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The Newsletter of AIAA Houston Section
The American Institute of Aeronautics and Astronautics

March / April 2014
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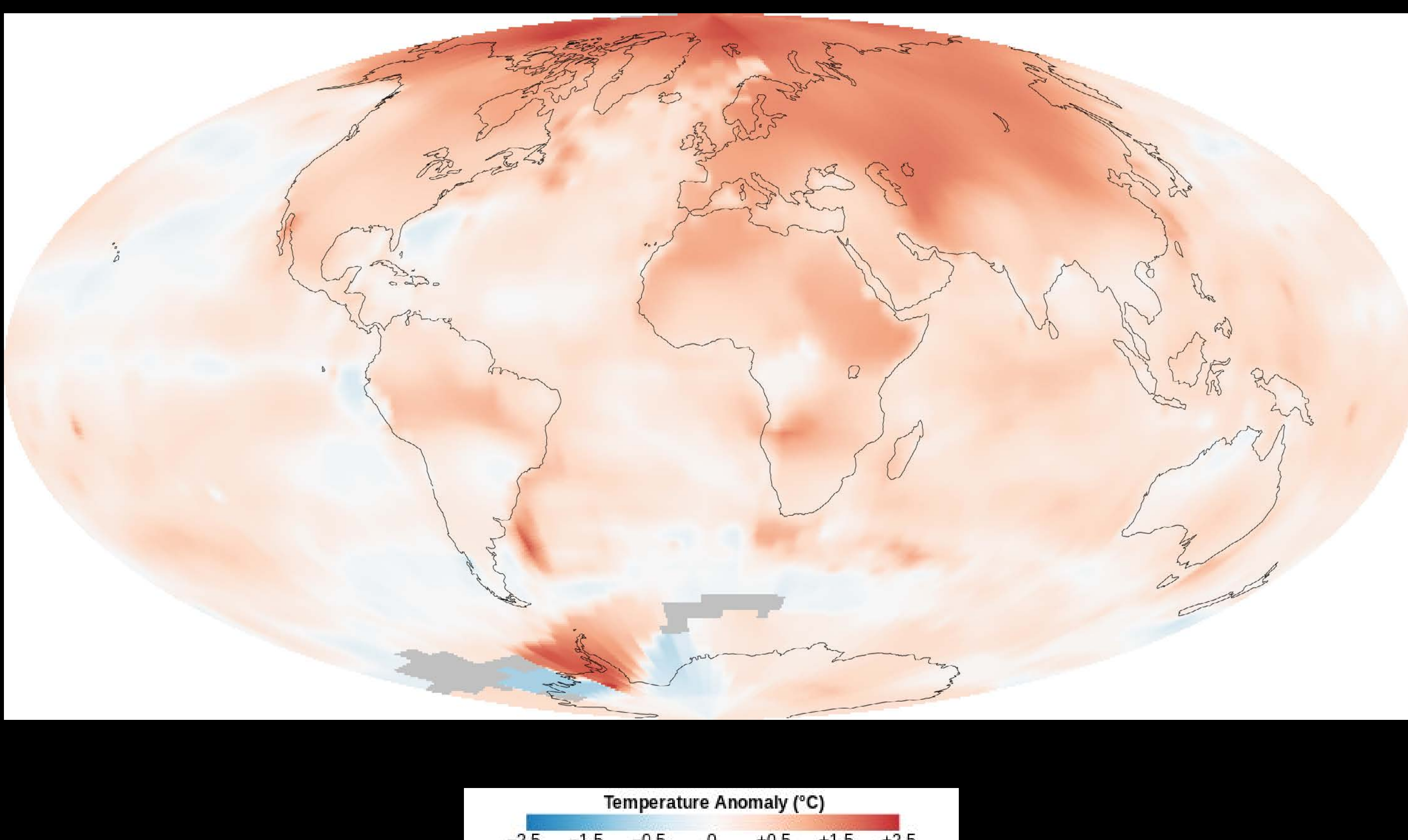
Climate Change
Science & Public Policy

Douglas Yazell, Horizons Editor & Aerospace America editorial board member



The map shows the 10-year average (2000–2009) global mean temperature anomaly relative to the 1951–1980 mean. The largest temperature increases are in the Arctic and the Antarctic Peninsula. Source: NASA Earth Observatory. [2009 Ends Warmest Decade on Record. NASA Earth Observatory Image of the Day, 22 January 2010.]

Horizons is a bimonthly publication of the Houston Section of the American Institute of Aeronautics and Astronautics.

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March / April 2014
Horizons, Newsletter of AIAA Houston Section

T A B L E O F C O N T E N T S

Congratulations!
Horizons and AIAA Houston Section Website
Section Chair Daniel Nobles
AIAA 2013 National Communications Third Place Award Winner

Front cover image: NASA image obtained via the Wikipedia global warming article.
This page: The 1889 van Gogh painting, The Starry Night.
This page: Skyline of downtown Houston, Texas USA, from Sabine Park. Author: Jujutacular. Source: the Wikipedia Houston article.

AIAA Houston Section Annual Technical Symposium (ATS 2014)

Michael Frostad, Chair

The American Institute of Aeronautics and Astronautics (AIAA) is a leading source of technical exchange in the aerospace field. From multiple avenues of publication and national conferences to student paper competitions, local lunch and learns, dinner meetings, and technical symposiums – AIAA provides opportunities to both discuss one's own work and learn from colleagues from around the world.

The AIAA Houston Section is fast approaching its own Annual Technical Symposium (ATS 2014), to take place on Friday, May 9, 2014, at NASA Johnson Space Center's Gilruth Center. The event will be a day for our Section and other attendees to come together and share their progress this past year. Our Section is one of the few, maybe the only Section, with its own technical committees, analogous to AIAA technical committees at the national level. With our Section's 14 technical committee Chairs, this is a great opportunity to not only learn about something in depth, but to expand one's breadth.

In addition to the many AIAA technical tracks at this ATS 2014 event, AIAA Houston Section is partnering with the local chapter of the International Council on Systems Engineering (INCOSE). They will organize three morning one-hour sessions and three afternoon one-hour sessions. This partnership makes sense for tackling the large aerospace challenges of bringing all the detailed technical work together in the form of a working product - a complete system. With INCOSE as a partner, ATS 2014 becomes a complete system.

ATS 2014 is not only about technical achievement, but also about the broader aerospace community. This year we are proud to have a luncheon panel that will discuss the burgeoning Commercial Space field. With representatives from Boeing's CST-100 program, Sierra Nevada's Dream Chaser program, and the Houston Spaceport, the luncheon will provide an opportunity for direct dissemination of information and an opportunity for the aerospace community at large to ask specific questions about these programs.

ATS 2014 is not just for professional members. It is also an opportunity for our university student chapter members to attend a technical conference without paying the cost of a national conference. It provides a local opportunity for students to display their work, practice their presentation skills in a real environment, and to network with employers – and, in turn, for employers to find new talent. This is one of the primary functions of AIAA, to build, maintain, and grow the aerospace community. We are pleased that ATS 2014 can serve in this role.

AIAA Houston Section ATS 2014, in partnership with INCOSE, will take place on Friday, May 9, 2014, but it will start on Thursday, May 8, 2014, with a dinner meeting, where attendees will enjoy a meal with colleagues and a presentation from former Navy Seal and Astronaut Commander Chris Cassidy.

As you can tell, ATS 2014 is AIAA Houston Section's largest event of the year. ATS 2014 has a great program, both technically and professionally, so we look forward to seeing you at the event! ■

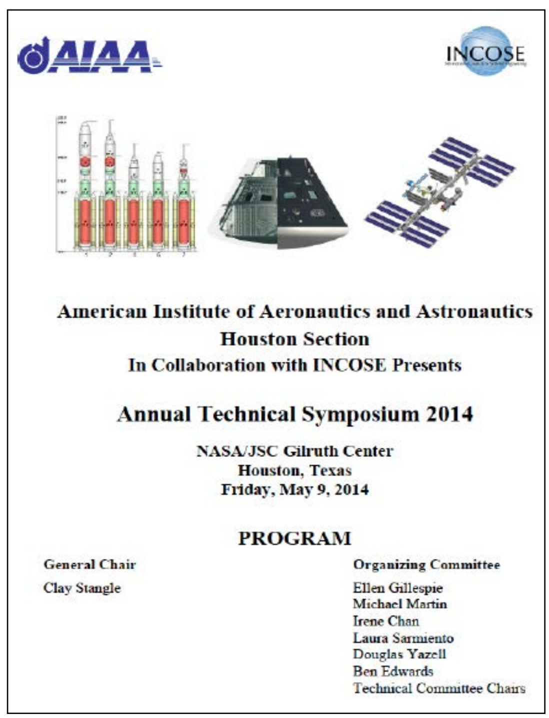
Find ATS 2014 details here. (Friday, May 9, 2014)

Find ATS Kickoff Dinner Meeting details here. (Thursday, May 8, 2014)

Spelled-out website addresses:

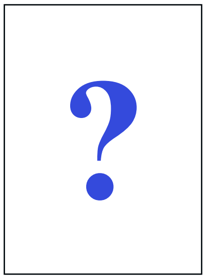
Find ATS 2014 (Friday, May 9, 2014) details at:
http://www.aiaahouston.org/2014-annual-technical-symposium/

Find ATS 2014 Kickoff Dinner Meeting (Thursday, May 8, 2014) details at:
http://www.aiaahouston.org/event/ats-kickoff-cdr-chris-cassidy/



Editor’s Corner Searching for our Next Editor

Douglas Yazell



Above: Our next Editor? Starting July 1, 2014, we hope to have our new Editor volunteering in that role.

Email
editor2013[at]aiaahouston.org

www.aiaahouston.org
An archive for Horizons on a national AIAA website is here.

Submissions deadline:
June 9, 2014, for the
May / June 2014 issue
(online by June 30, 2014).

Advertising:
Please contact us about rates.

I volunteered the cover story for this issue, *Climate Change Science & Public Policy*. I am a bit out of my comfort zone, but that is probably a good thing in this case.

On the one hand, I suddenly came to a new understanding about climate change after seeing an October 23, 2012, PBS television episode of *Frontline*. The episode title was *Climate of Doubt*, presenting an unflattering portrait of attendees at a climate change denial conference in Chicago. It was about the eighth such conference in that series, and I seem to recall it was the last in this series of conferences. Later I learned that quite a few Houston Clear Lake area residents were among the attendees. “You won!” said the journalist to a very successful climate change denialist. “What if you are wrong?” the journalist, John Hockenberry, asked. If my science literacy led me to this conclusion in 2012 instead of long ago, say 1992 or 2002, then I will sometimes be out of my comfort zone advising others about science and public policy.

On the other hand, in 2012 I reached an understanding of the climate change science that quite a few Americans, maybe half of all Americans, do not yet have. Reading a new book now, *Dog Whistle Politics*, by Ian Haney Lopez, is good public policy education. Talking about his new book, Lopez is featured online for now in two 30-minute episodes of Moyers & Company, a television show I enjoy often on Houston PBS via AT&T U-verse.

My bimonthly one-page climate change column continues in this issue. About a year ago it mentioned good work by Dan Kahan of Yale University. I heard some good things about Vox on the PBS television show Charlie Rose this week, including writing by Ezra Klein, formerly of the Washington Post. As a student, Klein applied to work his university’s newspaper. They turned him down, so he started a blog. Not succeeding with interview requests, he read voraciously in order to go deep on subjects of his writing. Think tanks were happy to supply their research results and the outputs of their writers. Taking a glance at www.vox.com, the first article I saw was about Kahan’s work, including climate change, written by Klein, dated April 6, 2014, *How Politics Makes Us Stupid*.

I am stepping down as Horizons Editor, effective June 30, 2014, the last day of our AIAA year. My last issue in that role will be our May / June 2014 issue, to be online by June 30. I started in this role on April 11, 2011. I will submit my writing on various subjects to the new Horizons Editor.

John Keener, Jon Berndt, and Dr. Steven Everett are my immediate predecessors in this role. Jon started in late 2004, and Steve later served in that role for two years.

Michael Frostad is our current Section Chair, and Michael Martin starts his year in that role on July 1, 2014. The Editor is not one of our Section’s elected roles, so a confirmed Editor candidate will serve as a volunteer appointed by the Chair.

The bimonthly PDF magazine format is excellent, but maybe a better format is a monthly newsletter blog, with a corresponding monthly newsletter email note, following the SpaceRef daily format. Maybe the PDF magazine should continue as a monthly publication, but as a lower priority.

Thanks go to all who made Horizons possible in recent years, to our contributors, and to our Horizons team!

Dr. Albert A. Jackson IV gives us a great and unique article, *Detecting Starships*. Its original title was *Extreme SETI*, but I suggested avoiding acronyms in the title. We aim to include something about 100 Year Starship (100YSS) in every issue of Horizons, and this article fits well with that theme.

Horizons adopted the Yahoo style guide, by the way.

Wes Kelly’s writing continues in this issue, Kelly’s Corner, a bimonthly column. We aim to include his writing in that column in every issue of Horizons.

For our next issue, the May/June 2014 issue, our cover story will be a Morpheus update from NASA/JSC manager Jon Olansen. Another story in that issue will, we hope, be from a very popular science lecturer in the Clear Lake area. We will make that request before his lecture. Also, Dr. Larry Friesen will write an article about the recent Lunar and Planetary Science Conference in the Woodlands, Houston, Texas USA. That issue will be online by June 30. ■

Above: The Boeing Way alligator in the Bay Area Blvd ditch on Sunday, April 27, 2014, about halfway to University Park Drive. It is surrounded here by hundreds of homes and a Boeing building. It is harmless for now. It is about five feet long. Based on its size below the elbow here, it is either pregnant or it is digesting a big meal. It can eat fish, turtles, and frogs from this ditch, as well as passing birds.

Climate Change Science & Public Policy

Douglas Yazell, Horizons Editor & Aerospace America Editorial Board Member

Science

The Climate Change National Forum (CCNF) *website* invites Fellows and Member-Scientists of three groups to join CCNF: AGU, AMS, and AIP (three sets of initials for professional science societies defined below). Each of these three science organizations provide short climate change summaries in agreement with the summaries provided by the United Nations Intergovernmental Panel on Climate Change (IPCC). CCNF columnists include writers from two universities in AIAA Houston Section territory, the University of Houston (UH) and Texas A&M University (TAMU): Professor Barry Lefer (UH) and Professor John Nielsen-Gammon (TAMU). In response to a recent CCNF *article* (Tail Risk vs. Alarmism) by MIT Professor Kerry Emanuel, TAMU Professor Andrew Dessler added a short comment and a link to his video on YouTube, *Decision Making Under Uncertainty (Should We Listen to the 97% or the 3%?)*.

American Geophysical Union (AGU)

The 2003 AGU climate change *position statement* *Human-Induced Climate Change Requires Urgent Action* was revised and reaffirmed in 2007, 2012, and 2013. "... no uncertainties are known that could make the impacts of climate change inconsequential."

American Meteorological Society (AMS)

The 2012 AMS climate change *information statement* is in force until 2017 unless they update it sooner. A brief excerpt: "The following is an AMS Information Statement intended to provide a trustworthy, objective, and scientifically up-to-date explanation of scientific issues of concern to the public at large. [Background] This statement provides a brief overview of how and why global climate has changed over the past century and will continue to change in the future. It is based on the peer-reviewed scientific literature and is consistent with the vast weight of current scientific understanding as expressed in assessments and reports from the Intergovernmental Panel on Climate Change, the U.S. National Academy of Sciences, and the U.S. Global Change Research Program. Although the statement has been drafted in the context of concerns in the United States, the underlying issues are inherently global in nature."

American Institute of Physics (AIP)

The Discovery of Global Warming is an AIP *website* providing, "a hypertext history of how scientists came to (partly) understand what people are doing to cause climate change."

Texas A&M University (TAMU)

A 2013 TAMU Times press release *lists* eleven climate scientists (TAMU professors) on call for media inquiries about the science of climate change, especially the science related to the recent IPCC report. A TAMU website page explains that these professors (and a few more TAMU climate change professors, 23 of them in all, the entire faculty of the Department of Atmospheric Sciences) support a brief climate change *summary* in agreement with IPCC reports.

The University of Houston (UH)

An excellent public panel discussion (*available* via YouTube) took place on February 11, 2013, thanks to the University of Houston. The subject was climate change, and the host was Professor Lefer of UH. One panelist was Professor Nielsen-Gammon from TAMU. The other panelists were one from the National Oceanic and Atmospheric Administration (NOAA) and one from Royal Dutch Shell.

The National Research Council (NRC)

The Amazon website provides a free kindle *edition* of a 78-page 2013 NRC book, *Climate Change, Evidence, Impacts, and Choices.*

The American Association for the Advancement of Science (AAAS)

What We Know is a new 2014 AAAS climate change *website*. This is discussed in a March 18, 2014 article in the Guardian, *Climate change is putting world at risk of irreversible changes, scientists warn: AAAS makes rare policy intervention urging US to act swiftly to reduce carbon emissions and lower risks of climate catastrophe*.

National Academy of Sciences (NAS)

Climate Change at the National Academies is the relevant *website*.

The United Nations Intergovernmental Panel on Climate Change (IPCC)

The introductory paragraphs from the Wikipedia IPCC *article* are reproduced here without notes, links, and acronym definitions.

"The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body under the auspices of the United Nations, set up at the request of member governments. It was first established in 1988 by two United Nations organizations, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), and later endorsed by the United Nations General Assembly through Resolution 43/53. Membership of the IPCC is open to all members of the WMO and UNEP. The IPCC is chaired by Rajendra K. Pachauri.

"The IPCC produces reports that support the United Nations Framework Convention on Climate Change (UNFCCC), which is the main international treaty on climate change. The ultimate objective of the UNFCCC is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic [i.e., human-induced] interference with the climate system". IPCC reports cover "the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation."

"The IPCC does not carry out its own original research, nor does it do the work of monitoring climate or related phenomena itself. The IPCC bases its assessment on the published literature, which includes peer-reviewed and non-peer-reviewed sources.

"Thousands of scientists and other experts contribute (on a voluntary basis, without payment from the IPCC) to writing and reviewing reports, which are then reviewed by governments. IPCC reports contain a 'Summary for Policymakers,' which is subject to line-by-line approval by delegates from all participating governments. Typically this involves the governments of more than 120 countries.

"The IPCC provides an internationally accepted authority on climate change, producing reports which have the agreement of leading climate scientists and the consensus of participating governments. The 2007 Nobel Peace Prize was shared, in two equal parts, between the IPCC and Al Gore."

NASA

The relevant NASA website is *Global Climate Change: Vital Signs of the Planet*. This includes a blog by Laura Faye Tenenbaum, *Earth Right Now: Your Planet is Changing. We're On It*. The blogroll includes RealClimate: Climate Science from Climate Scientists. *Other Sites* there include Andrew Revkin's Dot Earth in the Opinion Pages of the New York Times, Skeptical Science: Getting Skeptical About Global Warming Skepticism, and the Yale Forum on Climate Change & the Media.

