber coupled to a spectrometer was used to acquired spectra of a calibration light source (wavelength range 253–922 nm) at various temperatures. Examination of the LED spectra has shown several different effects, depending on the LED in question. Those with wavelengths above 590 nm tend to show a "blue shift" in their peak wavelength and an increase in intensity. Other LEDs developed secondary or tertiary peaks, or showed no peak shift at all, although all LEDs did show an increase in observed intensity. The optical fiber showed a slight non-uniform decrease in transmission as the temperature cooled to –195°C.

Various Analyses of Structures and Systems Pertaining to Optical Communications
Collin W. Petersen
Mentors: Hamid Hemmati and Abijit Biswas

The Optical Communications Group intends to experiment with a 2 by 2 meter Fresnel lens to determine its likelihood as an alternative to focusing mirrors for optical communications. The lens was delivered in four sections. A support structure was required for the lens in order to hold the four sections in a single flat plane with an adjustable degree angle.

In order to use the 200-in. Hale telescope for optical communications purposes, an optical filter membrane must be used to pass the communications wavelength while blocking sunlight wavelengths. This filter must withstand wind gusts of up to 50 miles per hour. Stress analysis predicts that the membrane will survive with a safety factor greater than two. The methods used were verified by pressure testing the material.

Mechanical and thermodynamic analyses were performed on a simple Golay cell in order to optimize its dimensions for best performance.

Flexures are examined as an inexpensive alternative to traditional methods for kinematically constraining a 1.5-meter spherical mirror.

Irregular Wavelike Structure in Saturn's Rings
Benjamin Pollard
Mentors: Linda Spilker and Stuart Pilorz

We have searched Saturn's A, B, and C rings for irregular wavelike structure using Voyager Photopolarimeter (PPS), Ultraviolet Spectrometer (UVS), and Radio Science (RSS) occultation datasets, as well as ring reflectivity profiles derived from Voyager images. A maximum entropy technique for conducting spectral analysis was used to estimate wave frequency power in relation to radial location for each dataset.

Using this method we have found irregular structure in the PPS and UVS inner B Ring occultation datasets previously identified in Voyager imaging data. Both finer structure, with a wavelength of around 20 km, and large structure with wavelengths of 200 to 1000 km, are visible in the occultation data and appear similar to that seen in the imaging data.

After removing ringlets from the C-Ring data, we have identified what appears to be a 1000-km wave sustained throughout the ring. The large dominant wavelength appears in all datasets; however, tests are currently being conducted in an attempt to verify its existence.

Irregular structure with a wavelength of approximately 20 km has been observed in the C Ring reflectivity profiles, but not within the occultation datasets. This leads us to doubt it is caused by ring surface mass density fluctuations detectable by the occultation experiments.

Determining the Locations of Brown Dwarfs in Young Star Clusters
Lauren Porter
Mentor: Amanda Mainzer

Brown dwarfs are stellar objects with masses less than 0.08 times that of the Sun that are unable to sustain nuclear fusion. Because of the lack of fusion, they are relatively cold, allowing the formation of methane and water molecules in their atmospheres. Brown dwarfs can be detected by examining stars' absorption spectra in the near-infrared to see whether methane and water are present. The objective of this research is to determine the locations of brown dwarfs in Rho Ophiuchus, a star cluster that is only 1 million years old. The cluster was observed in four filters in the near-infrared range using the Wide-Field Infra-Red Camera (WIRC) on the 100" DuPont Telescope and

Persson's Auxiliary Nasymith Infrared Camera (PANIC) on the 6.5-m Magellan Telescope. By comparing the magnitude of a star in each of the four filters, an absorption spectrum can be formed. This project uses standard astronomical techniques to reduce raw frames into final images and perform photometry on them to obtain publishable data. Once this is done, it will be possible to determine the locations and magnitudes of brown dwarfs within the cluster.

