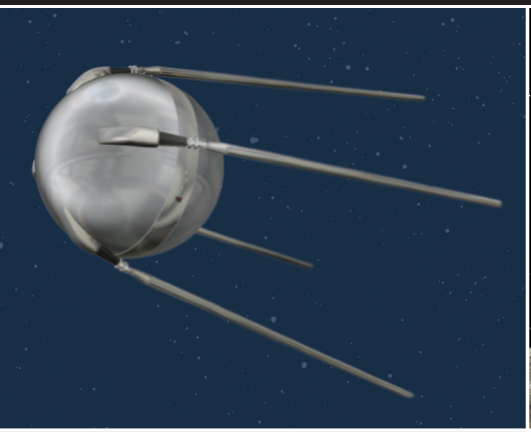
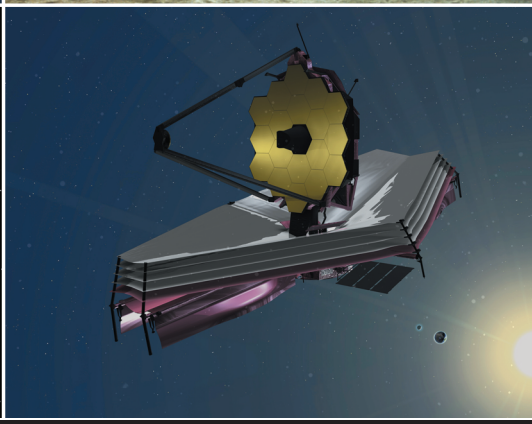
Reflections on 50 Years in Space

Beckman Auditorium,
California Institute of Technology





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50th Anniversary of Space Exploration Conference

September 19-21, 2007, the Graduate Aeronautical Laboratories California Institute of Technology (GALCIT), Northrop Grumman Space Technology and NASA's Jet Propulsion Laboratory (JPL) hosted Fifty Years in Space—an international conference in celebration of the 50th anniversary of space exploration. The event provided a venue for reflection on how far we have come in the past fifty years and where we are going in the future, from the perspective of an internationally-recognized group of invited experts.

Thank you, Dr. [Jean-Lou] Chameau (president of Caltech), and good morning, everyone.

When I was invited to speak at this event, I was told that the audience would be a who's who of international space. It certainly is, and it's exhilarating to be here. You comprise centuries of collective experience in the field of space. Among you sit men and women who have discovered things about our universe that a mere half century ago were inconceivable.

In the process, an international space movement based on cooperation and the quest for knowledge emerged from one originally based on geopolitical struggle and military competition. It has been a journey full of surprises. I thought this morning we might reflect on that journey a bit and on some of those surprises not as historical review, but rather as a means of generating insights that might have future relevance for your nations and for mine.

And what better place to begin this kind of reflection than right here in Southern California at Caltech, so ably led by Dr. Chameau.

And I would be remiss if I did not also recognize the chairman of the board of trustees, my former boss, and good friend, Kent Kresa.

I have a personal connection to this region. I grew up here. I was a nine-year-old in school here when Sputnik changed my life. My first job out of college was research and development of spacecraft. Like many of you, I too am a space cadet. To most people around the globe, this corner of America is the entertainment capital of the world. But to me, this is one of the world's most important centers of aerospace technology and innovation. And this Caltech campus is a hub. The British astronomer, Martin Rees, put it this way: He said, *"The universe of astronomy has no center, but the universe of astronomers does. For years that center has been in Pasadena, California."*

That sentiment applies to all the elements of space exploration and use, not just astronomy. The space age was born, in part, as a logical progression from decades of research conducted here by Theodore von Karman's aeronautical laboratory, known as GALCIT. He and his students did pioneering work on aeronautical theory and aircraft design that helped make Southern California the aircraft capital of the world. In 1944 GALCIT's work led to the establishment of the Jet Propulsion Laboratory [JPL], which currently manages many of the space missions we celebrate today. And Charles Elachi, the current director of JPL, is extending that legacy into the future.

Of course JPL got its start in jet and rocket propulsion, not space exploration. Indeed, our main efforts during the first years after Sputnik were driven by rocketry. After all, it was not just that beeping metallic sphere that induced so much hysteria throughout the free world; it was the Russian rocket technology that put it

there. Any rocket that could place a satellite there could also place a nuclear warhead here. And in fact, that is exactly what the Sputnik R-7 rocket was designed to do. What eventually grew into the space race also started in October of 1957 as a ballistic missile race.