A Johnson Space Center (JSC) connection is a climate change science instrument, RapidScat, to be installed on the International Space Station (ISS) in 2014.

Public Policy

C40 Cities (Houston)

C40CITIES: Climate Leadership Group is a website for this international alliance of large cities demonstrating leadership on climate change public policy. They started in 2005 when our Houston Mayor was Bill White. They continue now with Houston Mayor Annise Parker. This number of member cities on this list is now up to 67 cities. Houston is one of the cities on the steering committee.

Institutionalizing Delay

[Drexel Now press release, Philadelphia, December 20, 2013] *New Drexel Study Reveals Funders Behind the Climate Change Denial Effort*.

The first paragraph is, "A new study conducted by Drexel University environmental sociologist Robert J. Brulle, PhD, exposes the organizational underpinnings and funding behind the powerful climate change countermovement. This study marks the first peer-reviewed, comprehensive analysis ever conducted of the sources of funding that maintain the denial effort."

Brull uses strong language, concluding, "With delay and obfuscation as their goals, the U.S. Climate Change Counter-Movement (CCCM) has been quite successful in recent decades." and ending with, "Clarifying the institutional dynamics of the CCCM can aid our understanding of how anthropogenic climate change has been turned into a controversy rather than a scientific fact in the U.S."

This first of three papers by Brull was downloaded for this article using the above link to obtain a read-only document using the PDF/A format.

President Obama

The Obama team is providing sensible leadership, from the June 25, 2013 speech to the Climate Action Plan.

Conclusions

In agreement with my recommendations as an editorial board member, the AIAA national magazine *Aerospace America* addressed climate change recently with a one-page editorial, followed by a February 2014 cover story. It is good to see AIAA continuing to address climate change in this forum in addition to earlier efforts, but these two magazine articles are quite different from my writing about climate change in Horizons. The above cover story proclaimed on its cover, "Two new satellites that might cool the debate." That implies that we need more data before we can know that this challenge is real, but I refer readers to that AGU position statement's conclusion that urgent action is required.

Bill McKibben tells audiences, "When I was 27 and wrote *The End of Nature* [his 1989 climate change book], my theory of change was, 'People will read my book, and then they will *change*!' [Laughter]" That is a quote from *Hot in My Backyard*, the May 17, 2013 episode of *This American Life*, hosted by Ira Glass, who explains that McKibben learned that old-fashioned politics is required.

I am reminded of an American conservative group embraced by mainstream political groups until early 1961, the John Birch Society. Claire Conner's 2013 book, *Wrapped in the Flag: A Personal Memoir of America's Radical Right*, is a book and audiobook I found by chance and enjoyed recently. Conner was raised in a family at the center of the John Birch Society. The editorial and article in the May 12, 1961 issue of Life magazine (entire issue available via Google Books using External Link #2 in the Life magazine Wikipedia article) may have started the move from mainstream to fringe for the Society, but the change required a year or two of bad press for the Society, and the Society still exists. That 1961 Life magazine editorial is titled, *Unhelpful Fringes: the Present-Day Radicals, Left or Right, Bring Us Neither Hope nor Realism.*

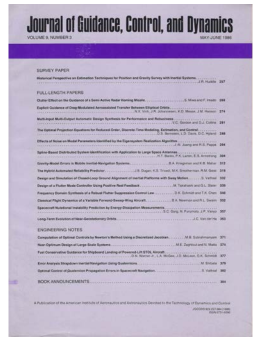
Keeping climate change in the news is a sensible goal for this AIAA Houston Section Horizons newsletter, where the NASA/JSC community is central to our membership. I recently asked a NASA/JSC community scientist, after his presentation about NASA Earth Observation satellites, "How many of those satellites are used for climate change study?" "All of them," he replied. The same suggestion applies for NASA and AIAA at the national level: keeping climate change in the news is a good idea.

Along these lines of keeping climate change in the news, Showtime presents a new cable television series, *Years of Living Dangerously*. Celebrities highlight the challenge of climate change. The first episode is available for viewing for free on that Showtime website.

No one has a monopoly on the very difficult problem of climate change, but the challenge is real. As the AGU climate change position statement explains, *urgent action is required*. ■

Sorcerer's Apprentice: The Digital-Age Library & the Privileges of Membership

Wes Kelly, Triton Systems LLC



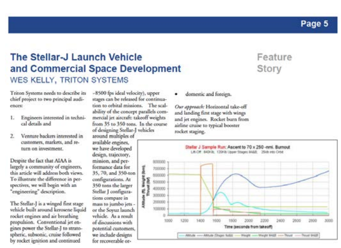
Is it possible that witnesses to revolutionary events in communications are not communicating about them to each other? We seem directed to examine the features of phone devices and their apps while we ignore the disappearance of printed media, or else their transformation into digital ghosts of themselves. What is happening? When it comes to AIAA or science journals (literally, for example *Science*) I can neither page through them on my shelves to find the article I am thinking of, nor can I give the boxes of these legacies away to wanting institutions now that I can access the information online or save it on a jump drive. Does anyone else wonder about this?

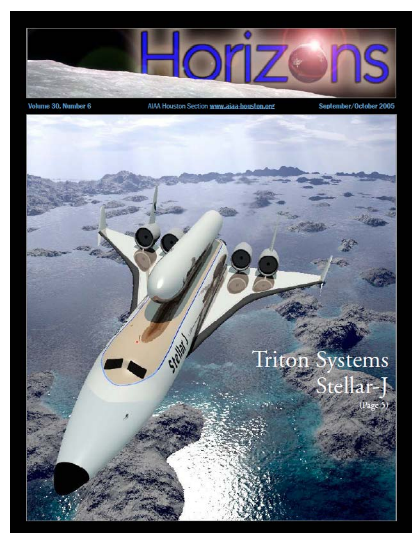
It was about a decade ago when I posted to *Horizons* a letter of concern about the content of archived AIAA papers available for downloading in pursuit of research. At that time optical character recognition (OCR) technology handled journal article equations very poorly and it appeared that hard won knowledge of decades back would erode away in an electronic desert sandstorm as they disappeared from library shelves. A case in point was the collective effort to reacquaint ourselves with the technology that landed Apollo on the moon for application to Orion. Were we to lose all traces of our heritage?

Fortunately this turned out to be a temporary problem. I go back to the same articles now in AIAA electronic archives (PDF files) and the texts are much more legible. Not only that, access to them has improved as well. For those of us who have been in this business for decades, we first became accustomed to either searching in bound volumes at institutional libraries carrying the likes of the AIAA journals of *Aircraft*, *Spacecraft & Rockets*, *Dynamics, Guidance and Control* or Propulsion… or subscribing to the journals themselves and storing them for years and years in basements, dens or offices until they could be called to serve in a technical crisis. At the time of the letter above, the journals might not have been available for electronic subscription, but technical libraries could access them for electronic download, as the JSC technical library allowed for civil servants and center contractors.

But just as other mainframe computer technologies have cascaded down to the desk and laptop machines, so has access to electronic libraries. In the particular case of the AIAA, journal subscriptions now include access to back issues all the way back to the first volumes. Other professional societies and journals offer similar programs; the American Association for the Advancement of Science, the Astronomical Society of the Pacific are two to which I can attest, but no doubt many others do as well, or else are in transition. Several conferences I know of provide their papers or abstracts online (Small Satellite Conference, Lunar and Planetary Science, American Astronomical Society). All of this brings us closer to detailed information increasing our own technical and scientific analytical capabilities.

Or I suppose it should. I didn't mention anything about big data and data mining, did I? These are hallmarks of our era as well, efforts to take advantage of streams of information like we never had access to before, data mining efforts which are intensive activities in their own right. To illustrate: if you know that the census of 2010 identified 308.7 million Americans, that number is a datum. If you know number *s* for each state or community, these are data. And then, of course, from the numbers shifted from previous decades, there are more and more inferences to be made. Back in grade school, I spent time contemplating the summary census statistics in geography books and almanacs, and they helped form my vision of the country. But lately, I must do much more sifting of professional journals than the recent census data. I have not explored





Above: The September 2005 Horizons Triton Systems Stellar-J cover story by Wes Kelly.

other online sources of information as thoroughly as that of the AIAA, but I do value and make use of them, and expect them to be valuable additions to a working library.

Even a professional society member might ask why. One rationale was that many early articles in the AIAA journal were devoted to the basic questions that I would ask as a preliminary designer of aerospace systems, sometimes written with a tentativeness or admission that they were struggling with the topic as much as I, the reader, was myself. This contrasts with more recent communications of very specialized researchers writing to each other in mature fields. But as the search through the archives continues for pertinent personal library entries, one sees patterns of research publications which correspond to the observations about differences in each decade's census.

Just like with other forms of data mining, lines of communication, sources and target relations seem to appear, flourish and then decline, to be replaced by others. As the research budgets of the 1960s increased, though, the original AIAA journal produced several technology offspring, some mentioned above. The "Journal" would continue to examine basic aerodynamic and structural conundrums via boundary problems and initial conditions, but the other journals would color their problems with solutions to planetary missions, types of aircrafts, or systems of optimization or control. It is alarming to think how much research was devoted to problems of VTOL craft, however, considering their insignificant civil impact. In contrast, despite the importance of understanding how to build serviceable liquid rocket engines for sustained space flight (an American aerospace Achilles heel), the development data provided by the archives is sparse compared to horns of plenty on solid rocket motors and their problems. Are there lessons to be drawn?

It was not always gripping to scan through successive tables of contents, but a personal element continually stirred me out of any lethargy. Instructors and professional colleagues would often grace the pages of these publications. Of the teachers, I would recall their professional research interests beyond the classroom or remember those of colleagues from decades back and then reflect on all our careers and fates.

On occasion, as the result of the availability of these resources, some quick studies of particular aerospace topics have resulted: solar electric, nuclear thermal, and beamed energy propulsion technologies are three instances that readily come to mind. Ten or twenty years ago, a quick study problem would have resulted in visits to university libraries and card catalogs. (And I would have convinced myself that the most crucial information was already purged from my home library with the last spring cleaning.) Today a quick study problem results in web searches and downloads or referring back to articles already in electronic folders.

That brings us back around to an initial concern. The accumulation of journals and magazines with exorbitant newsstand prices could someday break the rafters in my garage. Many are now backed up by access to electronic copies. But how can I release my grip on those printed-on-paper publications, or their grip on me? I am unaware of any institution that wants them. It appears that libraries, schools, and I have the same access to the electronic versions, and they have no interest in placing these printed-on-paper publications in bound volumes.

As dull as those journals were, with their institutional formats, it was exciting to know that someone had written a crucial, detailed description about how to travel to the Moon or Mars. Before I fully understood any journal article, before I pursued my education in that field very far, journals of that kind were in my hands. I picked them up in my hands and read them. Has the electronic library of today developed more effective alternatives? ■


AIAA JOURNAL
VOLUME 44, NUMBER 8
AUGUST 2006
AIRCRAFT TECHNOLOGY, CONVENTIONAL, STOL/VTOL
FLUID DYNAMICS
Table of Contents continued on back cover
A Publication of the American Institute of Aeronautics and Astronautics Devoted to Aerospace Research and Development
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Above: The March 2014 Lunar and Planetary Science Conference in the Woodlands, Houston, Texas USA. Image credit: LPSC royalty-free images.


JOURNAL OF SPACECRAFT AND ROCKETS
VOLUME 45, NUMBER 6
NOVEMBER–DECEMBER 2008
SPECIAL SECTION: ROUGHNESS AND HYPERSONIC BOUNDARY-LAYER TRANSITION
FULL-LENGTH PAPERS
Table of Contents continued on back cover


JOURNAL OF SPACECRAFT AND ROCKETS
VOLUME 45, NUMBER 6
NOVEMBER–DECEMBER 2008


AIAA JOURNAL
VOLUME 44, NUMBER 8
AUGUST 2006

Mars Flyby 2021: The First Deep Space Mission for the Orion and Space Launch System?

Sandy Magnus, AIAA Executive Director

Written Statement of

Dr. Sandra Magnus
Executive Director
American Institute of Aeronautics and Astronautics
Reston, Virginia

Hearing of the House of Representatives Committee on Science, Space, and Technology

February 27, 2014

Chairman Smith, Ranking Member Johnson, and distinguished members, I want to thank you for the opportunity to address you today concerning the future of human spaceflight. Spaceflight and the exploration of space captured my imagination when I was a young girl and steered me toward the study of science and engineering in the hopes of being able to take part in our nation's space program in some way. I have been very fortunate to have had the opportunities to participate in an endeavor in which I so passionately believe and feel is vital to our country. Today I was asked to address the importance of having an exploration architecture and strategic framework to guide NASA's investments in space. In order to understand how important this is, I think we need to examine the trajectory of the human spaceflight program over the previous decades.

We are all well aware of President Kennedy's famous speech to Congress on May 25, 1961, in which he declared that "I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth." We all know that declaration caught the imagination of the country, which at the time was fearful of the Soviet Union and its technological success with Sputnik.

Above: When asked by a reporter if she noticed a difference in the International Space Station on her current visit with the Atlantis STS-135 crew, versus an earlier lengthy visit, NASA astronaut Sandy Magnus mentioned the Cupola's addition, which was not on the station during her earlier stay there. This is one of series of photos showing Magnus, mission specialist for the Space Shuttle Program's final flight, taking advantage of the zero gravity of space and the panoramic view provided by the multi-windowed Cupola. July 16, 2011. Image credit: NASA.

Kennedy, spurred by realpolitik, committed to a lunar mission as a goal sufficient to illustrate to the world the preeminence of the United States and its way of life. While no one can dismiss the importance of his announcement for the development of the U.S. space program, the trajectory that Kennedy started the U.S. manned space program on still haunts us today.

For even though Kennedy's proposal was a noble goal; it was just that – a goal. Underlying that goal was neither a longer term strategy nor vision – let alone political consensus – for how or what the U.S. should do in space. It was a sprint to the moon for political purposes. And because of this the U.S. space program has since suffered. Those who considered the lunar goal a means to a political end ultimately undermined the long-term interests of the U.S. space program – for once that goal was reached, attention was diverted elsewhere. Others, convinced of the importance of the U.S. continuing to gain experience in space, sought successive goals upon which the U.S. could embark. The end result: we all know what happened to the space program in the early 1970s – only shortly after reaching the moon for the first time, the budget was cut and continued in a decline for the next twenty years. For NASA, it became, to a certain extent, a survival game. There was no committed long-term strategic plan, even though there was a community that was engaged in trying to define and institute one. In the absence of a strategic vision we instead planned and executed short-term tactical goals outside of a larger defined stable framework. This is the operational mode we are still working under today.

So from the beginning of the U.S. involvement in human spaceflight we have been trapped in a paradigm where we have a space program that has been constantly morphed and re-directed, often deployed as a tool for other purposes. I don't mean to imply that nothing positive has come out of this experience, however. The aerospace community in the United States is an amazing community and has been able to achieve some extraordinary things over the years as our space policy and programs have evolved and progressed – in commercial and civil space and in both manned and unmanned exploration as well. In general though, particularly in human spaceflight, the U.S. has typically lurched from goal to goal lacking a long-term stable strategic vision to tie our collective efforts together into an overarching space architecture.

So what has been at the heart of the problem of identifying and committing to a consistent national long-term strategic plan for the U.S. space program? Unfortunately, I believe that part of the problem is buried in human nature and another aspect can be attributed to our governmental structure. We human beings have a difficult time focusing, in general, on the long term. Space exploration is, by its nature, an enterprise that requires long-term focus and a steadfast commitment. It takes years to design, build, and execute missions. Put those multi-year missions into a larger connected framework that crosses generations and it is hard for humans to maintain a decades-long focus toward realizing the outcomes. Couple our inherent short-term attention spans with a federal government that turns over at least a fraction of its governing structure every two, four, or six years and the barriers to a long-term consistent strategy become painfully apparent. Human nature and the organizational impacts of the U.S. government are factors that are not entirely in our control, but they are real factors that have to be taken into account and addressed as we move forward. It is important to acknowledge these issues and overcome them together as we determine the course for our country in space for the next few decades.

So, how do we do this?

I have had the opportunity to live for four and a half months on the International Space Station, a program that illustrates a model for executing a long-term program in today's environment. The ISS, like Kennedy's lunar program, partially owes its existence to political motivations. The U.S. space station program was struggling (again a symptom of another goal that was created outside of a well-defined strategic plan with an overarching space architecture) in its development stage. A decision was made that the space station could become an instrument of U.S. policy aimed at employing Russian scientists as the Soviet Union began to unravel. This policy, important for reasons of national security, was formed with the intent to minimize the redirection of critical technical and scientific skills from the Soviet Union to less desirable places. As a result the International Space Station program, formulated from the base of the Freedom program with several of our allies, reached across the divide of the Cold War. Unlike the lunar program, however, once the geopolitical situation in Russia stabilized the ISS was not abandoned, although it came close a few times. I firmly believe that the success of the International Space Station is due to the fact that it was an international program bound with treaties at the highest levels of government. The nature of those treaties were such that each member government (sometimes reluctantly, I will admit, because of short-term pressures) was required to stay the course over the long term to work together on a large, complex program that could not have been accomplished any other way. The strength of these agreements benefitted all of the partner countries at various times. In 1961 Kennedy was able to commit and leverage resources for a decade due to the fear that the Cold War instilled. One wonders if such a commitment is possible today. The history of the space program since Kennedy's time suggests the answer is no – at least not without a substantial change in our approach.

Above: Space shuttle mission STS-135 mission poster. From left to right: Christopher Ferguson, Douglas Hurley, Sandra Magnus, and Rex Walheim. Image credit: NASA via Wikipedia.

A long-term, committed, and stable strategic plan for the U.S. space program is vital to the country's interests. A long-term plan accompanied by a stable, deterministic budget can leverage U.S. investments wisely and fruitfully. The ability to make decisions based on a long-term view will always allow for better outcomes rather than being forced to deal with the uncertainty of a plan and budget situation that morphs every year or every few years based on unpredictable forces such as elections and the changing nature of global geopolitics.

We live in interesting times. After 50 years of accumulating experience with humans in space and the resultant transfer of that technology and know-how to the private sector, we exist in a moment of our country's history where space has started to become accessible to an increasingly wider swath of the business community and general public. I must mention my visit to Cornell University last fall, where the students proudly showed me the CubeSat they were building to launch sometime this year. They had already launched a small satellite as a piggyback on a commercial launch the previous year and the CubeSat under construction was their second endeavor. They also showed me the mission control room they assembled and proudly talked about the ground stations they built, something that would not have been possible when I was in college 30 years ago! Could we have ever predicted such an outcome in Kennedy's time?