Mitigation of Laser Beam Scintillation in Free-Space Optical Communication Systems Through Coherence-Reducing Optical Materials
Christoffer Renner
Mentor: Hamid Hemmati

Free-space optical communication systems (also known as lasercom systems) offer several performance advantages over traditional radio frequency communication systems. These advantages include increased data rates and reduced operating power and system weight. One serious limiting factor in a lasercom system is optical turbulence in Earth's atmosphere. This turbulence breaks up the laser beam used to transmit the information into multiple segments that interfere with each other when the beam is focused onto the receiver. This interference pattern at the receiver changes with time causing fluctuations in the received optical intensity (scintillation). Scintillation leads to intermittent losses of the signal and an overall reduction in the lasercom system's performance. Since scintillation is a coherent effect, reducing the spatial and temporal coherence of the laser beam will reduce the scintillation. Transmitting a laser beam through certain materials is thought to reduce its coherence. Materials that were tested included: sapphire, BK7 glass, fused silica and others. The spatial and temporal coherence of the laser beam was determined by examining the interference patterns (fringes) it formed when interacting with various interferometers and etalons.

An Advanced Orbiting Systems Approach to Quality of Service in Space-Based Intelligent Communication Networks
Andrew Riha
Mentor: Clayton Okino

As humans and robotic technologies are deployed in future constellation systems, differing traffic services will arise, e.g., realtime and non-realtime. In order to provide a quality of service framework that would allow humans and robotic technologies to interoperate over a wide and dynamic range of interactions, a method of classifying data as realtime or non-realtime is needed. In our paper, we present an approach that leverages the Consultative Committee for Space Data Systems (CCSDS) Advanced Orbiting Systems (AOS) data link protocol. Specifically, we redefine the AOS Transfer Frame Replay Flag in order to provide an automated store-and-forward approach on a per-service basis for use in the next-generation Interplanetary Network. In addition to addressing the problem of intermittent connectivity and associated services, we propose a follow-on methodology for prioritizing data through further modification of the AOS Transfer Frame.

Hydrothermal Vent Sampler: Does Life Exist in High Temperature Environments?
César Rivadeneyra
Mentors: Alberto Behar and Jaret Matthews

The main purpose of this research is to search for the existence of biomass under extreme temperature and pressure conditions to determine the upper bounds of environments on which life can exist. Vents are, simply put, underwater volcano openings located at the bottom of the sea. The conditions at these locations are considerably extreme with pressures of up to 10,000 psi, and enormous temperature gradients. The temperature of the water near these vents is around 400°C, while that of the surrounding water is about 3°C. The extremity of these conditions makes it hard to estimate the existence of life in those environments. In order to find whether such existence happens, we need to search for biomass inside these vents. The vent sampler is a device that has the purpose of safely and accurately collecting this biomass for examination. This sampler is constituted of a series of filters of the order of 100-0.2 microns in size. Since this is a 3-year project, it has not concluded yet; however, during the time I contributed to this project, I worked with the mechanical design of this sampler device including the selection, assembly, and testing of the various subsystems and the design and construction of the electronics enclosure.

Satellite Validation: A Project to Create a Data-Logging System to Monitor Lake Tahoe
Rudy A. Roy
Mentors: Simon Hook and Ali Abtahi

Flying aboard the satellite Terra, the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) is an imaging instrument used to acquire detailed maps of Earth's surface temperature, elevation, emissivity, and reflectance. An automated site consisting of four buoys was established 6 years ago at Lake Tahoe for the validation of ASTER's thermal infrared data. Using Campbell CR23X Dataloggers, a replacement system to be deployed on a buoy was designed and constructed for the measurement of the lake's temperature profile, surrounding air temperature, humidity, wind direction and speed, net radiation, and surface skin temperature. Each Campbell Datalogger has been programmed to control, power, and monitor 14 different temperature sensors, a JPL-built radiometer, and an RM Young 32500 meteorological station. The logger communicates with the radiometer and meteorological station through a Campbell SDM-SIO4 RS232 serial interface, sending polling commands, and receiving filtered data back from the sensors. This data is then cataloged and sent back across a cellular modem network every hour to JPL. Each instrument is wired via a panel constructed with 18 individual plugs that allow for simple installation and expansion. Data sent back from the system are analyzed at JPL, where they are used to calibrate ASTER data.