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The innovative effort that first gave us Sputnik quickly developed in three major directions. The first direction focused on military applications. Military satellites with imaging cameras and other sensors made possible an alternative to dangerous and provocative reconnaissance over-flights such as those of the U-2 and Francis Gary Powers. With satellites came the "Open Skies" policy. The old Russian proverb, *Doveryay no Proveryay*—trust but verify—could now be applied to the arms race. We could now trust *because* we could verify. This ability eventually made possible, first, arms limitation treaties, and then arms reduction treaties. I would argue that intelligence-gathering and early-warning satellites have proven themselves to be some of the most important peace-keeping technologies in human history.

The second offshoot triggered by Sputnik was scientific discovery, and the promise and prestige that came with it. There was the race

to the moon. Being first to the moon promised huge national prestige to the winner. But it was not the highest scientific priority. For pure scientific value, the real action was in Earth observation and robotic exploration of the universe.

The successes and failures of American and Soviet robotic missions were soon watched as closely as those of the manned missions. By then, the public's interest in the conquest of space was becoming all-consuming, not just as an arena for the manned race, but as a source of exploratory fascination. Many of us in this room remember well the thrill of Mariner, Luna, Pioneer and Surveyor, as well as Apollo 11.

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As the Apollo program wound down, we experienced the advent of a new geopolitical environment exemplified by the word détente. Soviet/American cooperation was now the order of the day with such collaborative efforts as Sky Lab and the initial planning of the International Space Station.

But it was the unmanned missions that followed that came to be known as the Golden Age of Planetary Exploration. These missions were very international in nature: Mariners 9 and 10; the later

Pioneer missions; and of course the "Grand Tour" of the planets conducted by Voyagers 1 and 2. Many of the non-American scientists and engineers who are central to their own countries' space programs today got their start supporting some of these missions. That international spirit has largely survived, and now one is hard-pressed to think of an arena that inspires more good will and international cooperation than the scientific exploration of space.

The third innovation path resulting from Sputnik was the development of a commercial space industry. Let's return to the early sixties and consider the Pioneer 1 spacecraft. That small robot was the first space object of any kind designed and built by the private sector. It was built by a company started by two remarkable Caltech PhDs named Simon Ramo and Dean Wooldridge.

The Ramo-Wooldridge Company's accomplishment was important for two reasons. Most obviously because they produced what would go on to become a phenomenally successful family of deep-space probes. But also because, with the rapid establishment of a private-sector space industry, the U.S. gained an advantage over our Soviet competitors that, without a private sector of their own, they could never match. That advantage was access to vast new sources of creative human talent and to financial investment. The successor of Ramo and Wooldridge's company eventually became Northrop Grumman Space Technology. By the way, its president, Alexis Livanos, also a Caltech alumnus, will be paying tribute to

Dr. Ramo tomorrow morning here in Beckman Auditorium. I encourage you all to join him.

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In 1965, the Hughes Aircraft Company built the first of several commercial communications satellites. In the process, they helped to create the global communications revolution, which changed the course of human interaction forever. Before Intelsat, every phone call, regardless of distance, was made over wires, cables or radio. After that event, the race to connect the entire world accelerated—first with narrowband voice and data—then eventually through broadband and the Internet. This development of commercial communications satellites eventually did for our age what Guttenberg's printing press did for his, only many times over. It has indeed helped to flatten the world.

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In the defense arena, space has long fulfilled the destiny ascribed to it by visionaries so long ago. It has truly become the ultimate high ground. Our military communications, observation and defensive

capabilities in space are now indispensable to our nation's security. Space provides the capability to integrate our defensive systems in ways not possible in the past. But because they are so important, they are increasingly vulnerable to disruption or outright destruction. Concern for the security of these systems is not misplaced. One recent high-profile event reminded us all that satellite-killing is not a theoretical concern, but indeed a demonstrated capability today. And two of the nations on our government's list of terrorist nations aspire to space programs of their own, and are indeed close to realizing those aspirations.

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In the U.S., our national defense leaders are making important moves to protect and preserve our space-based capabilities by developing improved space situational awareness, and spurring private industry to design innovative new space systems that are "operationally responsive." Operationally responsive space means providing the ability to launch and field space systems faster than is now possible, giving our military the ability to augment, or if

necessary, replace missing space capability when and where it is needed.