We find ourselves at a pivotal point where private enterprise, again leveraging off of the foundational and groundbreaking work that the government has been conducting for the last five decades, feels that they understand the risk/reward equation enough to start engaging in activities in low Earth orbit. Government is prepared to foster this engagement. But in what context? What is the long-term plan? What are the outcomes we are trying to encourage as a nation?

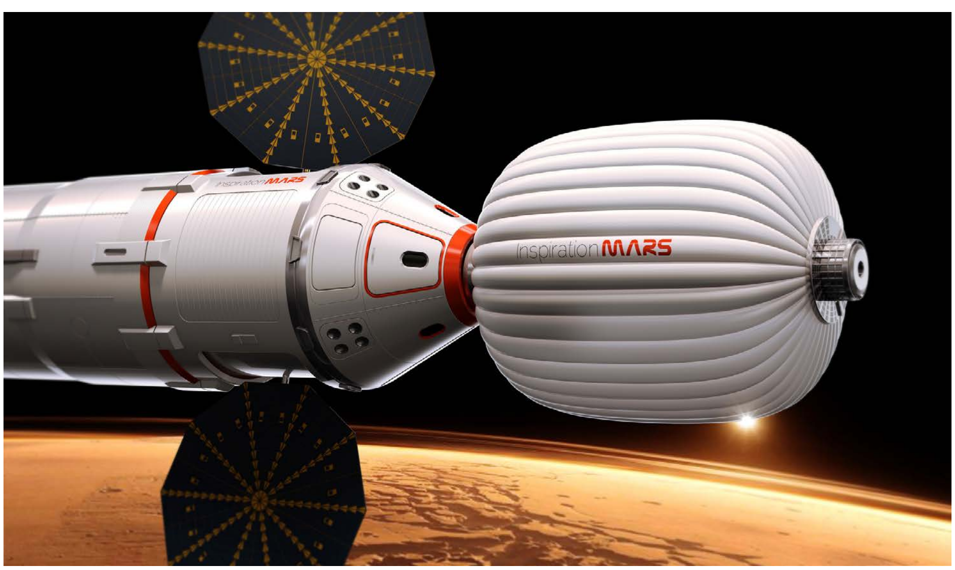
Government has a role that it must continue to play in space exploration and utilization. The role of government is to do the "hard" things; invest in the research and development that industry cannot, and to take on the tasks and push the boundaries that the private sector will not. Our strategy should encompass not only exploration but what we hope to accomplish in low Earth orbit and to encourage an economically viable industry there. We should consider how we want the U.S. to be leveraged for future roles in space, both in commercial and civil, in low Earth orbit and beyond. It should not be an "or," it should be an "and." Our plan – our vision – needs to be long term and stable in nature and comprehensive in scope, well thought out and well articulated, and, most importantly, fully resourced and executable. And finally we need to maintain our long-term focus and steadfast commitment to our strategy on the order of a decade or so at a minimum.

So the question being addressed today is "Can the Mars Flyby mission be a candidate for a deep space mission for the SLS system?" I would say that it is certainly one of many possible missions that could result. But once again, let me caution you. Let us not return to the misguided lessons of the past; any mission chosen cannot be done merely with the mindset of accomplishing a "goal" without clearly being tied to an overarching strategy.

A mission such as the Mars Flyby, or an asteroid retrieval or a lunar base, should be put in the context of the required longer term strategy to which I have been referring to. In the context of a coherent strategy and framework the appropriate missions will be defined logically, based on requirements developed within the strategic framework and then developed into a variety of mission and operational scenarios. The Mars Flyby thus can only be discussed in the context of that larger strategy and the associated missions and operational goals. I would also like to underscore that any plan, whether its goals are to retrieve an asteroid, establish a lunar base, or send people to Mars (or any combination thereof) is doomed to failure without the resources to support it – resources provided in a sustained and sustainable manner based on realistic projections.

Because it is not only the delineation of a strategic plan that is important but also the continuing commitment of the proper resources and necessary husbandry to that plan that will make it successful. Any strategic plan for any enterprise must be appropriately funded. So let me take a moment and talk about resources. NASA has found itself often in a position where it is given tasks to perform but then provided inadequate resources to fulfill them. Put in an impossible situation, nonetheless efforts are made to fulfill expectations that inevitably fall short. Failure to adequately source such large-scale endeavors from the outset inevitably leads to higher costs and inefficiencies that derive from the need to "rob Peter to pay Paul." These are hard things to address, but yet they are important, and understanding them requires comprehension and acceptance of some fundamental facts.

First, the development cycle for large, complex space projects, as we have already discussed, are very long term – from several years to as long as a decade or more. It is difficult to make intelligent and cost-effective decisions relating to the life-cycle costs of multiyear programs when you don't have control, let alone knowledge, of what your budget is more than a year out. Second, many state that NASA can no longer be cost effective. In these exceptionally lean budget times NASA has been experimenting with new approaches to program management and funding models and is learning to be more efficient but that is not enough. If you examine how they are constrained to run the agency, then one can easily see some adjustments that can help achieve even more efficiency and enable better financial decisions. Along with the uncertainty of budgets from year to year, NASA has



Above: Early artist's conception of Inspiration Mars capsule and habitat module passing by Mars. April 20, 2013. Image credit: Inspiration Mars Foundation. Image source: Wikipedia.

little or no control over their expense side of the budget; the politics of the situation make it difficult for them to adjust overhead, either facilities or workforce or the management of task assignments around the agency. Addressing both these issues at some level will improves NASA's ability to perform more cost effectively.

Today there are a lot of discussions constantly taking place about the U.S. budget; clearly we live in some fiscally challenging times. NASA currently gets about 0.5% of the U.S. budget – a figure I am certain you are all well aware of. You are probably also aware that this is the lowest relative amount of the federal budget that the agency has been allocated since before the Apollo program started. This is not enough, and we all know it. If we are going to be a nation that has a future in space, a nation with a strong strategic plan and the will to execute it, 0.5% of the national budget is simply not adequate. The nation has some major budgetary issues to address – I will not deny that. But the heart of our budget problems does not lie in the increasingly small fraction of the budget available to discretionary programs like NASA. Reducing NASA's budget will not solve the bigger problems we face. Reducing NASA's budget is a choice to not invest in our future.

Expanding our presence and continuing our exploration in space is important to our future. We are all aware of the long-term economic benefits of a healthy, robust space industry – you see that all around you today as we reap the harvest of our previous investments. But there is an intangible benefit as well. Space is "cool" and a strong motivating factor for our youth, a point of pride for our citizens. In my many years of being out and about discussing the activities of our country in space I have yet to find an audience that is not interested, and that does not get excited, about what we are doing. When we, the STS-135 crew, engaged with the public after our mission there were many people who expressed dismay when the shuttles were retired at what they thought was the end of the U.S. space program. Highlighting all of the exciting things occurring on the International Space Station and explaining that the U.S. was poised to expand our exploration efforts beyond low Earth orbit reassured them that the U.S. was not walking away from an enterprise that was important to them and in which we have lead for decades.

I thank you for inviting me to address you here today. I believe a strong, stable, strategically directed space program is vitally important to our country. A sustained national commitment to such a space program will not only benefit our country economically (in ways we cannot imagine) but also will serve as a strong motivation for our young generations to pursue challenging and exciting careers in science, math, and engineering – an intangible benefit but an important one – a benefit that Congress and the administration have declared as national priorities. Again thank you for the opportunity to address this committee and thank you as well for your continued support of the United States Space Program. I look forward to discussing this issue with you further, and to answering any questions you may have for me in this regard.

Dr. Sandra H. Magnus
Executive Director
American Institute of Aeronautics and Astronautics

Dr. Sandra H. "Sandy" Magnus is the Executive Director of the American Institute of Aeronautics and Astronautics (AIAA), the world's largest technical society dedicated to the global aerospace profession, with more than 35,000 individual members in 79 countries.

Born and raised in Belleville, Ill., Dr. Magnus attended the Missouri University of Science and Technology, graduating in 1986 with a degree in physics and in 1990 with a master's degree in electrical engineering. She also holds a Ph.D. from the School of Materials Science and Engineering at Georgia Tech (1996).

Selected to the NASA Astronaut Corps in April, 1996, Dr. Magnus flew in space on the STS-112 shuttle mission in 2002, and on the final shuttle flight, STS-135, in 2011. In addition, she flew to the International Space Station on STS-126 in November 2008, served as flight engineer and science officer on Expedition 18, and returned home on STS-119 after four and a half months on board. Following her assignment on Station, she served at NASA Headquarters in the Exploration Systems Mission Directorate. Her last duty at NASA, after STS-135, was as the deputy chief of the Astronaut Office.

While at NASA, Dr. Magnus worked extensively with the international community, including the European Space Agency (ESA) and the National Space Development Agency of Japan (NASDA), as well as with Brazil on facility-type payloads. She also spent time in Russia developing and integrating operational products and procedures for the International Space Station.

Before joining NASA, Dr. Magnus worked for McDonnell Douglas Aircraft Company from 1986 to 1991, as a stealth engineer. While at McDonnell Douglas, she worked on internal research and development and on the Navy's A-12 Attack Aircraft program, studying the effectiveness of radar signature reduction techniques.

Dr. Magnus has received numerous awards, including the NASA Space Flight Medal, the NASA Distinguished Service Medal, the NASA Exceptional Service Medal, and the 40 for 40 Award (given to former collegiate women athletes to recognize the impact of Title IX). ■

[The video recording (100 minutes) is available on YouTube.]

Detecting Starships

Feature Article

Dr. Albert Allen Jackson IV, Chair, AIAA Houston Section Astrodynamics Technical Committee, Lunar and Planetary Institute Visiting Scientist

[Figures by Doug Potter]

1. Introduction

The most sensible approach to the Search for Extraterrestrial Intelligence (SETI) is by way of the electromagnetic spectrum, mostly radio and maybe lasers, even the infrared. Many new methods of doing SETI are in the works [2], but one can ask the question: are there any other electromagnetic signatures of advanced extraterrestrial civilizations?

At almost the time of the paper by Philip Morrison and Giuseppe Cocco [2], Freeman Dyson [3] and Nikolai Kardashev [4] noted that advanced civilizations with innovative technologies could build artifacts such as Dyson Spheres or Kardashev civilizations which may have observable properties. Briefly, the Kardashev classification is:

- Type I – harnesses the energy output of an entire planet.
- Type II – harnesses the energy output of a star and generates about 10 billion times the energy output of a Type I civilization.
- Type III – harnesses the energy output of a galaxy, or about 10 billion times the energy output of a Type II civilization.

Roughly then, a Dyson Sphere would represent the technology of a Type II Kardashev civilization. In the following, I am going to abbreviate Kardashev Type I, II and III as K1, K2 and K3. (K is a nice letter here. It represents more than just Kardashev. It reminds me of the super civilization, the Krell, from the 1956 MGM science fiction movie, *Forbidden Planet*.) (Note: Strictly speaking Kardashev's original paper dealt with how an advanced civilization might power interstellar "beacons." Informally, his classification has passed into a scheme of taxonomy for tagging advanced civilizations. Whether that is a correct thing to do, the writer will not debate here.)

The materials composing a Dyson sphere would re-radiate waste heat in the infrared part of the electromagnetic spectrum. Such a search has been made for such K2 candidates. Just what kind of a technology one might look for at K3 scales has never been described, and it is not clear what to look for, or even if it is worth it.

What about K1 and K2 civilizations building starships? Might these be detectable in parts of the electromagnetic spectrum not usually associated with SETI?

Starships

Viewing, Horswell and Palmer [5] asked such a question about K1 and K2 starships in 1977. They enumerated the possibilities:

- Innocuous starships - Slow interstellar flight, such as World Ships.
- Energetic starships - keeping in mind three kinds of propulsion
    - Nuclear Fission
    - Thermonuclear Fusion
    - Matter-Antimatter

Viewing, et al., did not draw any particular conclusions about detectability.

Zubrin 1995 [6] examined the same question of energetic starships and did put forward some examples of detection. His standard ship was a 1,000,000 tons, acceleration at 0.01g, and powered at 1500 terawatts (TW). Zubrin's forms of starship radiation (Table 1) do not always use this standard source.

There may also be civilizations using beamed radiation, a very popular and technologically attractive way of implementing interstellar travel. Here are some versions of such ships (Table 2).

In this case, we would be looking for transmitter station radiation attenuated as a function of distance from our location. Many varieties of radiation may be involved; laser beam power and microwaves have received great attention.

A caveat: in most of the methods described, the observer must be inside the starship motor exhaust cone or transmitter cone of an energy beam. In general, this cone will be narrow. If one compares this with the full sky, there is little chance of starship detection. See the next section for more about this.

2. K2 Starships

Following the lead of Freeman Dyson and Nikolai Kardashev, we bravely extrapolate. Take the civilization to be K2. We make the assumption that the following problems have been solved for K2 starships:

1) They can run "hot." Ship construction materials can come into thermal equilibrium with temperatures as high as 5000 K. (This is close to the melting point of graphene.)
2) Material structural strength limits have been overcome. That is, there is support for Lorentz factors of up to at least 500, or 0.999998c (where c is

Table 1: Forms of Starship Radiation (adapted from Zubrin [6]).

Type	Radiated at Source	Frequency	Detection Object
Radio	80 - 2000 TW	24 – 48 kHz	Yes - Magsails
Visible	120000 TW	Infrared	Yes - Antimatter Ships, Possibly at 300 light years.
X-Rays	40000 TW	2 - 80 KeV	Nuclear Ships. Marginal at approx. 10 to 1,000 light years!
Gamma Rays	1 - 32 MeV	20 - 200 Mev	Antimatter Ships. Maybe not.

the speed of light). This means stress transmitted by drag due to interacting electromagnetic fields, or the support of very large magnetic flux densities, have been solved.
3) They can tolerate acceleration. K2 civilizations fly 1g or higher starships.
4) Disintegration due to relativistic dust or gas impact is solved.
5) K2 guidance, navigation and control: almost magic but still distinguishable as three separate functions.

Whatever the problem, a K2 civilization can solve it!

What to Look For

Postulate a generic K2 ship, that is to say, a high-Lorentz-factor ship.
If v is the velocity of the ship and c is the speed of light, then the Lorentz factor is $\gamma = 1/\sqrt{(1-\beta^2)}$, where β is v divided by c. The opening solid angle goes like one over γ . In the case of a 500 γ ship this angle, **Ω** (Figure 1), is approximately .12 steradians. Dividing by four pi steradians (corresponding to the entire sky) gives us .005. That is to say, there is a low probability of detecting this starship.

Note a Lorentz factor (lower case gamma) of 10 is equivalent to a ship speed of .995 times the speed of light. Take a hypothetical numerical example. Take the above K2 ship with gamma of 500 (yes, a "super science" ship), 0.999998 times the speed of light. This hypothetical K2 starship will be taken to be as hot as 5000 degrees K. (Graphene has a "melting" temperature near this.)

Suppose such a starship is making an interstellar trip. What might we see? While the ship's engine is running, and even after propulsion is off, there will be waste heat. It can be modeled as isotropic radiation in the rest frame of the ship. To an observer in another inertial frame, the radiation will be beamed, ~~the~~ a relativistic "headlight" effect (Figure 1).

Considering a ship of modest size and mass, a K2 ship accelerating at one gravity. For instance, if we have a ship 1000 meters long and 50 meters in diameter, generating 11402 terawatts in its rest frame, Doppler boosting [7] will generate approximately 1.2×10^8 terawatts beamed into the forward direction. However, as noted above, unless the ship is headed straight at the observer, it will be hard to see. Take into account the Doppler shifting of the characteristic wavelength, from near green in the rest frame to soft x-ray in the observer's frame. One might look for small anomalies in data from a host of new astrophysical satellite observatories (Figure 2).

3. Gravitational Machines

In 1963 Freeman Dyson [8] suggested that an advanced civilization might use massive binaries (binary stars, star systems with two stars orbiting their common center of mass) as "slingshots," a process later used by spacecraft in the solar system, in astrodynamics called a Gravity Assist, to save fuel and time (Figure 3). Dyson considered white dwarf star binaries and neutron star binaries. One now can add black hole binaries.

Like Dyson, assume the two stars in the binary system are of equal mass and in the same circular orbit about their common center of mass, assume the distance between them is at its maximum, which is twice the radius of the orbit, and assume the orbit's radius is 1000 km. Consider a ship approaching with a velocity V. Velocity gains from the slingshot are on the order of .002 to .006c. Not bad for free energy, except one has to live in the vicinity of, or travel to, such objects.

There is bad news. Lifetimes of these binaries, shortened by gravitational wave energy loss, and hence orbit decay and collapse to merging, are [9]:

- White dwarf star binaries: approximately 30 years
- Neutron star binaries: approximately 18 years
- Black hole binaries: approximately .1 year

These short lifetimes limit the usefulness of this slingshot process. Larger separation distances for the binaries result in longer lifetimes for the binaries but smaller starship velocity gains.

4. Surfing Black Holes

Another place to look for starships is isolated black holes. Rotating black holes (these will be referred to as Kerr black holes) and non-rotating black holes (Schwarzschild) have an interesting property when one has a trajectory close to them, particles (starships, in our case) no longer move according to Newtonian mechanics.

In Newtonian physics, when a spacecraft approaches a planet, from a distance assumed to be infinitely far from the planet, with an initial speed that exceeds escape velocity from that planet, it will return to infinity via a parabolic or hyperbolic trajectory, unless that craft fires

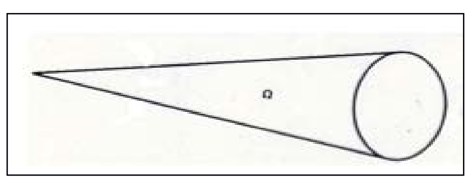


Figure1: Relativistic beaming from a point source.

Table 2. Details of starships using beamed radiation. Reference: Dana Andrews, 2010, http://bruceleeeowe.wordpress.com/tag/laser/)

Laser-Propelled Lightsail Characteristics

Mission Type	Probe	Explorer	Manned
Spacecraft Payload, kg	2000	20,000	50,000
Deceleration Spacecraft Mass, kg	2637	26,700	76,700
Acceleration Spacecraft Mass, kg	5160	42500	117,000
Spacecraft Coast Velocity, v/c	0.3	0.3	0.3
S/C Kinetic Energy, Joules	1.05×10^{19}	1.08×10^{20}	3.1×10^{20}
Acceleration Characteristics			
Laser Beam Power, Terawatts	50	200	1000
Beam Director Diameter, meters	50,000	50,000	50,000
Lightsail Diameter, meters	2000	5000	8000
Acceleration time, days	37	45	37
Radius at Cutoff, AU	1114	1235	1021
Total Beam Energy, Joules	1.6×10^{20}	1.2×10^{21}	3.2×10^{21}
Deceleration Characteristics			
Magnetic Dipole Moment, a-m^2	1.0×10^{15}	2.0×10^{16}	1.0×10^{17}
Deceleration Time, years	10.7	15.7	15.3

a rocket motor, encounters the planet's atmosphere, hits the planet's surface, or uses some other dissipative mechanism. However, in the case of a black hole, when the starship gets close enough, there are orbits that can go into temporary capture. If the starship approaches to within 10M of a Schwarzschild black hole, where M is the famous Schwarzschild radius, then the motion of the starship is not Newtonian, and the temporary capture orbit can occur (Figure 4). *[Editor: The Schwarzschild radius is the radius of a sphere such that, if all the mass of an object is compressed within that sphere, the escape speed from the surface of the sphere would equal the speed of light.(Wikipedia)]* For Kerr black holes, the situation is more complicated.