Radiometer Calibrations: Saving Time by Automating the Gathering and Analysis Procedures
Jeff Sadino
Mentors: Simon Hook and Ali Abtahi

Mr. Abtahi custom-designs radiometers for Mr. Hook's research group. Inherently, when the radiometers report the temperature of arbitrary surfaces, the results are affected by errors in accuracy. This problem can be reduced if the errors can be accounted for in a polynomial. This is achieved by pointing the radiometer at a constant-temperature surface. We have been using a Hartford Scientific WaterBath. The measurements from the radiometer are collected at many different temperatures and compared to the measurements made by a Hartford Chubb thermometer with a four-decimal point resolution. The data is analyzed and fit to a fifth-order polynomial. This formula is then uploaded into the radiometer software, enabling accurate data gathering. Traditionally, Mr. Abtahi has done this by hand, spending several hours of his time setting the temperature, waiting for stabilization, taking measurements, and then repeating for other temperatures. My program, written in the Python language, has enabled the data gathering and analysis process to be handed off to a less-senior member of the team. Simply by entering several initial settings, the program will simultaneously control all three instruments and organize the data suitable for computer analyses, thus giving the desired fifth-order polynomial. This will save time, allow for a more complete calibration data set, and allow for base calibrations to be developed. The program is expandable to simultaneously take any type of measurement from up to nine distinct instruments.

Aerogel Development
Rashmi Sahai
Mentor: Daniel Goods

Aerogel is one of the most promising materials of the future. Its unique properties, including high porosity, transparency, very high thermal tolerance, and environmental friendliness give it the potential of replacing many different products used in society today. However, the market for aerogel is still very limited because of the cost of producing the material and its fragility. The principle objective of my project has been to find new ways to apply aerogel in order to increase its practicality and appeal to different aspects of society. More specifically, I have focused on finding different chemicals that will coat aerogel and increase its durability. Because aerogel is so fragile and will crumble under the pressure of most coatings this has been no easy task. However, by experimenting with many different coatings and combinations of aerogel properties, I have made several significant discoveries. Aerogel (ideally, high density and hydrophobic) can be coated with several acrylic polymers, including artist's gel and nail polish. These materials provide a protective layering around the aerogel and keep it from breaking as easily. Because fragility is one of the main reasons applications of aerogel are limited, these discoveries will hopefully aid in finding future applications for this extraordinary material.

Upper Torso Control for HOAP-2 Using Neural Networks
Steven Sandoval
Mentor: Adrian Stoica

Humanoid robots have similar physical builds and motion patterns as humans. Not only does this provide a suitable operating environment for the humanoid but it also opens up many research doors on how humans function. The overall objective is replacing humans operating in unsafe environments. A first target application is assembly of structures for future lunar-planetary bases. The initial development platform is a Fujitsu HOAP-2 humanoid robot. The goal for the project is to demonstrate the capability of a HOAP-2 to autonomously construct a cubic frame using provided tubes and joints. This task will require the robot to identify several items, pick them up, transport them to the build location, then properly assemble the structure. The ability to grasp and assemble the pieces will require improved motor control and the addition of tactile feedback sensors. In recent years, learning-based control is becoming more and more popular; for implementing this method we will be using the Adaptive Neural Fuzzy Inference System (ANFIS). When using neural networks for control, no complex models of the system must be constructed in advance—only input/output relationships are required to model the system.

Multi-Mission System Architecture Platform: Design and Verification of the Remote Engineering Unit
John Sartori
Mentor: Martin Le

The Multi-Mission System Architecture Platform (MSAP) represents an effort to bolster efficiency in the spacecraft design process. By incorporating essential spacecraft functionality into a modular, expandable system, the MSAP provides a foundation on which future spacecraft missions can be developed. Once completed, the MSAP will provide support for missions with varying objectives, while maintaining a level of standardization that will minimize redesign of general system components. One subsystem of the MSAP, the Remote Engineering Unit (REU), functions by gathering engineering telemetry from strategic points on the spacecraft and providing these measurements to the spacecraft's Command and Data Handling (C&DH) subsystem. Before the MSAP project reaches completion, all hardware, including the REU, must be verified. However, the speed and complexity of the REU circuitry rules out the possibility of physical prototyping. Instead, the MSAP hardware is designed and verified using the Verilog Hardware Definition Language (HDL). An increasingly popular means of digital design, HDL programming provides a level of abstraction, which allows the designer to focus on functionality while logic synthesis tools take care of gate-level design and optimization. As verification of the REU proceeds, errors are quickly remedied, preventing costly changes during hardware validation. After undergoing the careful, iterative processes of verification and validation, the REU and MSAP will prove their readiness for use in a multitude of spacecraft missions.

