The Lifetime Surveillance of Astronaut Health NEWSLETTER

April 2024 | Vol 29 Issue 1

Editor's Note

BY **RONNIE RAFANAN**

Welcome to the April 2024 issue of the Lifetime Surveillance of Astronaut Health (LSAH) Newsletter. In this issue, we celebrate LSAH lead, Dr. Mary Wear's retirement, inform you of the Apollo Records Synthesis Project (ARSP), and recap information shared at the 2024 Human Research Program (HRP) Investigators' Workshop (IWS) by our LSAH Epidemiologists and NASA HRP team. Be sure to check out the *Clinic Corner* for information on neurocognitive testing offered to former astronauts, and the *Formers Corner* where we share images and captions submitted by you and your fellow crewmates. *Enjoy!*

In this Issue…

(Continued next page)

In this Issue… *(Cont'd)*

CLINIC CORNER:

Neurocognitive Testing Now Offered for Former Astronauts

– Update January 2024

BY **ANNA CEJKA, PHD, OPERATIONAL PSYCHOLOGIST**

The Behavioral Health and Performance (BHP) team at NASA Johnson Space Center is now offering neurocognitive exams for former astronauts. These exams provide information to former astronauts on their current cognitive functioning and establish a baseline with which to compare future testing results and to track cognitive functioning over time. During this two-hour evaluation, numerous areas of functioning are evaluated, including multiple forms of memory, problem-solving, attention, and fine motor skills. Formers that participate in neurocognitive testing have the option of utilizing a second day after their annual physical to attend the testing. Following the evaluation, results are sent to the former via secure messaging and recommendations for referrals are made if necessary. These evaluations are scheduled every four years after initial baseline until the astronaut reaches the age of eighty, then every two subsequent years.

In addition to helping former astronauts track their cognitive health over time, the data collected for LSAH through these tests will help NASA determine if spaceflight impacts how the brain ages. This information is particularly important as we look toward sending astronauts on longer duration missions to the Moon and Mars.

Since neurocognitive testing began in 2023, over 80% of former astronauts approached about testing have agreed to participate. Testing can be scheduled at any time by calling the FMC. As part of the evaluation process, an initial interview is conducted to gather relevant information regarding academic, occupational, and family history. This interview lasts roughly one hour and can be done in person at the former's annual physical or remotely any time prior to the neurocognitive exam.

For more information on neurocognitive testing, please contact anna.c.morgenthaler-cejka@nasa.gov.

If you are interested in scheduling a neurocognitive test, please feel free to call the FMC and we will help you get it set up. **Flight Medicine Clinic (FMC): (281)483-7999**

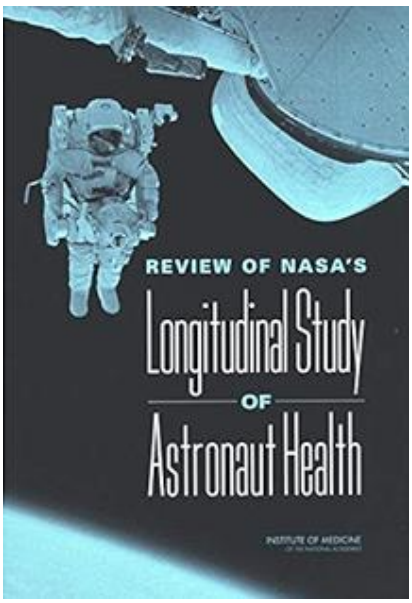
LSAH Team Spotlight:
Meet **Dr. Mary Wear**

By **MARY VAN BAALEN, PHD**

Dr. Mary Wear, PhD

Dr. Mary Wear, the lead to the Lifetime Surveillance of Astronaut Health (LSAH) contractor team, has announced her decision to retire this spring. She has been with LSAH since 1992 and has seen the team evolve from the research study, Longitudinal Study of Astronaut Health, to the occupational surveillance program it has been since 2010.

Mary was raised on a dairy farm in rural Minnesota. Many nights she stared at the Milky Way, especially Cassiopeia. Her childhood curiosity drew her to the W shape, but she never imagined that one day she would work at NASA. Mary graduated from Mankato State University (now called Minnesota State) in 1980 with a BS in Biology. Interested in science but not sure what to do next, she joined the Peace Corps and spent two years in Ghana, West Africa, teaching Biology and Physics to middle and high school students. The experience of seeing the devastating impact of untreated tropical diseases pointed Mary to a career in Public Health, leading her to earn her master's from the University of Texas School of Public Health (UTSPH) in 1987 and her PhD in 2001.