Of what advantage is this? First, a K2 civilization might use such a capture orbit as a free source of direction change. A ship moving at, say, .5c, would have to expend a lot of energy to change direction if a desired destination is not along a given trajectory. Why not move in that direction in the first place? That might be possible, but a ship may be constrained to a "takeoff" path not in the target direction.

Secondly, if the black hole is in the vicinity of a target destination, it is known that an orbiting particle (starship, in our case) close to a black hole will lose energy to gravitational radiation. To use this mechanism would require K2 technology capable of calculating the right distance and the shielding to survive the close-to-the-black-hole environment, which may be the black hole's accretion disk (though there should be some "bare" black holes in the universe). Kerr black holes, which will be the most common, present extreme astrophysical environments. (Note: almost all stars that collapse to black holes will be rotating.) Zeldovich and Novikov [10] have computed the number of loops that can be made about a Schwarzschild black hole for a special orbit that eventually becomes unbound. For Kerr black holes, such orbits exist, but analytic calculations are extremely difficult [11] and will most likely have to be made numerically (Figure 5).

Any K2 civilization "hot" starship orbiting a Schwarzschild or Kerr black hole will have visible waste radiation whenever an observer is in the black hole-ship-observer line of sight (Figure 6a). A close-orbiting object will have a fluctuating emission, peaked whenever the ship, hole and observer line up due to gravitational focusing (Figure 6b).

5. The Penrose Process

Kerr black holes are complex structures; the spacetime that surrounds them is very complex (Figure 7a). A black hole, in general, is surrounded by several surfaces;

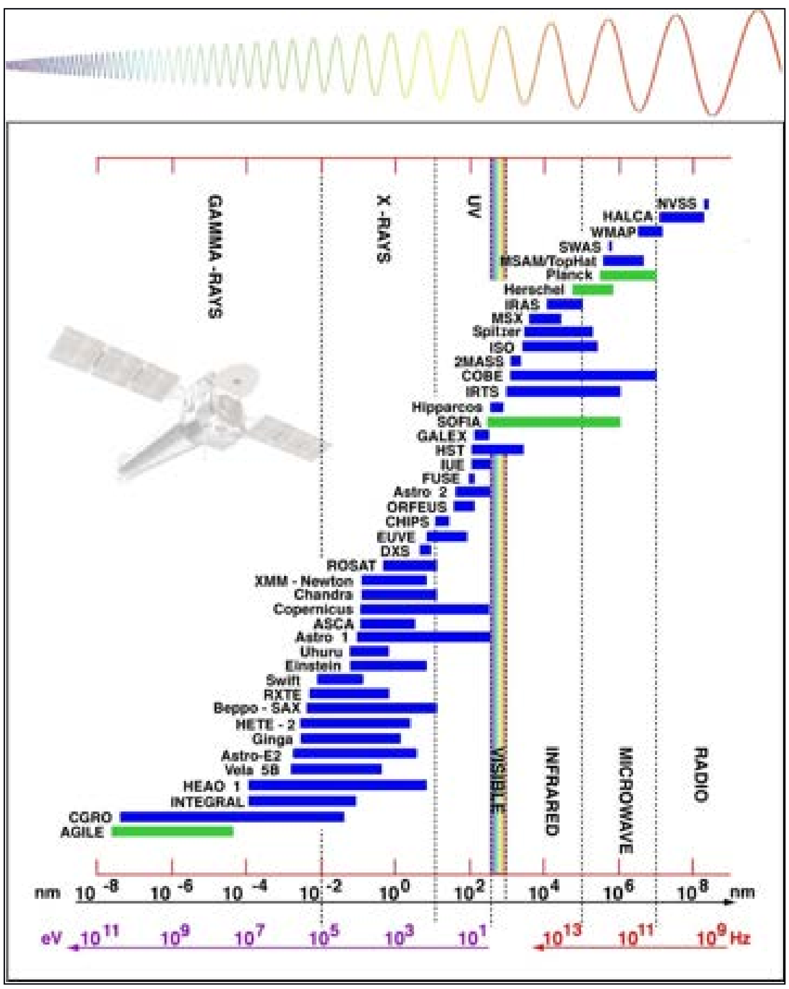


Figure 2: Astrophysical Observatories and the Electromagnetic Spectrum. Source: Wikipedia.

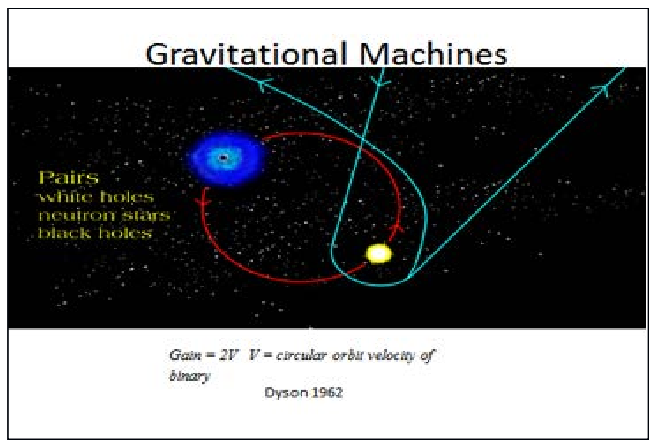


Figure 3: Gravitational Machines (Doug Potter).

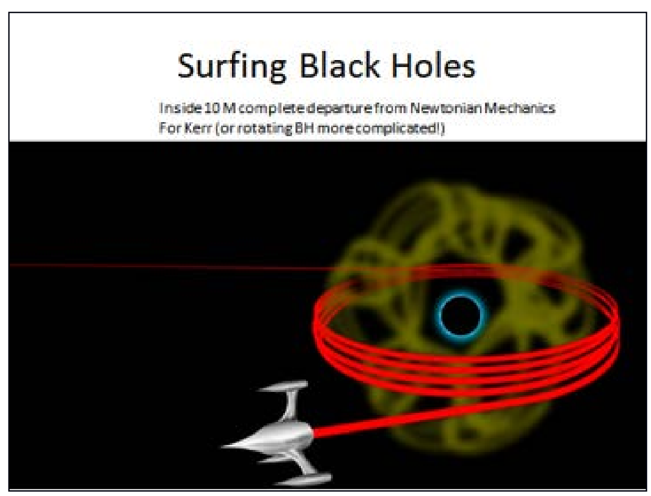


Figure 4: Looping a Black Hole (Doug Potter).

an inner event horizon, an outer event horizon, and a static limit (inside which nothing can remain at rest due to the dragging of space-time). A region between the outer event horizon and static limit, called the ergosphere, surfaces no observer/particle can maintain itself at a constant radius.

A detailed description [11] of the ergosphere is beyond the exposition given here. See Figure 7b for a schematic description. For a rapidly rotating black hole, the energy contained in the ergosphere is 10^{52} to 10^{54} ergs!

Roger Penrose discovered that for an objected injected into a Kerr black hole's ergosphere, if the object split into two pieces of matter, it can be arranged so that one piece escapes to infinity, while the other piece falls into the event horizon of the black hole. The escaping mass will extract energy from the hole.

A K2 civilization might devise a more sophisticated construct than given above and in Figure 7. There is one drawback to this process. It was found [11] that for the process to work efficiently, the incoming mass (or starship) would need an initial speed of .5c! If a starship can already do .5c, there may not be much advantage in this process, and a calculation shows not all that much speed can be extracted.

6. Jet Riders

The astronomical object SS 433 consists of a neutron star or black hole orbited by a "normal" companion star. The powerful gravity of the neutron star or black hole is drawing material from the stellar wind of its companion into an accretion disk of material tightly circling the dense, central object prior to being pulled onto that object (Figure 8). This disk propels jets of particles outward from its poles. In SS 433, the particles in the jets move at 26 percent of the speed of light. Objects such as these are called microquasars. The jet material can move at 90 to 95 percent of light speed [12].

Suppose a K2 civilization establishes a factory nearby, a K2 civilization with the ability to protect itself from the very harsh radiation environment. Suppose

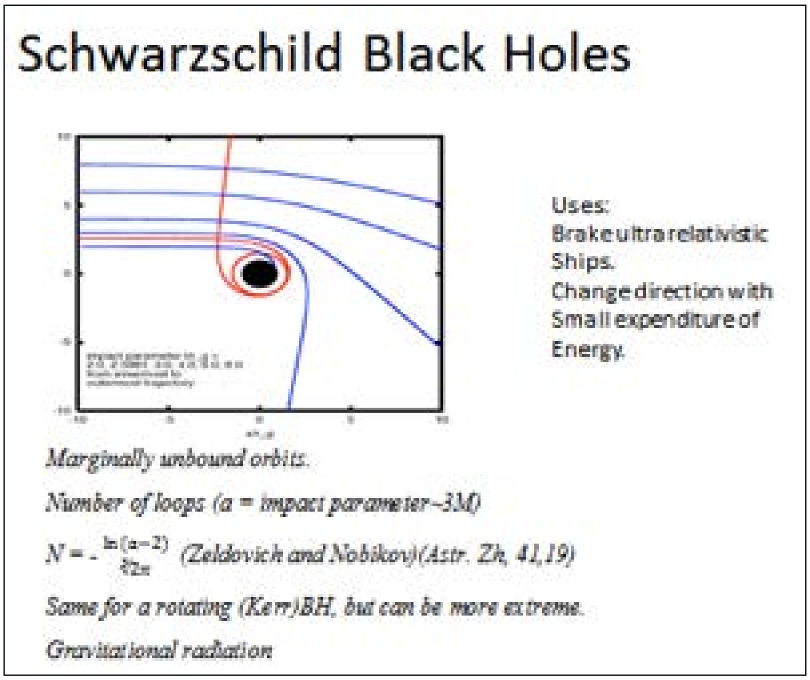


Figure 5: Orbiting a non-rotating (Schwarzschild) black hole.

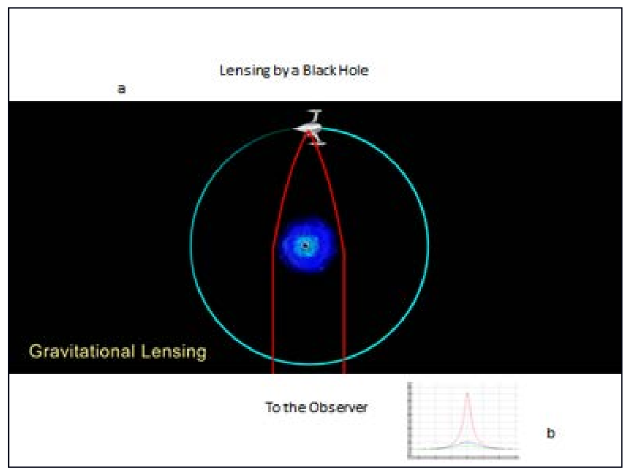


Figure 6 (6a and 6b): Gravitational lensing (D. Potter).

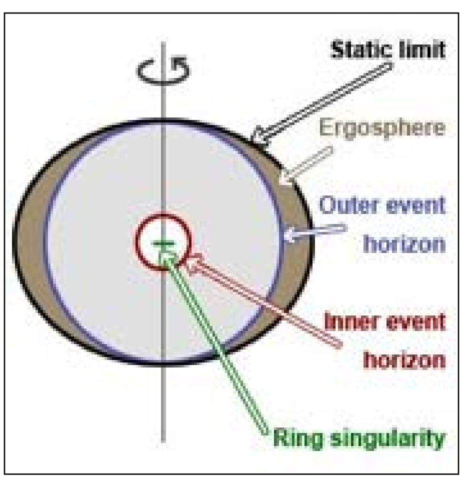


Figure 7a: A Kerr (rotating) black hole.

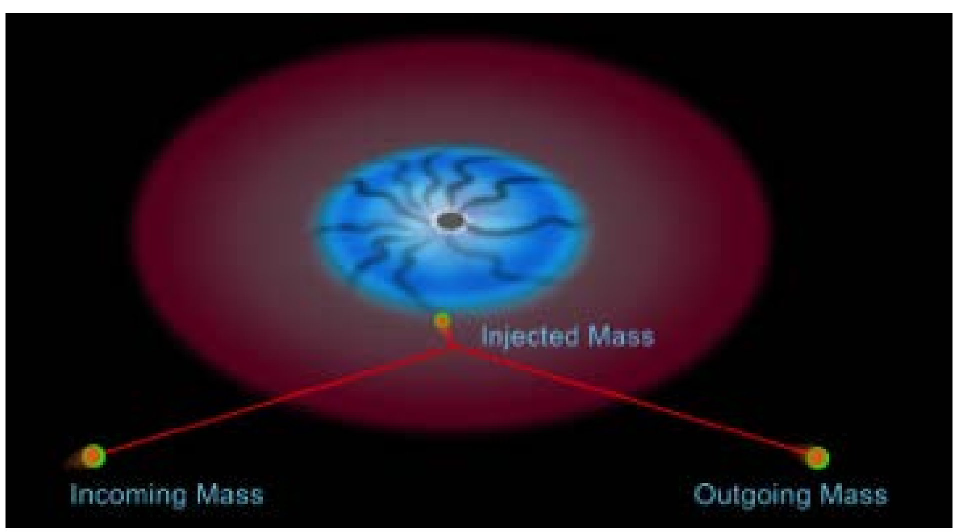


Figure 7b: A Kerr (rotating) black hole and the Penrose effect. (Doug Potter)

they build magsails [14] (or some such vehicle) and use the jet as a propulsion source. For SS 433, assume a jet speed of approximately .25c, and a jet with number density of approximately 10^{13}/cubic cm. Let the effective area of a magsail be 1 meter squared. The vehicle quickly attains an acceleration of approximately 24 g. If one can stay in the jet for about 18 days, ship proper time, then in 1000 astronomical units, one attains a speed of .5 times the speed of light.

A problem is that the material jet will, in general, be twisting about, as its source region does not rotate uniformly. This should be a problem of guidance, navigation, and control that a K2 civilization would have to solve.

7. Bow Shocks

The use of magnetic fields for interstellar flight was first considered by Bussard [13]. The vehicle collects gas from the interstellar medium and compresses it to the density of a plasma that will reach the conditions for fusion (an extremely difficult technology which may be attainable by a K2 civilization). Carl Sagan suggested a magnetic field could be used to scoop this interstellar gas. This was extended to magsails by Andrews and Zubrin [14], who proposed using magnetic fields as "brakes." Thus, an interstellar ship might use a magnetic field, plowing into the interstellar medium (particularly dense regions), to cause both energy and momentum loss, and hence to slow down. This process was noted by Bussard [13] and was quantified by Fisback in 1969 [15]. This would be useful in stopping, or at least slowing down, a relativistic interstellar spacecraft. The byproduct of this process can produce a bow shock. For example, runaway neutron stars show such a structure (Figure 10).

Radiation from the bow shock can range from the optical to the X-ray bands, mostly produced by synchrotron radiation. A starship will be much smaller than a neutron star, but detection of the radiation signature of a starship's bow shock could imply a very peculiar object.

8. Black Hole Lensing

If K2 civilizations utilize black holes as a method of redirection, or as "brakes," using gravitational radiation by orbiting in the non-Newtonian regions near a black hole, then the waste heat of the ship will be focused by the black hole (Figure 11a, same as Figure 6a), and one should see an anomalous peak (Figure 11b, same

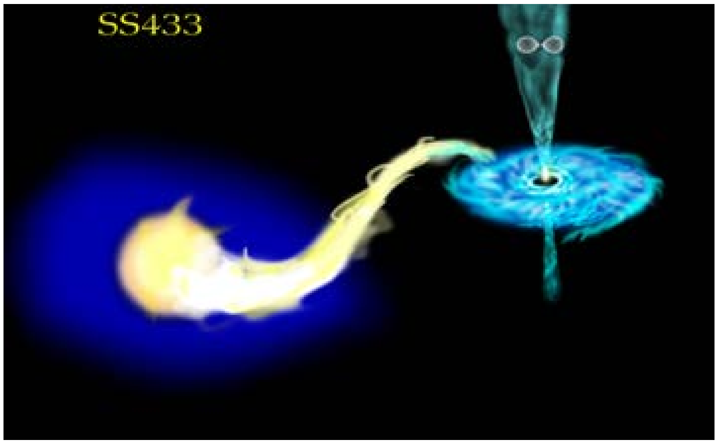


Figure 9. Magsail "jet riding." (Doug Potter)

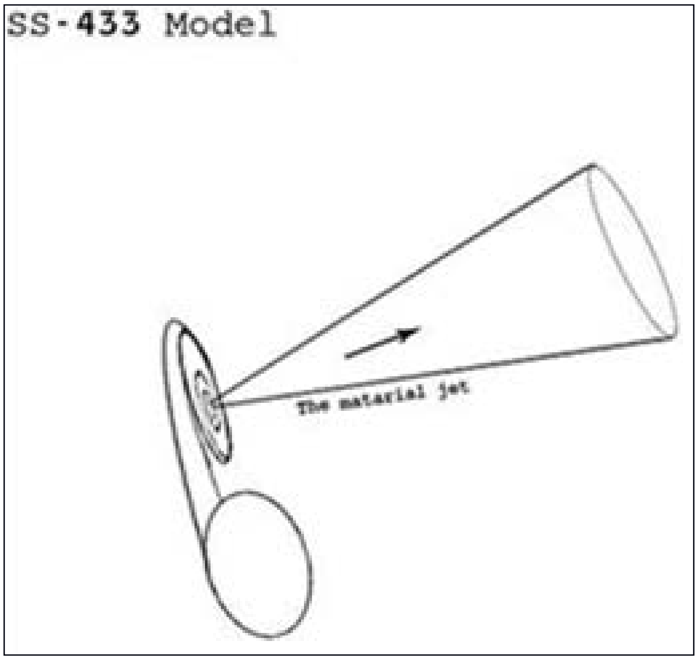


Figure 8: The material jet originates from a neutron star or a black hole.