Analyzing MER Uplink Reports
Stephen Savin
Mentor: Deborah Bass

The MER project includes two rovers working simultaneously on opposite sides of Mars each receiving commands only once a day. Creating this uplink is critical, since a failed uplink means a lost day and a waste of money. Examining the process of creating this uplink, I tracked the use of the system developed for requesting observations as well as the development, from stage to stage, in forming an activity plan. I found the system for requesting observations was commonly misused, if used at all. There are half a dozen reports to document the creation of the uplink plan and often there are discrepancies among them. Despite this, the uplink process worked very well and MER has been one of the most successful missions for NASA in recent memory. Still it is clear there is room for improvement.

Three Dimensional Rover/Lander/Orbiter Mission-Planning (3D-ROMPS) System: A Modern Approach to Mission Planning
Nathan Scharfe
Mentor: Barbara McGuffie

NASA's current mission planning system is based on point design, two-dimensional display, spread sheets, and report technology. This technology does not enable engineers to analyze the results of parametric studies of missions plans. This technology will not support the increased observational complexity and data volume of missions like Cassini, Mars Reconnaissance Orbiter (MRO), Mars Science Laboratory (MSL), and Mars Sample Return (MSR). The goal of the 3D-ROMPS task has been to establish a set of operational mission planning and analysis tools in the Image Processing Laboratory (IPL) Mission Support Area (MSA) that will respond to engineering requirements for planning future Solar System Exploration (SSE) missions using a three-dimensional display.

Utilizing Radioisotope Power Systems for Human Lunar Exploration
Timothy Schriener
Mentor: John Elliott

The Vision for Space Exploration has a goal of sending crewed missions to the lunar surface as early as 2015 and no later than 2020. The use of nuclear power sources could aid in assisting crews in exploring the surface and performing In-Situ Resource Utilization (ISRU) activities. Radioisotope Power Systems (RPS) provide constant sources of electrical power and thermal energy for space applications. RPSs were carried on six of the crewed Apollo missions to power surface science packages, five of which still remain on the lunar surface. Future RPS designs may be able to play a more active role in supporting a long-term human presence. Due to its lower thermal and radiation output, the planned Stirling Radioisotope Generator (SRG) appears particularly attractive for manned applications. The MCNPX particle transport code has been used to model the current SRG design to assess its use in proximity with astronauts operating on the surface. Concepts of mobility and ISRU infrastructure were modeled using MCNPX to analyze the impact of RPSs on crewed mobility systems. Strategies for lowering the radiation dose were studied to determine methods of shielding the crew from the RPSs.

Actuation of Deformable Mirrors Using Laser Controlled Pistons
Charles Scott
Mentor: Hamid Hemmati

Current deformable mirrors used for adaptive optics employ many actuators to adjust the mirror in order to compensate for optical irregularities. These mechanical actuators, which can number in the hundreds for a given mirror, require a significant amount of electrical wires in order to be controlled.

The objective of this research is to implement a different type of actuator that can be controlled without the use of wires. The actuator developed employs a laser to quickly heat and expand the air in a closed "cell." When the air expands, it pushes a membrane that causes the mirror to move. Creating an array of these cells, and scanning them with a laser can control a deformable mirror.

Testing showed that a single cell with a 5-mm diameter and 10-mm length can deflect a membrane of aluminized mylar in excess of our minimum requirement of 20 microns.

These cells can now be assembled in a 5×5 matrix and attached to many small mirrors. An electro-mechanical scanning assembly can be used to aim the laser directly onto individual cells, causing the mirror at that location to move.

Distribution and Diversity of Organic and Biological Signatures in Soils From the Atacama Desert
Aditi Sharma
Mentor: Alexandre I. Tsapin

The Atacama Desert is amongst the driest places on Earth. It is considered to be a suitable analog for the Martian surface in which to conduct studies of life and life detection. Soil samples were collected in June 2005 from the Atacama Desert and analyzed in the lab for amino acid content. HPLC was the primary tool used to analyze samples. The amino acids of interest are aspartic acid, serine, glutamic acid, glycine, and alanine. D and L isomers of each amino acid (except for glycine) were separated through HPLC. The purpose of this study is to find correlations between location of the sample collection sites and amino acid content as well as D/L isomer ratios in order to formulate theories of how different types of environments may affect the abundance and distribution of life forms. Initial analysis of data shows a general lack of or slight correlation between location and amino acid content. Some data appears to contradict the hypothesis that harsher environments would have a lower amino acid content than less harsh environments. Further analysis of data is needed to come up with a more conclusive report of the distribution of amino acids in the Atacama Desert.