Longitudinal Study of Astronaut Health, 1992

Between 1984 and 1992, Mary's scientific career started in the UTSPH library and computer center and continued at the Baylor College of Medicine Children's Nutrition Research Center. She also participated in the groundwork of two longitudinal research studies: Project HeartBeat (evaluating the development of cardiovascular risk factors in children) and the Corpus Christi Heart Project (surveillance of a population after hospitalization for a myocardial infarction). This unique experience led Mary to Krug Life Sciences in 1992 as Lead Scientist for the original Longitudinal Study of Astronaut Health. In 1998, Mary began leading the Epidemiology Section. Throughout company and contract transitions (Krug bought by Wyle in 2003, which was acquired by KBR in 2016), Mary held several additional roles, but her primary responsibility has been to manage and lead the LSAH Epidemiology team. From a small team of 7 to the current staff of 21, Mary has enjoyed working on the scientific mission of LSAH as well as the professional development of the Epidemiology team.

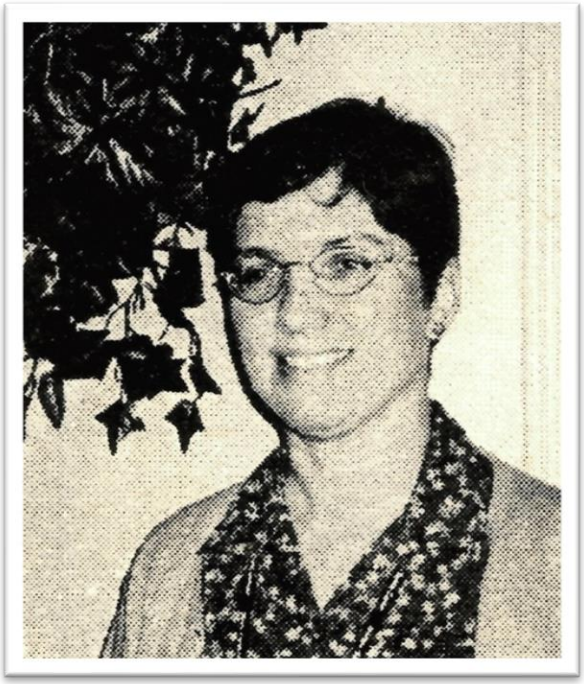
Whenever the LSAH team discusses the skill set each member brings to a project, the answer regarding Mary is her experience in longitudinal studies. The understanding of how data is collected over time and the caveats for analysis has been invaluable to the LSAH mission. Mary was involved in the original research study design and data collection from paper records to create the LSAH database. The LSAH database was used in 1999 to initially populate the electronic

medical record. Some examples of the many analyses that Mary has been involved are studies exploring musculoskeletal injuries related the astronaut career, cardiovascular outcomes that have impacted clinical testing, cancer outcomes in both active and former astronauts, and many more. Her contributions have been many, and I can personally say that I have learned a great deal from her in the 14 years we have worked together.

Mary is married to Bill Baker, also a graduate of the UTSPH. Together they raised twin boys, Alex and Edward, and they are the proud grandparents to Emmy, age 8. Mary says that behind every successful woman is a strong man and appreciates the support and encouragement that Bill has given over the years.

"From a country girl watching the stars to working at NASA has been a dream come true for Mary."

While we are sad to see Mary leave, we are pleased to announce that her replacement is Dr. Jacqueline Charvat, who was featured in the **LSAH Newsletter, Volume 27, Issue 2**.



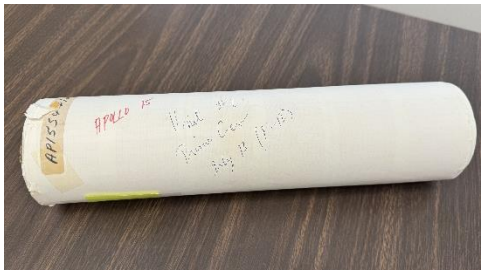
KLA Newsletter, 2001

Thank you, Mary!

The Apollo Records Synthesis Project: Bringing New Light to Historic Research and Medical Data

BY **SARA JORGENSEN, PHD, MSIS**

As NASA prepares to return to the Moon and continue on to Mars, data from the Apollo Program has become an important tool for understanding and mitigating the risks awaiting astronauts beyond low Earth orbit. The Lifetime Surveillance of Astronaut Health (LSAH) program has recently used Apollo data to create de-identified data sets assessing 21 health outcomes that may be associated with lunar landings. Those data sets will contribute to the development of countermeasure requirements for the Human Landing System (HLS) vehicles that will carry the Artemis astronauts to the Moon.



Strip chart: A strip chart generated during Apollo 15, recording crew data.

Apollo data offers unique windows into the challenges of lunar exploration, but its age can make it difficult to work with. The records created half a century ago have been stored on media common for that time, including paper documents, strip charts, photographs, film, and tape media. In today's digital world, it's not always easy for researchers to locate and access the information that these analog sources contain. In 2023, as custodians of historic record collections, LSAH and their colleagues at the Life Sciences Data Archive (LSDA) established the Apollo Records Synthesis Project (ARSP), pooling technical and subject-matter expertise to identify Apollo biomedical data and to employ 21st century digitization technologies to make it accessible.

Apollo data tape: Apollo-era EKG data housed on a data tape from the LSDA legacy media collections.