Figure 10: Neutron star bow shock. (Source: Wikipedia.)

as Figure 6b) in whatever part of the spectrum emerges from the starship's black-body radiation. A word of caution: strong-gravitational-field focusing is very complicated, where by "strong," we mean the use of a Schwarzschild or Kerr black hole to bend light as a gravitational lens when photons pass close to these compact bodies [17].

Figure 11: Lensing of a starship's waste radiation by a black hole. (See Figure 6.)

8.1 Black Hole Beamed Propulsion

Consider a K2 civilization taking advantage of a Schwarzschild or Kerr black hole as a means of focusing radiation from a beaming station onto a sail. The advantage of this is the enormous amount of amplification possible. One of the most promising modes of interstellar flight propulsion is the use of a sail, a transmitter, and maybe a "lens" to focus a beam of laser light or microwaves [18]. Extrapolate to a K2 civilization the use of a black hole as the focusing device. An approximate calculation for a Schwarzschild black hole shows that beamed radiation can be amplified by a factor 10^5 to 10^{15} [16]. Caution is advised. Almost all of the many astrophysical papers on "strong focusing" consider a lens that is either a Schwarzschild or Kerr black hole, but in that case, a focused source is either many light years away or is in orbit about the black hole, but is physically larger in extent than the black hole. These constraints, though a realistic astronomical configuration, may not match the K2 technological engineering setup considered here. There are physical consequences to consider too. A source behind a Schwarzschild black hole does not come to focus at a point but creates, in the first approximation, on the optical axis (the axis that connects the source and the observers), a "caustic," where the amplification is infinite [17]! This is due to using geometric optics as a model. A caustic, in the Schwarzschild case, may be thought of as a "tube" on the optical axis. This is because of the non-Newtonian nature of the strong gravitational field of a black hole. Photons that come from the right direction can go into orbit, either permanently or for a finite number of revolutions. Therefore, the location of the source image will be displaced on the image plane. In "weak lensing," there will be an Einstein ring that is the deformation of the light from a source into a ring through gravitational lensing of the source's light by an object with an extremely large mass. Black holes are the lenses of interest here. In the case of Kerr black holes, the "caustics" will be "sheets," complicating the process to the extreme. The exact location of a source and the sail location are the subjects of further study (Figure 12).

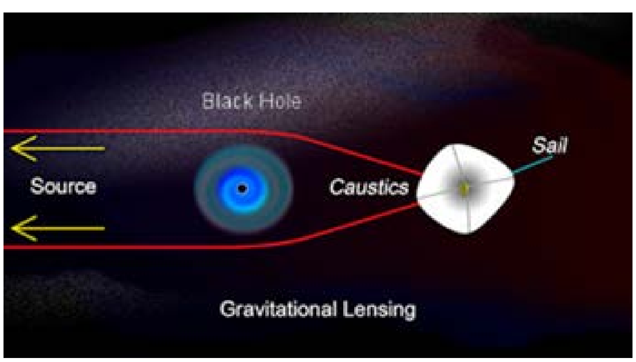


Figure 12: Black hole gravitational lensing as beamed propulsion.

9. Black Hole Bomb Propulsion

An electromagnetic wave impinging on a Kerr black hole can be amplified as it scatters off the hole if certain conditions are satisfied, giving rise to an amplified wave called superradiant scattering [19]. By placing a mirror around the black hole, one can make the system into a bomb [19]! In the modeling of a wave with frequency $\omega < m\Omega$ from a Kerr black hole, with m an azimuthal wave quantum number (1, 2, 3 …) and Ω the angular velocity of the Kerr hole at the horizon (The azimuthal quantum number is a number for the wave that determines its orbital angular momentum.), the scattered wave will be amplified, the excess energy being drawn from the Kerr black hole's rotational energy. (It will be assumed here that the radiation is spin 1 electromagnetic radiation.)

Imagine that a K2 civilization builds a "mirror" composed entirely of starships around a Kerr black hole. There are an immense number of possible configurations. Consider something like a truncated icosahedron (Figure 13a). It might be some other solid, as long as the inside surface forms a mirror to the incident radiation, as long as the configuration is such that transmitters – reflectors located towards the Kerr black hole can efficiently contain the scattered radiation (Figure 13b). The process would be that the transmitter's fire once and then by K2 technology become reflectors. The initial radiation would be amplified until the strength of the structure formed by the K2 "mirror-ships" can no

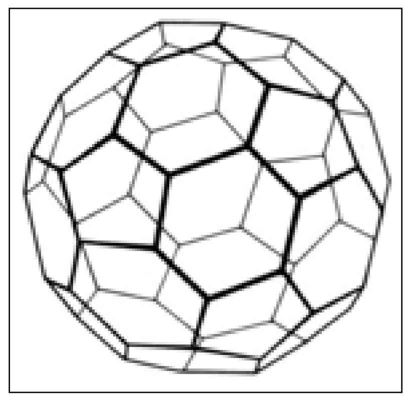


Figure 13a: Truncated Icosahedron.

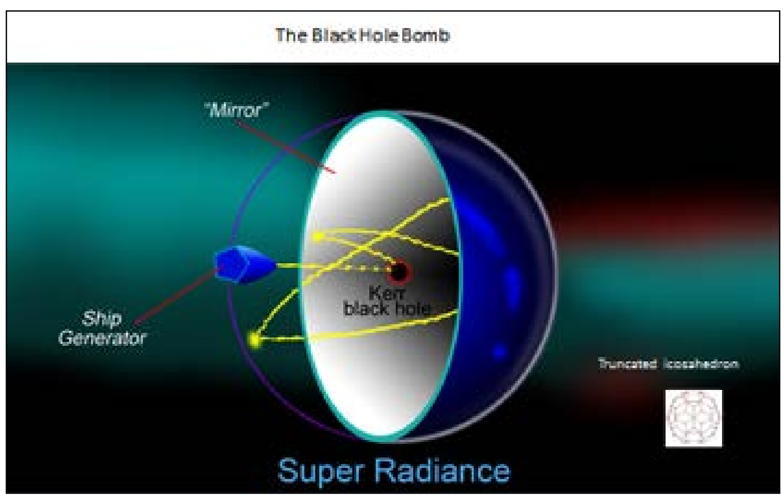


Figure 13b: Black hole bomb production.

longer contain the electromagnetic energy. Consider a 1 solar mass black hole rotating at about 10,000 radians per second, and a sphere located at 22 km. (The event horizon is approximately at 3 km.) At the end of 13 seconds (the [e-folding time](#)) the energy content is 10^{17} times the initial pulse. To match the "bomb" constraints, the transmitted pulse wavelength should be at about 18 km. How one would reflect and absorb long wavelength radio waves is a problem to be solved by a K2 civilization. Another possibility is that a spectrum of primordial black holes (PBH) exists, left over from the Big Bang [10]. PBH's in the range of 10^{-5} to 10^{43} grams might exist. For an Earth mass Kerr black hole, the event horizon is 9.0 mm. Placing the mirror at 1 m, one gets a growing timescale of about 0.02 second. The critical radiation would be a high frequency radio wave at about 33 GHz

With amplification of the order of 10^{17} [19], one has to leave it to a K2 civilization as to how keep the containment mirror-propulsion system from melting or being shattered. It would mean the system would have to be fine-tuned to these effects. With the right configuration, the structure would hold the energy until some material strength is exceeded, while keeping the radiation absorption from vaporizing, and a fleet of ships can fly off using some fraction of the amplified energy. *A source outputting 1 watt in could generate 10^{17} watts of "bomb" power out!*

10. Conclusions

Several kinds of starships have been presented (all the slower than light variety), along with their possible detection signals. We also speculated on modes of propulsion using high-energy astrophysical bodies.

The author admits the methods used to attain relativistic speed, using high-energy astrophysical processes, are far out in the tail of the distribution of speculation, however, so may be the existence of a Kardashev Type II (K2) civilization. These methods don't exhaust all the possible methods one could conceive. *The likelihood of observations of relativistic starships is increased if there exists a large number of starfaring civilizations.* Figure 2 is intriguing. Is there a ["Wow!" signal](#) [20] lurking in the non-standard parts of the SETI electromagnetic spectrum? *Starships braking in a dense interstellar region are attractive possible observations.* See Gregory Benford's Bow Shock [21]. ■

Above: Movie poster from the 1956 film Forbidden Planet. [Source](#): Wikipedia.

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NASA's Kepler Discovers First Earth-Size Planet In The Habitable Zone of Another Star

NASA Press Release, April 17, 2014

Using NASA's Kepler Space Telescope, astronomers have discovered the first Earth-size planet orbiting a star in the "habitable zone" -- the range of distance from a star where liquid water might pool on the surface of an orbiting planet. The discovery of Kepler-186f confirms that planets the size of Earth exist in the habitable zone of stars other than our sun.

While planets have previously been found in the habitable zone, they are all at least 40 percent larger in size than Earth and understanding their makeup is challenging. Kepler-186f is more reminiscent of Earth.

"The discovery of Kepler-186f is a significant step toward finding worlds like our planet Earth," said Paul Hertz, NASA's Astrophysics Division director at the agency's headquarters in Washington. "Future NASA missions, like the Transiting Exoplanet Survey Satellite and the James Webb Space Telescope, will discover the nearest rocky exoplanets and determine their composition and atmospheric conditions, continuing humankind's quest to find truly Earth-like worlds."

Although the size of Kepler-186f is known, its mass and composition are not. Previous research, however, suggests that a planet the size of Kepler-186f is likely to be rocky.

"We know of just one planet where life exists -- Earth. When we search for life outside our solar system we focus on finding planets with characteristics that mimic that of Earth," said Elisa Quintana, research scientist at the SETI Institute at NASA's Ames Research Center in Moffett Field, Calif., and lead author of the paper published today in the journal Science. "Finding a habitable zone planet comparable to Earth in size is a major step forward."

Kepler-186f resides in the Kepler-186 system, about 500 light-years from Earth in the constellation Cygnus. The system is also home to four companion planets, which orbit a star half the size and mass of our sun. The star is classified as an M dwarf, or red dwarf, a class of stars that makes up 70 percent of the stars in the Milky Way galaxy.

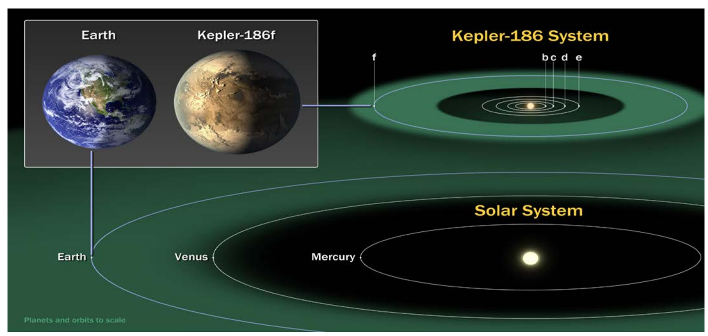
"M dwarfs are the most numerous stars," said Quintana. "The first signs of other life in the galaxy may well come from planets orbiting an M dwarf."

Kepler-186f orbits its star once every 130-days and receives one-third the energy from its star that Earth gets from the sun, placing it nearer the outer edge of the habitable zone. On the surface of Kepler-186f, the brightness of its star at high noon is only as bright as our sun appears to us about an hour before sunset.

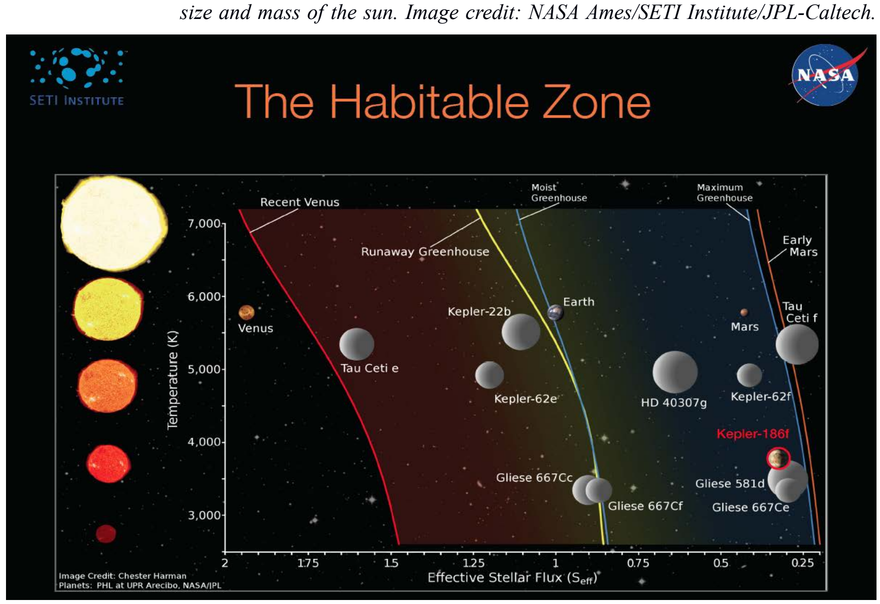
"Being in the habitable zone does not mean we know this planet is habitable. The temperature on the planet is strongly dependent on what kind of atmosphere the planet has," said Thomas Barclay, research scientist at the Bay Area Environmental Research Institute at Ames, and co-author of the paper. "Kepler-186f can be thought of as an Earth-cousin rather than an Earth-twin. It has many properties that resemble Earth."

The four companion planets, Kepler-186b, Kepler-186c, Kepler-186d, and Kepler-186e, whiz around their sun every four, seven, 13, and 22 days, respectively, making them too hot for life as we know it. These four inner planets all measure less than 1.5 times the size of Earth.

The next steps in the search for distant life include looking for true Earth-twins -- Earth-size planets orbiting within the habitable zone of a sun-like star -- and measuring the their chemical compositions. The Kepler Space Telescope, which simultaneously and continuously measured the brightness of more than 150,000 stars, is NASA's first mission capable of detecting Earth-size planets around stars like our sun. ■



Above: The diagram compares the planets of our inner solar system to Kepler-186, a five-planet star system about 500 light-years from Earth in the constellation Cygnus. The five planets of Kepler-186 orbit an M dwarf, a star that is half the size and mass of the sun. Image credit: NASA Ames/SETI Institute/JPL-Caltech.



Above: Presented at the press conference by Victoria Meadows, University of Washington, Virtual Planetary Laboratory Lead Team, NASA Astrobiology Institute. Image credit: NASA/Chester Harmon.

The Experimental Aircraft Association (EAA) Chapter 12 (Houston)

Mission

The EAA's Chapter 12, located at Ellington Field in Houston, Texas, is an organization that promotes all forms of recreational aviation. The organization includes interest in homebuilt, experimental, antique and classic, warbirds, aerobatic aircraft, ultra lights, helicopters and commercially manufactured aircraft and the associated technologies.

This organization brings people together with an interest in recreational aviation, facilitating social interaction and information sharing between aviation enthusiasts. Many of the services that EAA offers provide valuable support resources for those that wish to develop and improve various skills related to aircraft construction and restoration, piloting, aviation safety and aviation education.

Every individual and organization with an interest in aviation and aviation technology is encouraged to participate. (EAA membership is not required, but encouraged.) Meetings are generally from 6:30 PM to 9:00 PM at Ellington Field in Houston Texas. We welcome everyone. Come as you are and bring a guest; we are an all-aviation friendly organization!

Profiles in General and Experimental Aviation

(1) Lance Borden (Horizons *May 2011 issue*)
(2) Paul F. Dye (Horizons *July/August 2011 issue*)
More profiles will appear as soon as possible. Thanks to Richard Sessions (EAA Chapter 12) for suggesting this series.

Ideas for a meeting? Contact Richard at *rtsessions[at]earthlink.net.*
Another email contact: *eaachapt12[at]gmail.com.*
Experimental Aircraft Association (EAA) web site: *www.eaa.org*.
Chapter 12 web site: *www.eaa12.org*. Meeting dates are noted on their calendar.

Scheduled/Preliminary Chapter 12 Event/Meeting Ideas and Recurring Events

1st Saturday of each month – La Grange TX BBQ Fly-In, Fayette Regional (3T5)

1st Saturday:	Waco/Macgregor TX (KPWG), far east side of field, Chapter 59, pancake breakfast with all the goodies 8-10 AM, Dale Breedlove, jdbvmt[at]netscape.com
2nd Saturday:	Conroe TX Ch. 302 10 AM Lone Star Builder's Ctr Lone Star Exec.
2nd Saturday:	Lufkin TX, Fajita Fly-In (LFK)
2nd Saturday:	New Braunfels TX, pancake Fly-In
3rd Saturday:	Wings & Wheels, 1940 Air Terminal Museum, Hobby Airport, Houston TX, *www.1940airterminal.org*
3rd Saturday:	Jasper TX BBQ lunch, Fly-In (JAS)
3rd Saturday:	Tyler TX, breakfast fly-in, 8-11 AM, Pounds Field (TYR)
4th Saturday:	Denton TX, Tex-Mex Fly-In
4th Saturday:	Leesville LA, Lunch Fly-In (L39)
4th Saturday:	Shreveport LA, Lunch Fly-In (DTN)
Last Saturday:	Denton TX, Fly-In, 11AM-2 PM (KDTO)

[April 29, 2014]

The annual week-long airshow EAA AirVenture is gearing up for Monday, July 28, through Sunday, August 3, 2014. As usual, the location is Oshkosh, Wisconsin.

The 1940 Air Terminal Museum at Hobby Airport
An AIAA Historic Aerospace Site

Douglas Yazell, Editor

A bimonthly column about the 1940 Air Terminal Museum, a 2008 addition to the list of AIAA Historic Aerospace Sites. The museum is restored and operated by the non-profit Houston Aeronautical Heritage Society.

1940 Air Terminal Museum
8325 Travelair Street
Houston, Texas 77061
(713) 454-1940
www.1940airterminal.org

[April 26, 2014]

Enjoy visits to the museum, open for affordable visits most days. The third Saturday of most months is the day for a lunch-hour-centered program called Wings & Wheels. For just a few dollars (meals usually available from a gourmet truck, Flaming Patties), unique visits on these special days are available. Displays always include aircraft just outside the museum's back door, and displays often include memorable automobiles from Houston area car clubs just outside the museum's front door.

Upcoming Wings & Wheels event dates are Saturday, May 17, 2014 (Learn to Fly Day, inspired by the Experimental Aircraft Association's first International Learn to Fly Day of 2009), and Saturday, June 21, 2014 (theme to be announced).

[Image credits: the 1940 Air Terminal Museum website. Model T automobile owner: museum volunteer Broderick Thompson.]

Climate Change and Local Responses

Douglas Yazell, Article #8 in this Bimonthly Series

[April 28, 2014]

After a NASA/JSC community scientist expertly delivered a public presentation about current and planned NASA Earth Observation satellites, I asked him how many of those satellites are used for climate change study. "All of them," he replied. I note in passing that a national Congressman, whose district includes NASA/JSC, once told our AIAA Houston Section dinner meeting audience that NASA should cancel climate change satellites, since he claimed they are redundant.