A Population Study of Wide-Separation Brown Dwarf Companions to Main Sequence Stars
Jeffrey J. Smith
Mentor: Joseph C. Carson

Increased interest in infrared astronomy has opened the frontier to study cooler objects that shed significant light on the formation of planetary systems. Brown dwarf research provides a wealth of information useful for sorting through a myriad of proposed formation theories. Our study combines observational data from 2MASS with rigorous computer simulations to estimate the true population of long-range (>1000 AU) brown dwarf companions in the solar neighborhood (<25 pc from Earth). Expanding on Gizis et al. (2001), we have found the margin of error in previous estimates to be significantly underestimated after we included orbit eccentricity, longitude of pericenter, angle of inclination, field star density, and primary and secondary luminosities as parameters influencing the ability to detect brown dwarf companion systems in observational studies. We apply our simulation results to current L- and T-dwarf catalogues to provide updated estimates on the frequency of wide-separation brown dwarf companions to main sequence stars.

Compact Micro-Imaging Spectrometer (CMIS): Investigation of Imaging Spectroscopy and Its Application to Mars Geology and Astrobiology
Paul Staten
Mentor: R. Glenn Sellar

Future missions to Mars will attempt to answer questions about Mars' geological and biological history. The goal of the CMIS project is to design, construct, and test a capable, multi-spectral micro-imaging spectrometer for use in such missions. A breadboard instrument has been constructed with a micro-imaging camera and several multi-wavelength LED illumination rings. Test samples have been chosen for their interest to spectroscopists, geologists and astrobiologists. Preliminary analysis has demonstrated the advantages of isotropic illumination and micro-imaging spectroscopy over spot spectroscopy.

Analysis of Quantum Information Test-Bed by Parametric Down-Converted Photons Interference Measurement
Wing To
Mentor: Deborah Jackson

Quantum optical experiments require all the components involved to be extremely stable relative to each other. The stability can be "measured" by using an interferometric experiment. A pair of coherent photons produced by parametric down-conversion could be chosen to be orthogonally polarized initially. By rotating the polarization of one of the wave packets, they can be recombined at a beam splitter such that interference will occur. Theoretically, the interference will create four terms in the wave function. Two terms with both photons going to the same detector, and two terms will have the photons each going to different detectors. However, the latter will cancel each other out, thus no photons will arrive at the two detectors simultaneously under ideal conditions. The stability of the test-bed can then be inferred by the dependence of coincidence count on the rotation angle.

Solar System Visualization (SSV) Project
Jessica Todd
Mentors: Barbara McGuffie and Eric De Jong

The Solar System Visualization (SSV) project aims at enhancing scientific and public understanding through visual representations and modeling procedures. The SSV project's objectives are to (1) create new visualization technologies, (2) organize science observations and models, and (3) visualize science results and mission plans. The SSV project currently supports the Mars Exploration Rovers (MER) mission, the Mars Reconnaissance Orbiter (MRO), and Cassini. In support of the these missions, the SSV team has produced pan and zoom animations of large mosaics to reveal details of surface features and topography, created 3D animations of science instruments and procedures, formed 3-D anaglyphs from left and right stereo pairs, and animated registered multi-resolution mosaics to provide context for microscopic images.

MECA TECP Testing and Experimentation
Erik Tollerud
Mentor: Mike Hecht

MECA (the Microscopy, Electrochemistry, Conductivity Analyzer) is an instrument on the Phoenix 2007 mission to Mars designed to investigate the properties of high-latitude Martian soils. One of the MECA components, TECP (the Thermal and Electrical Conductivity Probe) is in an advanced stage of hardware development but requires testing and characterization. Two separate experiments are examined to attempt to answer open questions regarding the operation of the TECP. The humidity sensor tests showed a number of important details about the operation and design of the humidity sensor integrated on the TECP. The second experiment focused on the details of how the TECP contacts the soil it is inserted into and provided important answers to questions regarding the viability of this method of characterizing soils.