Another important trend in military space is the potential to provide persistent global surveillance in support of our strategic and tactical operations. This capability will give our warfighters the ability to dwell above any area of interest, sensing suspicious activity 24/7, day or night, and in all weather, significantly reducing an adversary's ability to hide their intentions.

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This capability becomes increasingly important as the Global War on Terrorism spreads to more remote locales. This space-based capability will augment our nation's already robust ground-based and airborne capabilities.

Turning now to commercial space, its future will clearly continue to be affected by global market forces and growing international participation. As an example, later this month, Arianespace, a company of 23 shareholders representing ten different nations, will launch the latest Intelsat, Intelsat 11. The spread of commercial broadband service, direct-to-home television and digital services will continue, as well as many new space-based information delivery services that we haven't even considered today. And we will certainly witness advances in the commercial exploitation of

data from civil navigation and earth sensing systems, as the nations of the world continue to find new ways to integrate their data into information systems to address issues such as global warming.

I hope we will also see breakthroughs in the lowering of launch costs. Advances in materials science and propulsion, coupled with the steady growth in computing power, should continue to lower the barriers to participation by small, highly creative companies. As it does so, the innovation and talent of the individual will count for more and more. The accomplishments of Burt Rutan's team at Scaled Composites and his Spaceship One would have been unthinkable a dozen years ago. Tomorrow, there will be alternative means to lift man into space, even a fledgling space tourism industry.

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But perhaps it is the future of space discovery that is brightest of all. Again I return to the roster of space-faring nations and its many new additions. Last week, Japan launched a three ton-orbiter, named the Kaguya, bound for the moon. China and India also have lunar missions in the works. And the U.S., of course, is now committed to a new era of manned space exploration under the leadership of NASA Administrator Mike Griffin.

As for unmanned programs, the Mars Rovers demonstrate the potential of robotics today. They have been phenomenally successful and all those at JPL who have been working on them deserve the highest commendation. Having said that, I think the "looking-versus-going" trend will continue. The advance of space-based sensing technologies will continue to allow us to precede expensive and long-term human journeys with unmanned probes and orbiting observatories. Chandra has given us an exciting look into the X-ray spectrum and the James Webb Space Telescope promises even more dramatic discoveries as it succeeds the great work that the Hubble is doing today.

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Another trend is that of data integration. The NPOESS [National Polar-orbiting Operational Environmental Satellite System] will integrate data from several polar-orbiting Earth observation satellites to generate knowledge that otherwise would have cost a fortune in more narrowly-focused systems. In fact, systems integration is a trend that will cut across all three paths of innovation within the space domain—defense, discovery and commerce. The ability to collect rivers of data from various sources and turn that data into usable knowledge will help intensify the breathtaking pace of technological advances.

If there is one theme that these first fifty years in space reinforces again and again it must surely be this: Our journey into space has returned benefits that were unforeseen and unpredictable on that day in early October 1957—benefits that go far beyond the inventions of Tang, Velcro and Teflon.

Space, which first served as an avenue for military competition, is now also a platform for achieving greater global security and for advancing the cause of peace.

Space exploration and use has created new industries that today generate billions of dollars of revenue, employ millions of people worldwide, and improve the lives of virtually everyone.

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Space, which first served as a coliseum for two grappling superpowers, now welcomes new nations to explore and utilize its potential, and in the process, draws all mankind closer together.

But such is the nature of any quest for knowledge, be it the exploration of the heavens or of the human genome. Far from being a drag on a nation's progress, exploration has always proven

an engine of progress. Throughout history, those nations that explored first were the first to prosper. Those that lagged behind did so at great cost to themselves economically, culturally and in terms of their national security. If there is any one thing that we can do to hasten our exploration and use of space I think it must be to reach out to our respective citizens with just this appeal. Yes, there is still much to learn here on Earth and we must learn it. But there is much to learn—and perhaps more to gain—out there.

Let me close with a final thought. I'm reminded of the Apollo 8 mission—the first manned mission to orbit the moon. As its three astronauts—Frank Borman, Jim Lovell and Bill Anders—peered through their capsule window and first saw the Earth rising above the surface of the moon, they had a deeply moving reaction. They had come all that way to study the moon, but instead found themselves mesmerized by their view of spaceship Earth.

As we reflect on our first fifty years in space, let us recognize that the beneficiaries of the next fifty years will be all those who live here on Planet Earth.

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