Working in the NASA/JSC community from 1992 to 2011, I never heard unreasonable political talk of that nature in our work community. Once Constellation was canceled, I heard two complaints that the decision was political.

With these superlative satellites in mind, I see the January 22, 2014, news article on the NASA climate website is, "*NASA Set for a Big Year in Earth Science with 5 New Missions*," by Steve Cole of NASA Headquarters and his co-authors.

1. Global Participation Measurement (GPM) Core Observatory
2. Orbiting Carbon Observatory (OSO-2)
3. Soil Moisture Active Passive (SMAP)
4. ISS-RapidScat
5. ISS-Cloud-Aerosol Transport System (CATS)

The International Space Station (ISS) climate change science instruments are of interest to our NASA/JSC community, since ISS is so central to our work. In fact, the article explains that, *"NASA plans to launch five Earth-observing instruments to the ISS through 2017. These missions are developed and operated jointly by the International Space Station Program and the Earth Science Division."*

Salon.com presented a helpful article recently [April 26, 2014], "*The rise and fall of America's climate deniers: How politics hijacked the fight against global warming: Partisan rhetoric has stymied real action on climate change, but there's still hope, says philosopher Dale Jamieson*," by Lindsay Abrams. It includes this quote from Dale Jamieson (something he sometimes says), "*It isn't that we failed to act because we think there's uncertainty about the science, rather we think there's uncertainty about the science because we failed to act.*"

The NASA climate website is an example of excellence and courage. AIAA is less restricted in some ways, so AIAA can do even more in some ways. Like the American Geophysical Union (AGU), AIAA can issue a position statement. With 800 professional members, a position statement from AIAA Houston Section is a good idea. With 35,000 members and 100 corporate members, a one-page position statement from AIAA is a good idea.

AIAA is very active politically in non-partisan public policy. This science is as well-understood as human evolution, Darwinian evolution, and the age of the Earth, along with the age of other celestial bodies studies in our AIAA fields of expertise. The basic results of climate change science have not changed since the 1980s, according to a Stanford Carnegie Institute guest on a recent episode of the PBS television Tavis Smiley show. As for the urgency, on a recent episode of a PBS television Charlie Rose show, Michael Mann said that 1 of the 13 feet of storm surge in Hurricane Sandy was due to rising sea levels and climate change.

The AGU position statement was first issued in 2003, saying urgent action is required. The first United Nations Intergovernmental Panel on Climate Change (IPCC) report was issued in 1990. The IPCC summarizes science results and obtains signatures from many nations for the IPCC reports. Urgent action was required well before 1990.

In earlier installments of this column I mentioned Claire Conner's memoir *Wrapped in the Flag*, the story of her life in a family at the heart of the John Birch Society. She mentions Fred Koch, one of the original Birch founding (1958) members. I note the Fox News website is wrapped in the flag, too.

I am reading another great book, *Dog Whistle Politics*, by Ian Haney Lopez. It mentions climate change once, but the entire book places the big picture, starting with the pre-WW2 New Deal, into good perspective. He has plenty of criticism for conservatives and Republicans such as Wallace, Goldwater, Nixon, Reagan, George H. W. Bush, and George W. Bush, but also for liberals and Democrats such as Carter, Clinton, and Obama. Presidential candidate Gerald Ford is one of the few who refused to use these unpleasant tactics. It is an affordable book, and the Apple iBooks store sample, the first 89 pages of the book, summarizes the entire book.

Bill McKibben's theory of change was, "People will read my book [1989, *The End of Nature*], then they will *change*!" He says that jokingly now to make the point that old-fashioned politics are required. I encourage that, with the books by Ian Haney Lopez and Claire Conner in mind.

In closing, here are excerpts from the *2015 United Nations Climate Change Conference* article, from Wikipedia, the free encyclopedia.

The United Nations Climate Change Conference, COP21 or CMP11 will be held in Paris, France in 2015. This will be the 21st yearly session of the Conference of the Parties (COP 21) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 11th session of the Meeting of the Parties (CMP 11) to the 1997 Kyoto Protocol. The conference objective is to achieve a legally binding and universal agreement on climate, from all the nations of the world. Leadership of the negotiations is yet to be determined.

Background

While 2014 conference is the next in the annual series, Ban Ki-moon has directed more attention toward this 2015 conference in Paris. A statement made by Ban Ki-moon forecast the climate change summit to be held in September 2014 and the Paris conference, but made no reference to the 2014 conference in Lima.

According to the organizing committee, the objective of the 2015 conference is to achieve, for the first time in over 20 years of UN negotiations, a binding and universal agreement on climate, from all the nations of the world.

Location and participation

The location of UNFCCC talks are rotated by regions throughout United Nations countries. The 2015 conference will be held at Le Bourget from 30 November to 11 December 2015.

Negotiations

The overarching goal of the Convention is to reduce greenhouse gas emissions (GHGs) to limit the global temperature increase to 2 degrees Celsius above current levels.

See also

- Post–Kyoto Protocol negotiations on greenhouse gas emissions
- Politics of global warming
- IPCC Fifth Assessment Report

James C. McLane, Jr. 1923-2012

Address to AIAA Houston Section about the late James C. McLane, Jr., Part 5 of 6

James C. McLane III, from the Presentation of June 13, 2013

After serving as a fighter pilot in WW2 he went back to Clemson College on the GI bill to get a degree in Civil Engineering. One grandfather had lost a lot in the depression and always admired a neighbor who had a steady job and retirement because he worked for the Post Office. He advised my dad to look for a government job. This was very good advice!

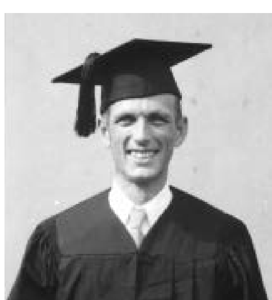
So in 1948 my father applied for work at Langley Field near Hampton Virginia where the NACA operated a cluster of great wind tunnels. In those days NACA employed dozens of engineers to manually digest the data from their test runs. The work was tedious and my father hated it. He did get to design some equipment, including one item I can see in photographs of that era, a glass-walled operator's room inside the huge low speed wind tunnel, big enough to hold a full size airplane.

When he reported for his first day at work at Langley, the interviewer looked over my father's paper work. He said "Hey! I see you have an instructor pilot rating and you flew P-51 Mustangs. How about instead of the engineering job you hire in as a Test Pilot? We have a couple slots open right now!"

My Dad was excited, but realized that my mother would not have any of that. The man who had originally introduced my parents to each other had become a test pilot for McDonald aircraft and was killed in a crash. There is no way my mother would let my dad take a test pilot job. Interestingly, a while later NACA hired Neil Armstrong for one of these test pilot positions.

The work at NACA was militarily important so my dad was excused from the call up of experienced fighter pilots during the Korean War. Later the fact that he once worked at Langley helped him secure a job in Houston at the Manned Spacecraft Center. As you know Bob Gilruth's Space Task Group that put man in space with project Mercury all came from Langley.

In 1951 my father left Langley and relocated the family to Tullahoma, Tennessee, where the Air Force ran a large wind tunnel facility named Arnold Engineering Development Center. At the end of WW2 the allies had boxed up a German supersonic wind tunnel and shipped it to middle Tennessee where there was a surplus of electric power to run it. Along with the tunnel they relocated dozens of captured German scientists and engineers. The German wind tunnel was obsolete by the time it was running so the Air force built a far more ambitious facility which is still in use. Blowing air through supersonic wind tunnels takes a massive amount of electrical power (One tunnel at Arnold center was driven by a single 300,000 horsepower electric motor.) and the Tennessee Valley Authority (TVA) dams provided the juice. At Tullahoma my



James C. McLane, Jr. 1923-2012

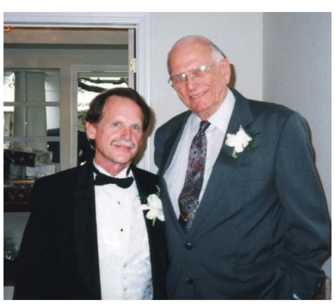
Dad shared an office with a German rocket scientist named Guenther Delmeier, a man who, just a few years earlier, had been bombed while working for Werner Von Braun. So just ten years after he had been flying around Germany looking for things to shoot, he was now sharing an office with one of his former targets!

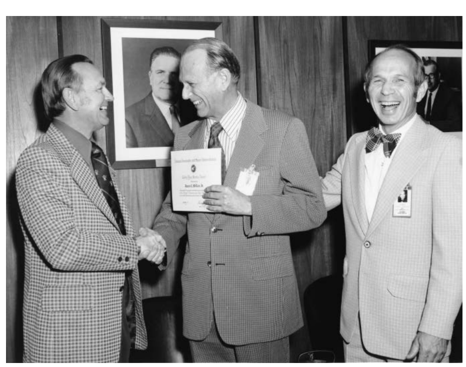
At Arnold Center my father's last job was to design a very sophisticated space simulation chamber, the Mark 2 Facility. This vacuum chamber was designed to be able to test nuclear powered spacecraft. The Air Force spent many millions of dollars developing the technology, but in the end the chamber was just too expensive to build. The project was top secret, but one day an artist's conception appeared in Aviation Week magazine! Many years later one of the Russian engineers temporarily assigned to Houston for the Apollo Soyuz Test project showed my dad a Russian text book about space simulation. The Russian book included a drawing and description of his old Mark 2 facility, as if it had been built and was currently in use. Apparently the Russians thought it was fully operational.

It was his work on the design of the Mark 2 chamber that positioned him to later be in charge of the Space Environment Simulation Lab here at JSC.

My father was recruited to come to Houston by Aleck Bond, and initially he worked under Alec in various capacities. His most important early assignment was to coordinate the design of the Lunar Receiving laboratory. This was a tough job since another major government agency, the United States Geological Survey (USGS) wanted to place the lab in Denver and run it themselves. I recall my mother hosting receptions in our home for Nobel Prize winning scientists and geologists who wanted to handle the Moon rocks. The many distinguished scientists who would be analyzing the Moon rocks argued forever about what facilities they wanted. To expedite things my Dad just decided on the specifications and had the laboratory built as quickly as possible because the feuding scientists could never reach a consensus. My dad wrote an important paper that was published in 1967 in Science magazine about this unique Moon rock lab

At that same time another significant test facility was being built at the Manned Spacecraft Center – the Space Environment Simulation lab. Building 32 would house a cluster of high tech space simulation chambers. Some were sophisticated enough to conduct long-duration manned tests of complete spacecraft. The largest of the chambers is Chamber A, shaped somewhat like a vertical foot ball it is 90 feet high, 50 feet in diameter and has a single 40 foot diameter round door shaped like a porthole. Manned testing inside the chambers was very risky because if there was an emergency, it would take a very long time to let the air back into the chamber and rescue the astronauts. In reality, the high fidelity manned tests performed inside these chambers duplicated the conditions of outer space and even some of the risk of being there. ■





Current Events

http://www.aiaahouston.org/2014-annual-technical-symposium/

American Institute of Aeronautics and Astronautics
Houston Section
In Collaboration with INCOSE Presents

Annual Technical Symposium 2014

NASA/JSC Gilruth Center
Houston, Texas
Friday, May 9, 2014

PROGRAM

General Chair
Clay Stangle

Organizing Committee
Ellen Gillespie
Michael Frostad
Michael Martin
BeBe Kelly-Serrato
Irene Chan
Laura Sarmiento
Douglas Yazell
Ben Edwards
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PROGRAM SUMMARY

7:45 AM – 4:30 PM	Registration Desk on First Floor	Alamo Ballroom
8:00 AM - 9:00 AM	*Speaker*: Pete Hasbrook - State of the ISS	Alamo Ballroom
Session A 9:00 AM – 10:15 AM	1. Climate Change 2. Safety and Mission Assurance (S&MA) 3. Space Commercialization 4. INCOSE	Discovery Rio Grande Longhorn Lone Star
Session B 10:30 AM – 11:45 AM	1. Climate Change 2. S&MA 3. GN&C 4. INCOSE	Discovery Rio Grande Longhorn Lone Star
12:00 NOON – 1:30 PM	Lunch	Alamo Ballroom
12:00 PM – 1:30 PM	*Space Commercialization Panel Speakers*: Former astronauts Chris Ferguson, Lee "Bru" Archambault, and Arturo Machuca from the Houston Airport Director's Office	Alamo Ballroom
Session C 1:45 PM – 3:00 PM	1. Robotics and History 2. Astrodynamics 3. EVA and Space Exploration 4. INCOSE	Discovery Rio Grande Longhorn Lone Star

Social at Perry's Steakhouse
487 Bay Area Blvd., Houston, TX 77058

Morning Program – Session A

	Discovery (1)	Rio Grande (2)	Longhorn (3)	Lone Star (4)
8:00 - 9:00	Morning Key Note Speaker – Pete Hasbrook			
	Session A-1: Theme – Climate Change Chair: Douglas Yazell	Session A-2: Theme – S&MA Chair: Roger Kleinhammer	Session A-3: Theme – Space Commercialization Chair: Steve Everett	Session A-4: Theme – Systems Eng (INCOSE)
9:00 - 9:25	**A-1.1** Climate Change Science and Public Policy **Douglas Yazell and Daniel Cohan**	**A-2.1** Building a Database for a Quantitative Model **Joseph Kahn**	**A-3.1** Technology Transfer and Commercialization **Kumar Krishen, Ph.D**	**INCOSE-1** Why Do I Need To Understand Systems Engineering? **Courtney Wright & Tony Williams**
9:25 – 9:50		**A-2.2** Data Used in Quantified Reliability Models **Roger Kleinhammer**	**A-3.2** Accelerating Space Commercialization **Alex Monchak, MBA**	**INCOSE-1.2** Systems Engineering Requirements **Ken Robinson**
9:50 - 10:15		**A-2.3** The "Best" Reliability Data for the Job **Roger Kleinhammer**	**A-3.3 INCOSE** – An Integrated Approach to Making Mars Exploration More Feasible and Cost Effective **Wayne McCandless**	
10:15 – 10:30	15 Minute Break			

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Morning Program – Session B

	Discovery (1)	Rio Grande (2)	Longhorn (3)	Lone Star (4)
	Session B-1: Theme – Climate Change Chair: Douglas Yazell	Session B-2: Theme – S&MA Chair: Roger Kleinhammer	Session B-3: Theme – GN&C Chair: Steve Everett	Session B-4: Theme – Systems Eng (INCOSE)
10:30 – 10:55	**B-1.1** Climate Change Science and Public Policy **Douglas Yazell and Adrian Shelley**	**B-2.1** An Example of Risk-Informed Design **Richard Banke, Ph.D.**	**B-3.1** Model Based GN&C Simulation and Flight Software **Ryan Odegard**	**INCOSE-2** Virtual Black Boxes for Commercial Airliners: A Systems Engineering Approach **Wayne McCandless**
10:55 - 11:20		**B-2.2** What to Expect When Your Workplace is in Deep Space **Dianna DeMott**	**B-3.2** Savitzky-Golay-Filter Application to Moment Of Inertia Estimation **James Turner**	
11:20 – 11:45		**B-2.3** Using the Systems Engineering Life-Cycle to Develop and Agent-Based Model and Simulation **Ipek Bozkurt**	**B-3.3** Optimal Covariance Minimization Algorithm For The Continuous Kalman Filter **James Turner**	
12:00 - 1:30	*Lunch Key Note Space Commercialization Panel Speakers:* **Former astronauts Chris Ferguson, Lee "Bru" Archambault, and Arturo Machuca from the Houston Airport Director's Office**			

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Afternoon program – Session C

	Discovery (1)	Rio Grande (2)	Longhorn (3)	Lone Star (4)
	Session C-1: Theme – Robotics and History Chair: Dr. Zafar Taqvi	Session C-2: Theme –Astrodynamics Chair: Dr. Al Jackson	Session C-3: Theme – EVA and Space Exploration Chair: Larry Friesen	Session C-4 Theme – Systems Eng (INCOSE)
1:45 - 2:10	**C-1.1** NOAA and the ARCs **Dr. Paul Frenger, MD**	**C-2.1** Gravity Losses, the Rocket Equation and "U" **Wes Kelly**	**C-3.1** Integration of Optimized Leading Edges onto Wave Rider Configurations **Patrick Rodi, Ph.D.**	**INCOSE-3** Railroad Accident Investigation **Smokey Culver**
2:10 - 2:35	**C-1.2** Design and Implementation of a Semi-Autonomous Mobile Robot Prototype **Fatih Karabacak**	**C-2.2** Stability of Lunar Distant Retrograde Orbits **Gary Turner, Ph.D.**	**C-3.2 INCOSE** – Look Ahead and Listen Now **Terry Hill**	
2:35 - 3:00	**C-1.3** Suddenly Tomorrow Came – The Audiobook Project **Ted Kenny**	**C-2.3** The Casimir Effect: Traveling Faster than Light **John M. DiIorio**	**C-3.3** MAJIC: A Gyroscopically Actuated Astronaut Mobility Unit for Future EVA Missions **Michele Carpenter, Ph.D.**	
3:00 - ???	**Social at Perry's Steakhouse** 487 Bay Area Blvd., Houston, TX 77058			

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The JSC Astronomical Society

Building an Astronomer's Chair Complete with Sketch Desk and Red Lighting (Part 6 of 7)

Jim Wessel, JSCAS Educational Outreach Chairman

The JSC Astronomical Society (JSCAS)
www.jscas.net

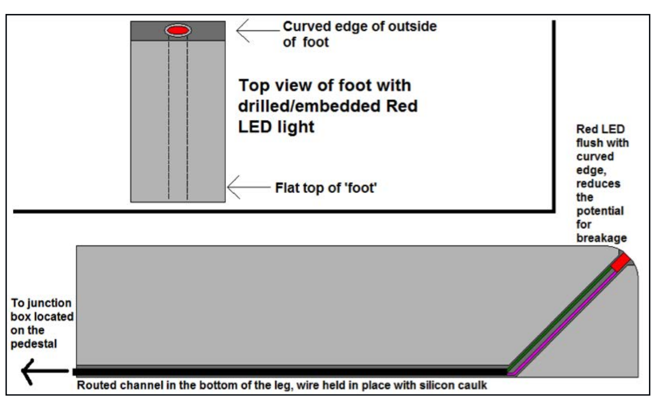
This article first appeared in the March 2011 issue of Starscan, the JSCAS newsletter.