Investigation of Solar Radiation Properties at the Battleship Promontory Area, Antarctica
Sara Van Nortwick
Mentor: Arthur L. Lane

JPL scientists in January 2005 visited the unique Battleship Promontory Area of the Antarctic Dry Valleys at 76° 54′ S, one of the few places on the Antarctic continent home to viable life. Cryptoendolithic microorganisms manage to survive on and inside rocks in Antarctica's harsh conditions of extreme dryness and cold that are not so different from the past and present conditions on Mars. We are investigating the physical properties of these biological creatures through analysis of optical spectra collected from a variety of rock samples over the deep UV, visible, and near-infrared regions with the intent of gaining key insights into the environmental factors that make such a habitat viable for life. The LabView programming environment is equipped with the tools necessary to create an interface to visualize, manipulate, and normalize extensive raw reflectance and corresponding incident spectral data. We are determining the meaning of the colors observed and their relationship to the ability to acquire energy and investigating differences between the photosynthetic processes in full sunlight and diffuse/shadow lighting. Comparisons between spectral data collected in the field and from returned samples in the lab validate the accuracy of our field collection methodology.

Team X Spacecraft Instrument Database Consolidation
Kelly Wallenstein
Mentor: Terri Anderson

In the past decade, many changes have been made to Team X's process of designing each spacecraft, with the purpose of making the overall procedure more efficient over time. One such improvement is the use of information databases from previous missions, designs, and research. By referring to these databases, members of the design team can locate relevant instrument data and significantly reduce the total time they spend on each design.

The files in these databases were stored in several different formats with various levels of accuracy. During the past 2 months, efforts have been made in an attempt to combine and organize these files. The main focus was in the Instruments department, where spacecraft subsystems are designed based on mission measurement requirements. A common database was developed for all instrument parameters using Microsoft Excel to minimize the time and confusion experienced when searching through files stored in several different formats and locations. By making this collection of information more organized, the files within them have become more easily searchable. Additionally, the new Excel database offers the option of importing its contents into a more efficient database management system in the future. This potential for expansion enables the database to grow and acquire more search features as needed.

BEAM Technology Flight Demonstration
David Wang
Mentor: Ryan M. Mackey

As technologies advance, their growing complexity makes them harder to maintain. Detection methods for isolating and identifying impending problems are needed to balance this complexity. Through comparison of signal pairs from onboard sensors, the Beacon-based Exception Analysis for Multimissions (BEAM) algorithm can identify and help classify deviations in system operation from a data-trained statistical model.

The goal of this task is to mature BEAM and validate its performance on a flying test bed. A series of F-18 flight demonstrations with BEAM monitoring engine parameters in real time was used to demonstrate in-the-field readiness.

Captured F-18 and simulated F-18 engine data were used in model creation and training. The algorithm was then ported to the embedded system with a data buffering, file writing, and data-time-stamp monitoring shell to reduce the impact of embedded system faults on BEAM's ability to correctly identify engine faults. Embedded system testing identified hardware related restrictions and contributed to iterative improvements in the code's runtime performance.

The system was flown with forced engine flameouts and other pilot induced faults to simulate operation out of the norm. Successful detection of these faults, confirmed through post-flight data analysis, helped BEAM achieve TRL6.

SHERPA Electromechanical Test Bed
John Wason
Mentor: J. (Bob) Balaram

SHERPA (Strap-on High-altitude Entry Reconnaissance and Precision Aeromaneuver system) is a concept for low-cost-high-accuracy Martian reentry guidance for small scout-class missions with a capsule diameter of approximately 1 meter. This system uses moving masses to change the center of gravity of the capsule in order to control the lift generated by the controlled imbalance. This project involved designing a small proof-of-concept demonstration system that can be used to test the concept through bench-top testing, hardware-in-the-loop testing, and eventually through a drop test from a helicopter. This project has focused on the Mechatronic design aspects of the system including the mechanical, electrical, computer, and low-level control of the concept demonstration system.

Crewbot Suspension Design
Nathan Wood
Mentor: Brett Kennedy

Planetary Surface Robot Work Crews (RWC) represent a new class of construction robots for future deployment in planetary exploration. Rovers currently being used for the RWC platform lack the load carrying capabilities required in regular work. Two new rovers, dubbed Crewbots, being designed in JPL's Planetary Robotics Lab specifically for RWC applications greatly increase the load carrying capabilities of the platform.

A major component of the rover design was the design of the rocker type suspension, which increases rover mobility. The design of the suspension for the Crewbots departed from the design of recent rovers. While many previous rovers have used internal bevel gear differentials, the increased load requirements of the Crewbots calls for a more robust system. The solution presented is the use of an external modified three-bar, slider-linkage, rocker-style suspension that increases the moment arm of the differential. The final product is a suspension system capable of supporting the extreme loading cases the RWC platform presents, without consuming a large portion of the Crewbots' internal space.

