

ACKNOWLEDGEMENTS

This thesis represents not only my work at the keyboard, it is a milestone in more than one decade of work at MIT and specifically within the Space Systems Laboratory. My experience at MIT has been nothing short of amazing. Since my first day during RO on August 16th, 1994 I have felt at home at MIT. I have been given unique opportunities... and taken advantage of them. This includes working at the SSL for over ten years, starting as an undergraduate research assistant in the Spring of 1996. Throughout these years I have learned that there are those who build tools and those who use them; my passion is in creating the tools used in cutting edge research. This thesis presents the lessons learned in creating one of those special tools: SPHERES. SPHERES is the result of work by dozens of people, who I wish to thank. But this thesis is also the result of many experiences I have encountered at MIT from dozens of remarkable individuals who I also wish to acknowledge.

First and foremost I wish to thank my advisor, professor **Dave Miller**, director of the MIT Space Systems Laboratory. He has been supportive since the days I began working on the Origins testbed as an undergraduate; I remember he used to say something like "you're always the first one in and the last one out working on that project!" to encourage me to stay in the lab. Ever since, Dave has supported me not only by providing a research assistantship over almost seven years, but also academically and emotionally through the rough road to finish this thesis. Thanks to him I had the opportunity to build SPHERES... and test it in the KC-135! He helped me come up with the thesis topic and guided me over almost a year of development. And during the most difficult times when writing this thesis, he gave me the moral support and the freedom I needed to move on.

My thesis committee guided me through all these years. Thank you to **Jonathan How, Eric Feron, Brian Williams, and Javier deLuis** for being my major advisors. Jon and Brian supported SPHERES with several students; Eric guided me through my undergraduate capstone class; and Javier has supported SPHERES and my research since 1999. Also thank you to **Jeff Hoffman** for being part of my Generals committee, a thesis reader, and an inspiration in many ways. And thank you to **Dava Newman**, with whom I worked with as associate advisor for two years during my undergraduate career and whom became one of my thesis readers.

Dozens of people have helped and taught me immensely at the MIT SSL. *Mom Sharon* welcomed me to the lab my sophomore year in 1996. She has been a source of love and energy ever since. Dave's assistants, **Peggy** and **Marilyn** have been amazing help all this time. And then, there's the students before me, mentors in many ways. My UROP supervisors **Graeme Shaw** in 1996 and **Greg Mallory** in 1997-98, with whom my 'permanent' stay at the SSL began. **Cyrus Jilla** who has been an inspiration on how to make things 'perfect'. A special acknowledgement goes to my office mate of many years: **Laila Elias**.

She was a true friend ever since we began to share an office in 1999. Laila is an amazing person in too many ways. And I also thank **Becky** and **Scott** (also Aero/Astro class of '98!), my other great office mates who have been supportive in every way. Also thank you to **Rick** and **Luke** for three years of trips to the mountains.

A special group from the SSL is not mentioned yet, because they deserve their own part: the *SPHERES team*. I praise the enormous amount of help and teaching by **Paul Bauer** throughout these years. Thank you to those who helped the project as staff and graduate students: **Ray Sedwick, Edmund Kong, Mark Hilstad** (and for teaching me to ski!), **John Enright** (and Sarah), **Alice Liu, Simon Nolet, Dustin Berkovitz, Arthur Richards, Al Chen, Soon-Jo Chung, and Ryan Lim**. Also thank you to everyone at Payload Systems who has helped with the project and supported me in many ways: **Javier de Luis, Steve Sell, Stephanie Chen, Bob Grimes, Edison Guerra, John Merk, Chris Rockhold** and the marvelous **Joanne Vining**. I also recognize the support and help from the *Air Force STP* and *DARPA* offices for their support of the SPHERES program. And, for providing the experience of a lifetime, thank you to **John Yaniec** and the *NASA JSC RGO* for their support of five SPHERES reduced gravity campaigns. Lastly, I wish to acknowledge the thirteen students who taught me how to teach a lab class and who built the prototype SPHERES: *George Berkowski, Chad Brodel, Sarah Carlson, Dave Carpenter, Stephanie Chen, Allen Chen, Shannon Cheng, Daniel Feller, Stuart Jackson, Fernando Perez, Bradley Pitts, Jason Szuminski, and Julie Wertz*.