**This issue:
A guide to making
your own red LED lighting system**

Protection in these dark and troubling times…

In this case, I mean the danger of tripping in the dark. Here is another case in which I did not plan ahead, and things might have been easier if I had. As the stool was nearing completion, I was still thinking about what final touches I could add to it to make it really exceptional in both form and function. I have seen lights attached to telescope tripods to alert onlookers to the tripod's widespread footprint in the dark. I thought this was a bright (pun intended) idea and in my case would serve to increase the aspect of safety when I carried my astronomer's stool to a publicly attended dark site. My original idea was to go out and buy a few battery powered, press top LED lights. The thinking was that I would cut a notch out of the upper surface of the four stool legs that matched the circumference of the lights, installing them, and then perhaps placing a strip of metal over the light to hold it in place and somewhat protect it from being directly stepped on when getting into or out of the chair. This method has a few drawbacks. Among them are the ever present danger of breaking the lights since they are wider than the width of the 2 x 4 "foot" and the cut-out notch itself would structurally reduce the upper surface of the stool's feet. That upper surface has a critical role as a step when the chair is at or near its maximum height. Also cutting that notch out would weaken the area right before the upper curve of the foot, making it more susceptible to breaking off entirely. All these reasons, coupled with the fact that John dabbles in electronics, made us look in a different direction.

After a bit of back and forth brainstorming, I finally proposed to John that we build the entire LED lighting system from components to our own design and specifications. The main idea was that the red LED light would be located near the distal tip of each of the feet and would be recessed to become flush on the top surface of the foot. Secondly, the line providing the power would be run along the length of each of the four legs to a single central power supply. A preliminary sketch of the idea in both a top and side view immediately follows.



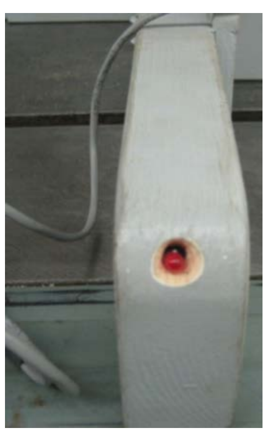
To start us on the path of a new lighting system, John made a practice foot with exactly the same dimensions as the ones that were already built into the pedestal. This was a good thing, because it allowed us to figure out how to hold the wood at a solid 45° angle for drilling for the LED light without crimping the wood in a vise. (A piece of wood to either side of the practice foot worked nicely.) The practice foot also allows us to figure out how we were going to rout out the thin areas where the wiring would be run along inside the bottom of the feet. The two pictures below show the routed out areas under a foot and the central pedestal, respectively.

Design of a lighting system for this my stool was a little complex as there are two removable legs and a pedestal between the two permanent legs. Since the overriding design was to be able to remove a pair the legs, this also meant we had to also be able to disconnect the power cables from the power supply. This problem was solved by screwing a junction box (photo of its location below, left) to one of the fixed legs with three 1/8" mono mini jacks (normally used for audio purposes) installed in the top long side of the box and a 2.1 mm power jack installed in one end. This power jack enabled us to use an existing battery box (photo of battery box, below, right) with an output of 6 volts from 4 "D" cells and eliminated the need for an "On/Off switch" by allowing one to simply unplug the power supply. If desired, an alternative power supply configuration can be designed, and here is an online reference website to that end: *http://led.linearl.org/led.wiz*.

LEDs for the fixed legs could be wired permanently in series as they never have to be disconnected. A 33 ohm 1/4 watt resister was soldered to the negative lug of the power jack along with another wire that was connected to the negative lugs of each of the three mini jacks. Here is a picture of the internals of the junction box.

The negative wire from another two wire cable was connected to the other end of the resistor and the cable run through a hole in the bottom of the box, through a vertical hole in the leg, to the channels cut in the bottom of the permanent legs and around the pedestal (picture below).

The positive wire from this cable and another wire were soldered to the positive lug of the power jack. The second wire was soldered to each positive lug of the three mini jacks. Length of the wire from the resistor was measured, cut, stripped, and the negative end soldered to the cathode lead of one LED. Shrink tubing was used to cover the joint and wire up to the plastic of the LED. The other wire was soldered to the anode lead of the LED and another sleeve of shrink tubing placed over the connection. Here is a close up of a red LED unit (top), and a second picture (bottom) shows the seated red LED in the tip of a foot.



The entire red LED unit was electrical taped before sliding the assembly through the hole in the leg to position it and fixing the cable in the prepared channel in the bottom of the legs. A second LED assembly was prepared and put in place in the other fixed leg and the cable was run to the point where the original cable entered the channel from the junction box. The anode wire from the first LED was soldered to the cathode wire of the second LED and the joint protected by shrink tubing. Next, the anode wire of the second LED was soldered to the positive wire from the junction box and protected by shrink tubing. Note that a slight enlargement had been prepared in the leg channel to accommodate these connections. (A picture of the connection area is below.)

Preparation of the LEDs for the removable legs was slightly different. These would be single LEDs, powered by parallel circuits, and require more resistance to limit current (150 ohm, 1/4 watt resistors were used.), and also require a 1/8" mini plug to connect to the junction box (positive wire to the tip electrode and negative to the body). One removable leg require an extension of the cord slot up the back end of the leg to allow passage of the cable and a hole drilled slightly above the junction box in the support wedge of the fixed leg to allow access for its plug (picture below, top). The second removable leg required a hole drilled from the channel in the bottom at a point even with the junction box on the fixed leg and a hole drilled through the support wedge of the removable leg to allow access to the junction box for its plug.

The wires were not looped around the outside of the vertical support for fear of them being damaged by either an errant foot, or the hanging footrest itself. The previous two images (center and right) show the other sides of the holes in relation to the feet that the two wires provide power. If you compare them with the previous picture, and think about the geometry for a second, you will quickly deduce which wire goes to which leg. This gives yet another way to make absolutely sure that the correct removable leg is re-attached to the correct position on the central pedestal when it is being re-assembled.

All wiring on the underside of all the feet and central pedestal have been silicon caulked into place, so they are somewhat protected from sticks and stones and such on the ground, but yet it can be quickly removed to make any needed repairs or adjustments.

If you are playing along at home, and following the logic here, you will realize that there is one unoccupied female jack on the junction box. Well, for a change I was thinking ahead and asked John to give me the means to provide electricity to a similar lighting system for the legs of my future tripod. Using the same wiring process as described above, a cable had the near end capped with a male plug (positive wire to end electrode and negative to body). The terminal end of the cable was stripped and 3 additional wires were spliced onto it (positive to positive wires and negative to negative with all protected by shrink tubing). Those three wires were each capped with a red LED light unit (150 ohm resistor soldered to the cathode side of each LED and each lead protected with shrink tubing). This allows for one red LED light to be attached to the outside of each of the three legs of my eventual tripod mount. They will likely be secured in place with Velcro. The following 3 pictures show (1) the wiring system for the tripod, (2), the whole lighting system lit up with John's tripod stepping in for the demonstration, and the whole illuminated with ambient lighting, and finally (3) the red LED system up and running, glowing in the dark.

I am very pleased with the final functionality of the entire lighting system. There is very little chance of damage to the wiring within the pedestal proper, and the wire running to the tripod would be easy enough to replace if it was broken or severed. I believe that there is sufficient light for safety's sake but not so much light that it will be distracting to other observers while at a dark site. Theirs is a distinct possibility that the three wires at the distal end of the tripod lighting cable aren't long enough to run down the legs for my tripod, but this is a relatively easy fix down the road. ■

Next issue:
Things I would have done differently, acknowledgments, & a final wrap-up.

JSC Astronomical Society (JSCAS) Calendar
Upcoming Events from the JSCAS Calendar (Updated April 26, 2014)
The JSCAS calendar: use the calendar link at www.jscas.net.
JSCAS meetings are held on the second Friday of every month at 7:30 PM in the auditorium of the USRA building (almost always at this location): 3600 Bay Area Blvd, at the SW corner of the intersection with Middlebrook Drive.

2014

May 3 (Saturday): Haak Winery Star Party, sunset at 1959 hours (7:59 PM), twilight at 2025 hours (8:25 PM), Moon WaxCrst@22.2%.
May 9 (Friday): Dr. Stanley Love, NASA/JSC, presentation title: to be announced
May 17 (Saturday): Lunar and Planetary Institute (LPI) SkyFest, 8-10 PM, sunset at 2009 hours (8:09 PM), twilight at 2035 hours (8:35 PM), Moon rises at 2312 hours (11:12 PM).
May 25 - June 1 (Sunday - Sunday): Texas Star Party
June 13 (Friday): Dr. David Talent. presentation title: to be announced

Above: Upcoming presentations for 2014-2015 in this lecture series in the Houston Clear Lake area will be announced as soon as possible. Details will be available using the link below. (Archived video recordings are also available there.)

www.lpi.usra.edu/education/lectures/

Calendar

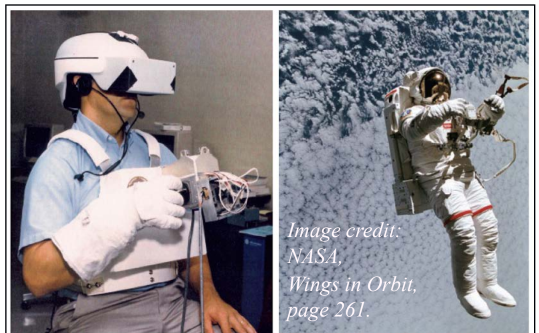
All calendar items are subject to change without notice.

Section council meetings (email secretary2013[at]aiaahouston.org)
Time: 5:30 - 6:30 PM usually
Day: First Tuesday of most months except for holidays.
Location: NASA/JSC Gilruth Center is often used. The room varies.

Recent Section Events

April 17, 2014, AIAA Houston Section Guidance, Navigation & Control (GN&C) technical committee lunch-and-learn with guest speaker Dr. Wyatt Johnson of the NASA/JSC Morpheus program, hosted by technical committee Chair Dr. Steven Everett.

April 29, 2014, AIAA Houston Section Extra-Vehicular Activity (EVA) technical committee lunch-and-learn with guest speaker Jeff Hoblit, Virtual Reality Laboratory/L3 STRATIS – Technical Lead – Simplified Aid for EVA Rescue (SAFER) Expert. Hosted by technical committee Chair Evelyn Miralles.



Astronaut Mark Lee trains for his Simplified Aid for EVA Rescue test flight (STS-64 [1994]) using the virtual reality flight trainer (left) and on orbit (right).

Upcoming Section events

Audiobook in work by Ted Kenny, NASA/JSC, Chair, AIAA Houston Section *History technical committee*, Suddenly Tomorrow Came, A History of JSC. The author of this 1993 book is Henry C. Dethloff. See that web page for author information and a short bio. Ted Kenny is scheduled to make a presentation on the subject of this audiobook at ATS 2014 (below)

May 8, 2014: AIAA Houston Section Annual Technical Symposium (ATS 2014) kickoff dinner meeting with invited speaker, NASA astronaut Commander Chris Cassidy, 5:30 - 8:00 PM, NASA/JSC Gilruth Center.

May 9, 2014: AIAA Houston Section Annual Technical Symposium (ATS 2014), 8:00 AM - 3:00 PM, followed by a social at Perry's Steakhouse.

2014 AIAA Conferences: *www.aiaa.org* (Click on the events link.)

5 - 9 May 2014: Pasadena, California, SpaceOps 2014

26 - 29 May 2014: Istanbul, Turkey, 6th International Conference on Research in Air Transportation (ICRAT 2014)

26 - 28 May 2014: St. Petersburg, Russia, The 21st St. Petersburg International Conference on Integrated Navigation Systems

5 June 2014: Williamsburg, Virginia, 2014 Aerospace Today and Tomorrow

16 - 20 June 2014: Atlanta, Georgia, AIAA Aviation & Aeronautics Forum and Exposition (AVIATION 2014)
- 11th AIAA/ASME Joint Thermophysics and Heat Transfer Conference
- 14th AIAA Aviation Technology, Integration, and Operations Conference
- 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference
- 20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference,
- 20th AIAA/CEAS Aeroacoustics Conference
- 21st AIAA Lighter-Than-Air Systems Technology Conference
- 30th AIAA Aerodynamic Measurement Technology and Ground Testing Conference
- 32nd AIAA Applied Aerodynamics Conference
- 44th AIAA Fluid Dynamics Conference
- 45th AIAA Plasmadynamics and Lasers Conference
- 6th AIAA Atmospheric and Space Environments Conference
- 7th AIAA Flow Control Conference
- 7th AIAA Theoretical Fluid Mechanics Conference
- AIAA Atmospheric Flight Mechanics Conference
- AIAA Balloon Systems Conference
- AIAA Flight Testing Conference
- AIAA Modeling and Simulation Technologies Conference
- AIAA/3AF Aircraft Noise and Emissions Reduction Symposium

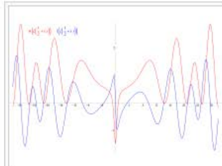
22 - 27 June 2014: Honolulu, Hawaii, 12th International Probabilistic Safety Assessment and Management Conference

Riemann hypothesis

From Wikipedia, the free encyclopedia

In mathematics, the **Riemann hypothesis**, proposed by Bernhard Riemann (1859), is a conjecture that the nontrivial zeros of the Riemann zeta function all have real part 1/2. The name is also used for some closely related analogues, such as the Riemann hypothesis for curves over finite fields.

The Riemann hypothesis implies results about the distribution of prime numbers. Along with suitable generalizations, some mathematicians consider it the most important unresolved problem in pure mathematics (Bombieri 2000). The Riemann hypothesis, along with the Goldbach conjecture, is part of Hilbert's eighth problem in David Hilbert's list of 23 unsolved problems; it is also one of the Clay Mathematics Institute Millennium Prize Problems.



The real part (red) and imaginary part (blue) of the Riemann zeta function along the critical line Re(s) = 1/2. The first non-trivial zeros can be seen at Im(s) = ±14.135, ±21.022 and ±25.011.

The Riemann zeta function ζ(s) is a function whose argument s may be any complex number other than 1, and whose values are also complex. It has zeros at the negative even integers; that is, ζ(s) = 0 when s is one of −2, −4, −6, ... These are called its **trivial zeros**. However, the negative even integers are not the only values for which the zeta function is zero. The other ones are called *non-trivial zeros*. The Riemann hypothesis is concerned with the locations of these non-trivial zeros, and states that:

> The real part of every non-trivial zero of the Riemann zeta function is $\frac{1}{2}$.

Thus the non-trivial zeros should lie on the **critical line** consisting of the complex numbers $\frac{1}{2} + it$, where t is a real number and i is the imaginary unit.

There are several nontechnical books on the Riemann hypothesis, such as Derbyshire (2003), Rockmore (2005), Sabbagh (2003), du Sautoy (2003). The books Edwards (1974), Patterson (1988), Borwein et al. (2008) and Mazur & Stein (2014) give mathematical introductions, while Titchmarsh (1986), Ivić (1985) and Karatsuba & Voronin (1992) are advanced monographs.

Millennium Prize Problems
P versus NP problem
Hodge conjecture
Poincaré conjecture (solved)
Riemann hypothesis
Yang–Mills existence and mass gap
Navier–Stokes existence and smoothness
Birch and Swinnerton-Dyer conjecture
V • T • E

[May 2, 2014]
More about this next issue, partly from that 2003 book by John Derbyshire. Our readers will probably solve this cranium cruncher by the time our next issue is published (June 30, 2014). *Source*: Wikipedia.

VII.

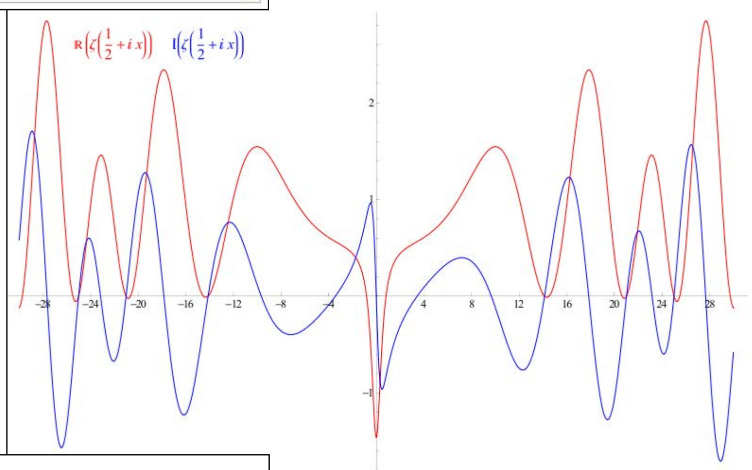
Ueber die Anzahl der Primzahlen unter einer gegebenen Grösse.

(Monatsberichte der Berliner Akademie, November 1859.)

Meinen Dank für die Auszeichnung, welche mir die Akademie durch die Aufnahme unter ihre Correspondenten hat zu Theil werden lassen, glaube ich am besten dadurch zu erkennen zu geben, dass ich von der hierdurch erhaltenen Erlaubniss baldigst Gebrauch mache durch Mittheilung einer Untersuchung über die Häufigkeit der Primzahlen; ein Gegenstand, welcher durch das Interesse, welches Gauss und Dirichlet demselben längere Zeit geschenkt haben, einer solchen Mittheilung vielleicht nicht ganz unwerth erscheint.

Bei dieser Untersuchung diente mir als Ausgangspunkt die von Euler gemachte Bemerkung, dass das Product

$$\Pi \frac{1}{1-\frac{1}{p^s}} = \Sigma \frac{1}{n^s},$$



Riemann zeta function

The Riemann zeta function is defined for complex s with real part greater than 1 by the absolutely convergent infinite series

$$\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s} = \frac{1}{1^s} + \frac{1}{2^s} + \frac{1}{3^s} + \cdots.$$

Leonhard Euler showed that this series equals the Euler product

$$\zeta(s) = \prod_{p \text{ prime}} \frac{1}{1-p^{-s}} = \frac{1}{1-2^{-s}} \cdot \frac{1}{1-3^{-s}} \cdot \frac{1}{1-5^{-s}} \cdot \frac{1}{1-7^{-s}} \cdots \frac{1}{1-p^{-s}} \cdots$$

where the infinite product extends over all prime numbers p, and again converges for complex s with real part greater than 1. The convergence of the Euler product shows that ζ(s) has no zeros in this region, as none of the factors have zeros.

The Riemann hypothesis discusses zeros outside the region of convergence of this series, so it must be analytically continued to all complex s. This can be done by expressing it in terms of the Dirichlet eta function as follows. If the real part of s is greater than one, then the zeta function satisfies

$$\left(1 - \frac{2}{2^s}\right)\zeta(s) = \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{n^s} = \frac{1}{1^s} - \frac{1}{2^s} + \frac{1}{3^s} - \cdots.$$

However, the series on the right converges not just when s is greater than one, but more generally whenever s has positive real part. Thus, this alternative series extends the zeta function from Re(s) > 1 to the larger domain Re(s) > 0, excluding the zeros $s = 1 + 2\pi i n/\ln(2)$ of $1 - 2/2^s$ (see Dirichlet eta function). The zeta function can be extended to these values, as well, by taking limits, giving a finite value for all values of s with positive real part except for a simple pole at s = 1.