Characterization of Unimorph-Membrane Microactuators and Error-Analysis of the Characterization Process
Matthew Wright
Mentor: Eui-Hyeok Yang

Microactuators are versatile, low-cost, low-mass electrical-mechanical devices that can be used in many applications. Microactuators consist of two electrodes sandwiching a PZT (piezo-electric) film between them. The centers of the microactuators deflect when a voltage is applied across the electrodes. In order to correctly apply this technology for use, it is important to fully characterize the actuation behavior. Measuring the deflection profile as a function of the voltage of various microactuators is crucial. This measurement process has errors associated with it, so it is being studied to determine the accuracy of the data. In certain applications, microactuators may undergo many cycles of deflection; testing various microactuators through many cycles of deflection simulates these circumstances. However, due to an unknown issue, many of the microactuators exhibit defects that cause them to fail when voltage is applied to their electrodes. These defects do not allow for the acquisition of significant deflection profiles. Vibrations are the largest cause of error in deflection measurements, and the microactuators withstand continuous cycles of deflection, yet the cause of damage is still to be determined. Future projects will be needed to characterize the deflection profiles of various microactuators and to overcome the defects in the microactuators that are currently present.

Reconfigurable Advanced Receiver Design and Implementation
Jiajing Xu
Mentor: Kourosh Rahnamai

While the demand for real-time broadband information access has grown and continues to grow at a rapid pace, the need for a reconfigurable receiver system has increased. To achieve the goal to communicate with multiple shuttles at a time, a filter bank in polyphase structure is introduced. This paper presents the design and implementation for high-speed, high-performance, and fixed-point polyphase filter banks. The polyphase filter structure is designed such that the use of a fixed-point system has minimum impact on the performance of the filter. The final hardware implementation is done on a Xilinx FPGA chip.

A Unifying Multibody Dynamics Algorithm Development Workbench
John Ziegler
Mentor: Abhinandan Jain

The development of new and efficient algorithms for multibody dynamics has been an important research area. These algorithms are used for modeling, simulation, and control of systems such as spacecraft, robotic systems, automotive applications, the human body, manufacturing operations, and micro-electromechanical systems (MEMS). At JPL's Dynamics and Real Time Simulation (DARTS) Laboratory we have developed software that serves as a computational workbench for these algorithms. This software utilizes the mathematical perspective of the spatial operator algebra, which allows the development of dynamics algorithms and new insights into multibody dynamics.

Equipping an FPGA-Based Mars Rover With an LN-200 IMU
Nicholas Zola
Mentor: R. Kevin Watson

The Mars Exploration Rovers (MER) currently navigating the surface of Mars are outfitted with an advanced stereo-vision correlation algorithm which allows them to "see" three-dimensionally and autonomously avoid obstacles in their path. A bottleneck of this system is that it is computationally intense and requires 3 minutes of processing for every correlated image and path choice. Taking advantage of the optimization and reprogrammability of FPGAs, the Mobility Avionics lab has reduced this process to under a second. The lab is demonstrating the advancement with a prototype rover, complete with an LN-200 inertial measurement unit (IMU), which is a flight spare from MER. The LN-200 is a space-grade, six degrees-of-freedom IMU using three fiber-optic gyroscopes and three silicon accelerometers and no moving parts. It has particular power-sequencing needs and communicates with a specialized serial protocol (SDLC over RS-422), requiring specific hardware and software for proper functionality and interfacing with an FPGA. The process of incorporating the LN-200 into the system is described herein.

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In 2005, over 150 undergraduate students and first-year graduate students participated in a variety of research programs coordinated by the Jet Propulsion Laboratory Education Office in conjunction with the Caltech Student-Faculty Programs Office. The programs give students the opportunity to conduct research under the guidance of an experienced mentor for a 10-week period. Students gain valuable experience while contributing to the ongoing goals of JPL. Students are required to submit progress reports and an abstract, and to give an oral presentation of their projects to an audience of JPL staff and other students. This set of abstracts provides brief descriptions of the projects that were conducted by these students and their mentors. A schedule of student talks is also included.

Students presenting their work have come to JPL through one of the following programs: SURF – Summer Undergraduate Research Fellowships, MURF – MURF Undergraduate Research Fellowships, NASA USRP – Undergraduate Student Research Program, NASA Space Grant Work Force Development Program, and NASA PGGURP – Planetary Geology and Geophysics Undergraduate Research Program.

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