I also thank an organization: the *Tech Model Railroad Club*. Thanks to the hands-on work in building things at the club I got my second UROP at the SSL! I want to especially thank **Jeff Birkner** for teaching me about electrical things; about the professionalism needed when creating new things; and most importantly for becoming a lifelong friend.

I took part of many other activities, with countless people teaching and helping me every step. Thank you to everyone from *4E*, especially **Atif, Rex, Chris, and Ann**. Your friendship was irreplaceable. Thank you to everyone at *LSC* for many years of movies and popcorn. Thank you to the *Sailing Pavilion* coaches and staff who made every summer in grad school remarkable. Thank you to everyone at the *ASA* and the *DSL/SAO*, especially **Tracy Purinton** and **Laurie Ward**. Also thank you to everyone at the *GSC*, of whom **Emmi Snyder** stands out notoriously as an amazing source of support. I also thank the members of the *Career Fair* and the *GSC GradRat Committee* who gave me years of fun while trying to write the thesis! And, behind all of these activities, are two people whom I worked with me and many others throughout the way and I wish to thank for their support and inspiration: **Dean Larry Benedict** and **Dean Ike Colbert**.

I was also involved in activities outside MIT, where I met amazing people while showcasing Mexican Culture in the Boston Area. Thanks to everyone at the *Mexican Consulate* who has supported the community through good and bad times. And thank you to the many people from *FOMNI* and other organizations who have worked with me over the years in dozens of cultural events.

An talking about Mexico: I have special friends to thank, going back to my pre-MIT days. Thank you to the *cuatro diablitos*: **Javier Garcia-Terruel**, **Roberto Montañez**, **David Thomas**... and, I have to especially thank **Ashley Viberg**, whom I consider my best friend since high school. He taught me to sail... and between him and his parents they taught me better english! His unconditional support has been essential all these years. I thank his parents, **Gordon** and **Dale**, for it was them who suggested I should come to MIT while on a trip to Valle in 1993; I am not sure I would be at MIT without their encouragement. I also thank a special teacher in high-school, **Mrs. Jenka Guevara**. Thanks to her I could enjoy learning at the ASF, even after school! And thanks to **Ceani** for her continued friendship through high school and even at MIT. Lastly, I wish to acknowledge a friendship that began at the ASF and became ripe throughout my years at MIT: thank you to **Kevin Tangney** and his family. Since the first year I arrived at MIT (for eleven years now!) the *Tangney's* have welcomed me at their home for Thanksgiving, a tradition that I hope will continue for decades to come! Plus, I can't forget about the many sailing trips.

I finish with Mexico, where the most basic source of my life energy resides: my family. I have an amazing family, unique in many ways, and the stereotype of a *perfect* family in many others. Their support has been unconditional all these years; they have given up many things for me to be at MIT; they have cherished with me every great moment and supported me whenever I needed it. And I need to thank them in spanish now...

*¡GRACIAS a toda la familia! A la **Abuelita** lunática por prestarme su cerebro, a **Lucerito** por su amor inmenso, y a mi tía y madrina **Fer** que me apoya y ama inmensamente. ¡Su amor no cabe en ningún lado! Gracias a **Rocio** y **Patiño** por querer tanto a mis papas y a mi. Gracias a **Tío Luis** por ser mi tío de MIT, a tía **Margarita** por siempre apoyar a mis papas, y a todos mis **primos** por siempre recibirme en México con mucha alegría. Gracias a **Mane** por apoyar a mi familia tantos años; a **Sofi** y **Alex** por su amor hacia nosotros desde siempre; y a **Gabi** y familia por siempre estar con nosotros.*

*Y en muy especial, gracias a mi papá, mi mamá, y mi hermano. Esta tesis es de la familia **Saenz Otero**. Es una combinación de todos los conocimientos que me dio **papá**, desde los Legos, los viajes a la NASA, las computadoras, la carpintería, los trenes, y más. Todo esto unido con el amor y la personalidad maravillosa que tiene mi **mamá**. Y gracias a **Edgar**, que aguanto tantos años solito con mis papas para que yo pudiera seguir en MIT siempre tranquilo.*

GRACIAS FERNANDO SAENZ, ARACELI OTERO, Y EDGAR SAENZ OTERO.