In the strip 0 < Re(s) < 1 the zeta function satisfies the functional equation

$$\zeta(s) = 2^s \pi^{s-1} \sin\left(\frac{\pi s}{2}\right) \Gamma(1-s)\, \zeta(1-s).$$

One may then define ζ(s) for all remaining nonzero complex numbers s by assuming that this equation holds outside the strip as well, and letting ζ(s) equal the right-hand side of the equation whenever s has non-positive real part. If s is a negative even integer then ζ(s) = 0 because the factor sin(πs/2) vanishes; these are the **trivial zeros** of the zeta function. (If s is a positive even integer this argument does not apply because the zeros of sin are cancelled by the poles of the gamma function as it takes negative integer arguments.) The value ζ(0) = −1/2 is not determined by the functional equation, but is the limiting value of ζ(s) as s approaches zero. The functional equation also implies that the zeta function has no zeros with negative real part other than the trivial zeros, so all non-trivial zeros lie in the **critical strip** where s has real part between 0 and 1.

Bernhard Riemann

Bernhard Riemann, 1863

Born	Georg Friedrich Bernhard Riemann September 17, 1826 Breselenz, Kingdom of Hanover (modern-day Germany)
Died	July 20, 1866 (aged 39) Selasca, Kingdom of Italy
Residence	Kingdom of Hanover
Nationality	German
Fields	Mathematics
Institutions	Georg-August University of Göttingen
Alma mater	Georg-August University of Göttingen Berlin University
Doctoral advisor	Carl Friedrich Gauss

Section News

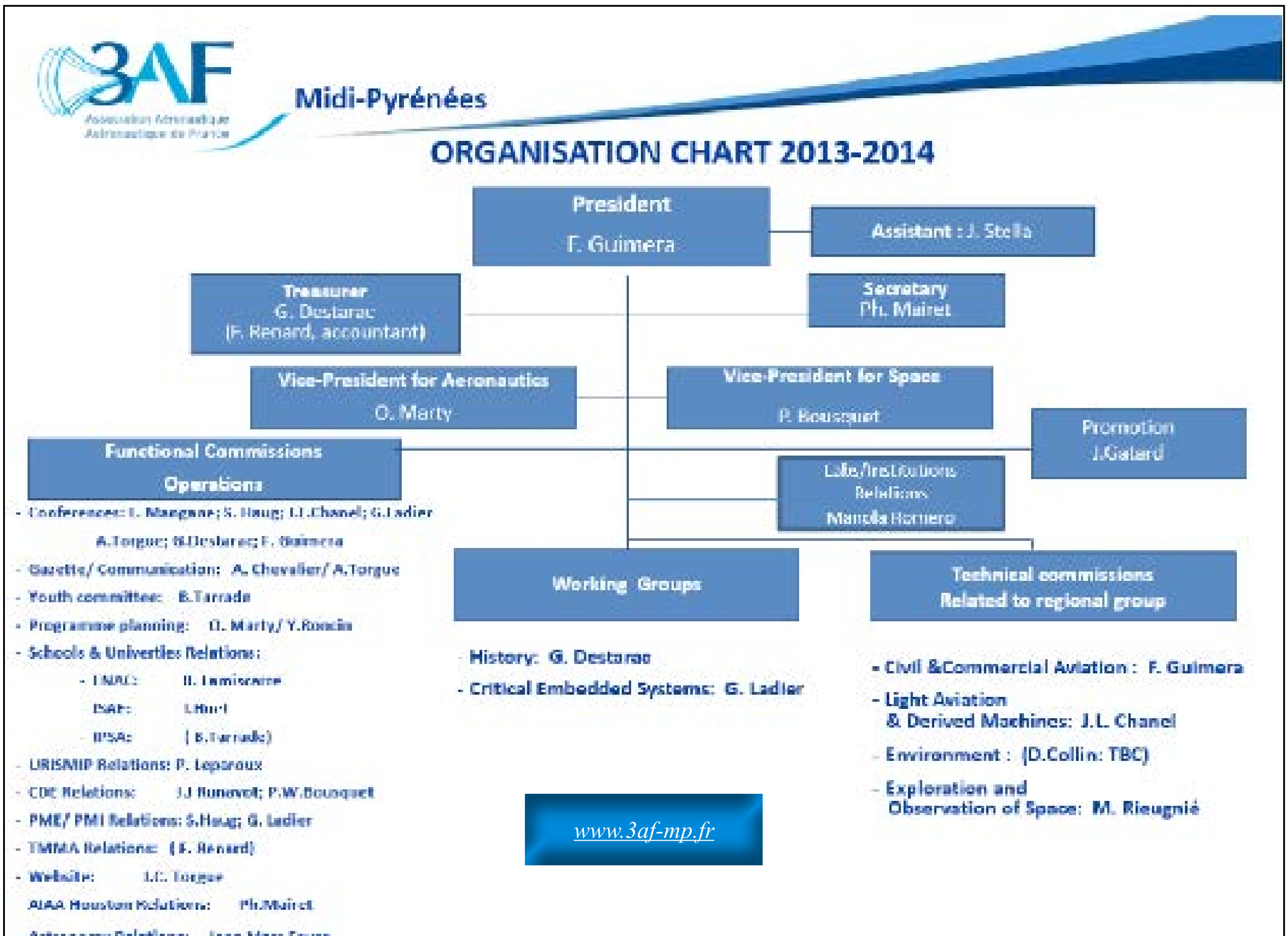
Jean-Pierre Condat of Toulouse, France was featured in our last issue of Horizons on pages 16 and 17. We are very pleased that he allows us to use two more images in this issue of Horizons. His website is *Des Collages Du Sud*.

http://jeanpierre.condat.free.fr

The most famous flight dates of pilots Chuck Yeager and Charles Lindbergh are October 14, 1947, and May 20-21, 1927, respectively (*Wikipedia*).

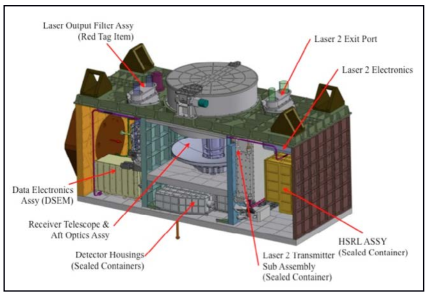
Association Aéronautique et Astronautique de France (3AF)

Sister Section of AIAA Houston Section since 2007
Jumelée avec AIAA Houston Section depuis 2007

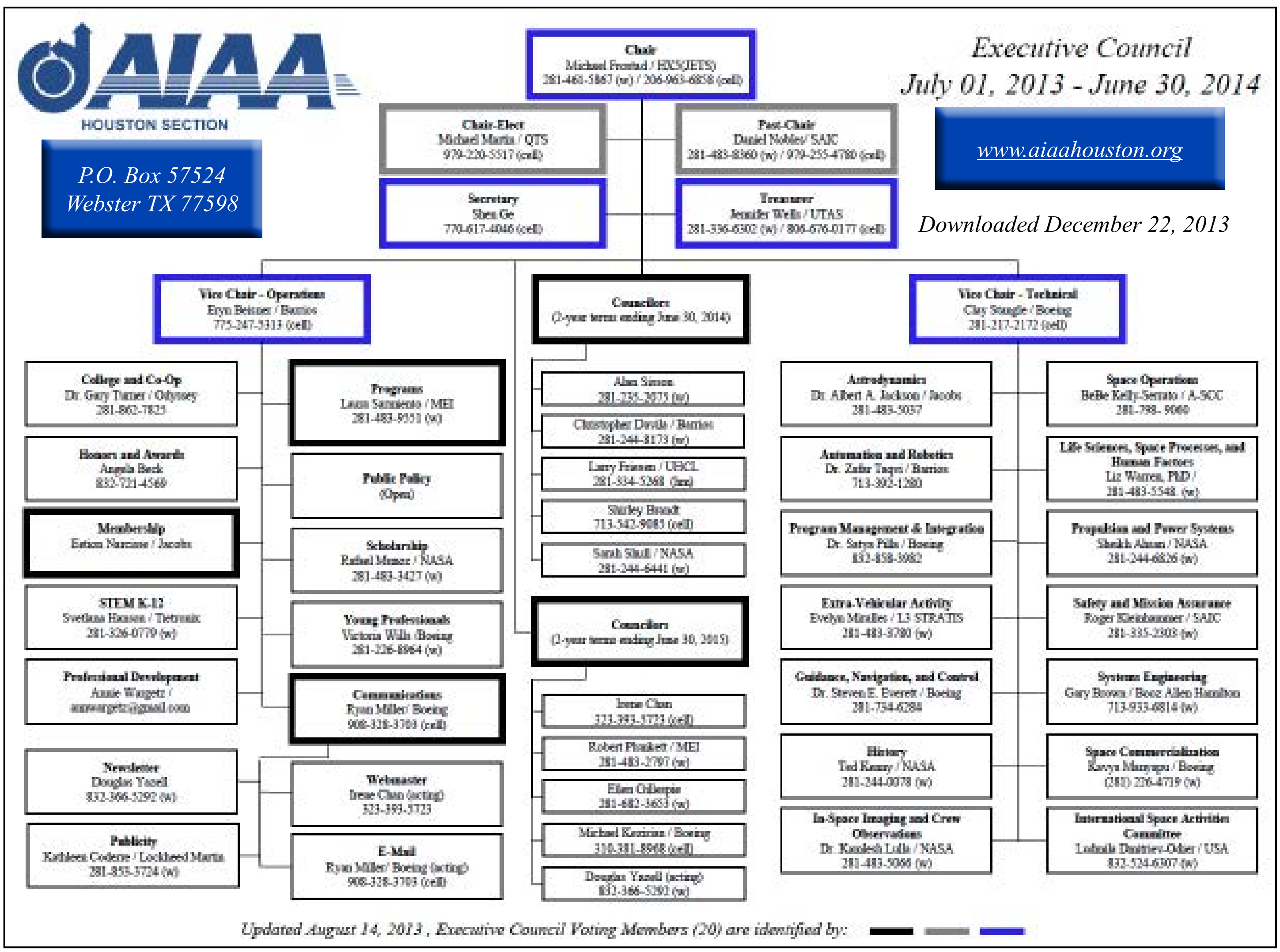


[April 29, 2014]

The NASA Cloud-Aerosol Transport System (CATS) climate change science instrument is scheduled to be installed on the International Space Station this year. As noted in the climate change column earlier in this issue, RapidScat is another such ISS 2014 climate change science instrument, and NASA plans to launch five such Earth-observing instruments to the ISS through 2017.



The American Institute of Aeronautics and Astronautics (AIAA)



Student Section News

Rice University AIAA Student Section Advisor:
Professor Andrew Meade, *meade[at]rice.edu*
713-348-5880, www.ruf.rice.edu/~meade/

Above: Image credit: Rice University

Recent Region IV Student Paper Conference in New Mexico

Dr. Gary Turner, AIAA Houston Section College and Co-Op Chair, and Douglas Yazell, Horizons Editor

[April 26, 2014]

A few details of recent activities and more are provided on this page. More next issue.

I recently learned [DY] that our Rice student chapter has about 30 members, a lot more than I would have guessed. That is good news!

I was also reminded that their advisor would like our Section to organize events for them at their venue. Section members, please keep them in mind. For example, a Section member once took a spacesuit there and gave a presentation on that subject.

The Rice/NASA Connection

Address at Rice University on the National Space Front by John F. Kennedy
September 12, 1962

Within months of his January 1961 inauguration, John F. Kenney issued his famous challenge to the nation's scientific community: land a man on the moon by decade's end. That challenge would be met in 1969 with "one giant leap for mankind."

That speech predicted that Rice would contribute significantly to the revitalized U.S. space effort. Indeed, in the years ahead the university established the country's first space science department in 1963 and opened its Space Science and Technology building in 1966. A sizeable number of NASA scientists and engineers, particularly at the Johnson Space Center, have come from Rice. Rice scientists helped develop the space helmets worn on the first moon landing. To date, fourteen astronauts are Rice University graduates, including Peggy Whitson '85 (Ph.D.), who served as the first female commander of the International Space Station.

Above: Rice Space Science history blog. http://rsi.blogs.rice.

AIAA Region IV Student Conference

Albuquerque, NM

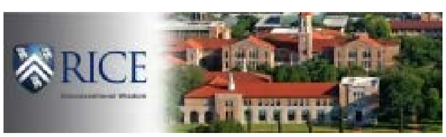
April 24-26, 2014

Organized by the AIAA-Albuquerque Section
Hosted by the University of New Mexico-AIAA Student Branch

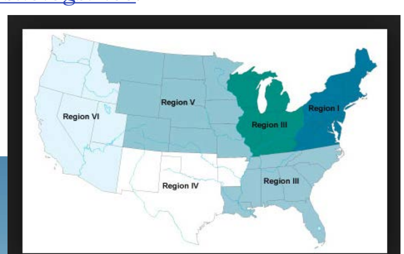
Guest Speakers:

ART THOMPSON

COL. JOE KITTINGER



Above: Image credits: Rice University.



Conference Tour:

Above: The event scheduled industry-leading keynote speakers and networking with fellow AIAA members from the Air Force Research Lab, Sandia National Labs and local aerospace companies. Credits: AIAA Region IV Student Paper Conference 2014. https://region4.aiaastudentconference.org

Student Section News
Please send inputs to Dr. Gary Turner, our College and Co-Op Chair: collegecoop2013[at]aiaahouston.org.

Student Section News

Faculty advisor: Professor John E. Hurtado
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http://stuorg-sites.tamu.edu/~aiaa/

TEXAS A&M UNIVERSITY

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Vice Chair	Alejandro Azocar	alejandroazocar [at] tamu.edu
Treasurer	Steve Anderson	andeste [at] tamu.edu
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Publicity Chair	Nick Page	npage340 [at] tamu.edu
SEC Representative	Nhan Phan	Trongnhanphan [at] tamu.edu
Webmaster	Nick Page	npage340 [at] tamu.edu
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Freshman Class Rep.	Farid Saemi	farid.saemi [at] gmail.com

See the prior page for details about the recent 2014 AIAA Region IV Student Paper Conference.

Above: Nick Ortiz, Class of 2013, Senior Class Representative.

[April 27, 2014, Douglas Yazell]

The Texas A&M University (TAMU) student chapter is always the biggest and most active chapter in our Section, but I recently learned that our Rice University student chapter has about 30 members. The TAMU student chapter probably has more than 30 members, but we will report that number here in Horizons in a later issue as soon as we obtain an approximation. No rush.

Professor James Turner plans to attend our Section's Annual Technical Symposium (ATS 2014) of Friday, May 9, 2014,with a student or two, and they plan to deliver some presentations in the morning or afternoon sessions.

Texas A&M University Climate Change Experts

Texas A&M University TAMU Times *article*, September 26, 2013, adapted here from the article

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John Nielsen-Gammon
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[The AIAA student section is not associated with climate change studies, but climate change is a subject of interest for AIAA and NASA.]

Student Section News
Please send inputs to Dr. Gary Turner, our College and Co-Op Chair: collegecoop2013[at]aiaahouston.org.

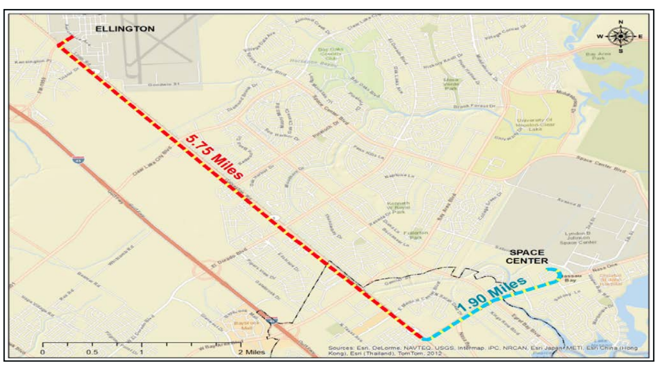
AIAA Houston Section
P.O. Box 57524
Webster, Texas USA 77598

The American Institute of Aeronautics and Astronautics

In the News

Space Shuttle Carrier Aircraft Permanent Display

[April 28, 2014]
As we rush to publish this issue of Horizons by April 30, we note this historic occasion by presenting this NASA JSC Today email note addressed to NASA civil servants. The map is provided by Space Center Houston.



JSC Special: 'The Big Move' Kicks Off Tonight

By now you know that NASA's Shuttle Carrier Aircraft, NASA 905, will soon be united with the life-sized orbiter mock-up at Space Center Houston to create an epic exhibit experience.

Here's more on how it will go down: A 1,000-foot convoy will journey home on an eight-mile trek through the bay area during the nights of April 28 to 29, going at the speed of a person *walking*, and arriving the morning of April 30. Roads will close so workers can dismantle streetlights, signs and utility poles as the convoy approaches.

The portion of Highway 3 (Old Galveston Road) between its intersections with Scarsdale and NASA Parkway, will close from 9 p.m. to 4:30 a.m. Monday, April 28. Then, on Tuesday, April 29, NASA Parkway from Highway 3 to Saturn Lane will close from 9 p.m. to 4:30 a.m. (See Route Map.)

No utilities are expected to be interrupted. The convoy will travel at night for the safety of our neighbors and the workers involved in this complex transfer, as well as to minimize the impact on local residents, the traveling public and businesses. However, as a caution, be aware that there may be traffic impacts and plan accordingly.

The SCA convoy is set to journey home to Space Center Houston at the speed of just 3 mph. The jumbo jet will travel nearly six miles on Monday, April 28, and two miles on Tuesday, April 29, arriving early Wednesday, April 30.

Monday, April 28, "Move Day 1"

- 6 p.m.: 747 convoy begins moving from corner of Challenger and Aerospace to corner of Challenger/Dixie Farm Road and Highway 3.
- 9 p.m.: Highway 3 is closed from Scarsdale to NASA Parkway.
- 9:15 until around 10 p.m.: The convoy carrying the 747 departs Ellington Field after roads closed.

Tuesday, April 29, "Move Day 2"

- 5 a.m.: The convoy scheduled to park on E. Commerce Street at corner of Highway 3 and NASA Parkway.
- 5 a.m.: Road closure ends and roads re-open to public (worse-case scenario, 7 a.m.)
- 9 p.m.: NASA Parkway is closed from Highway 3 to Saturn Lane.
- 9:15 p.m.: The convoy resumes after roads are closed, moving east on westbound lane of NASA Parkway.

Wednesday, April 30, "Arrival at Space Center Houston"

- ~ 1 to 3 a.m.: Estimated time for convoy to arrive at Space Center Houston. Upon arrival, the 747 will be parked in C-2 section of SCH parking lot until the next day.
- 4:30 a.m.: Estimated time for plane to be secured at Space Center Houston.
- 4:30 a.m.: Estimated time to end road closures re-open to the public.
- 9 a.m.: Space Center Houston parking lot and center open to visiting guests.

AIAA Mission and Vision Statement

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