Two Goals, One Challenge

LSDA and LSAH have complementary missions. LSDA houses and manages data from research funded by NASA's Human Research Program (HRP). LSAH houses and manages data generated through the clinical care and occupational health surveillance of current and retired astronauts. In the 2020s, these are distinct tasks, but during the Apollo Program the boundaries were less clear. Not only did Apollo predate the rules and systems that now govern medical privacy and research ethics, but as NASA began to learn how humans were affected by space flight, the most important research questions were also medical questions. As a result, LSDA and LSAH have inherited records that were originally part of a single pool of material created during Apollo, and both projects are facing the challenges of identifying useful data in the records and enabling its reuse in new research.

For LSDA, work with Apollo-era records is part of a broader effort to integrate its materials in legacy analog formats into its online repository. Since 2020, LSDA's Media Migration Project (MMP) has employed archivists with training in information science to assess and inventory its legacy collections, to identify sources of data, and ultimately to create digital versions that can more easily be shared for retrospective research. As part of ARSP, MMP is currently focusing on LSDA's Apollo-era legacy materials. The project has two goals: to locate and identify new Apollo datasets in the legacy collections, and to identify more detailed versions of datasets that are currently available from LSDA in summarized form. Summarized, published data was preferred for preservation in the Apollo era, but in today's reuse-focused environment less-processed formats with more detail have become more valuable.

LSAH has inventoried its collection of historic materials, composed primarily of medical records containing less-processed data. LSAH needs improved access to the information in the records. Many are transcripts and reports where individual data points—like how an astronaut reacted to lunar dust exposure—are scattered within a narrative, and many are handwritten. Medical students and an epidemiology intern have examined this material to find evidence of health outcomes from exposure to dust on the Moon, but this is a painstaking, labor-intensive and time-consuming task. LSDA's MMP archivists can help LSAH implement technologies like optical character recognition (OCR), which encodes the text of scanned documents to make them searchable. LSAH can help LSDA by providing a user's perspective on how digitized materials can be managed to create maximum reuse potential.

Current and Future Projects

ARSP is currently focused on three tasks: identifying sources of data, planning for digitization and long-term preservation, and prioritizing digitization based on research needs.

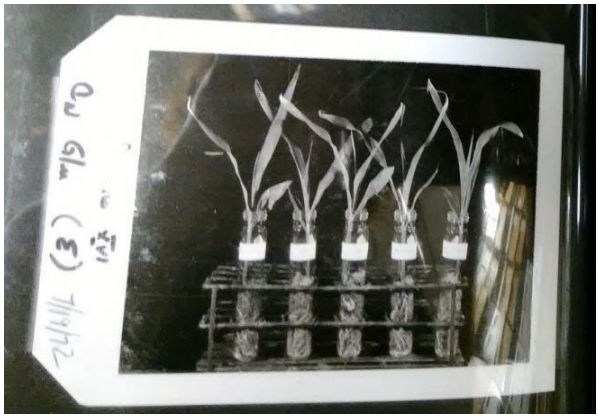
1. Identifying Data

ARSP is working to identify new data sources inside and outside of our collections. MMP archivists have recently identified two groups of records in LSDA's collections: a set of radiation data and a set of plant biology records documenting experiments with growing plants in regolith. The ARSP team also examined the papers of Dr. Charles Berry, JSC's Director of Medical Research and Operations and Director of Life Sciences during the Apollo era, which are housed at UTMB's Moody Medical Library in Galveston.

UTMB Archives: An ARSP archivist examines Apollo-era records at UTMB's Moody Medical Library. The team identified medical and research datasets in the papers of Dr. Charles Berry, housed in the UTMB archives.

2. Planning for Digitization and Preservation

ARSP is currently planning for a digitization facility—including scanners and a processing workstation— to create digital versions of paper materials and still photographs (prints and slides) that conform to the standards set by the National Archives and Records Administration (NARA) and the Federal Agency Digital Guidelines Initiative (FADGI). These high-quality scans



LS73 Plants Small Detail: An image from a collection of records documenting an Apollo-era experiment with growing plants in lunar regolith. In addition to photographs, the collection includes tables, notes, and slides. SMEs associated with NASA's Space Biology Program are interested in working with this data.

will ensure the continued usability of the digitized records as new technologies for extracting data from scanned materials are developed. For the present, OCR tools will be used to transform the scans into searchable text documents. This will enable a range of uses, including data harmonization and analysis using natural language processing (NLP) and other machine learning tools. In the future, ARSP may be able to implement new tools like handwritten text recognition (HTR) to further improve accessibility.

3. Prioritizing Based on Research Needs

Once the digitization facility is operational, ARSP will prioritize materials based on their relevance for Artemis needs. When the team identifies potentially useful material, archivists reach out to SMEs in the appropriate disciplines. The team also welcomes expressions of interest from researchers interested in working with Apollo data. Understanding researcher needs assists with establishing the priority list for digitization and processing.

As this collaboration evolves, it will explore new ways for LSDA's and LSAH's Apollo Program records to support NASA's return to the Moon and a path to Mars. By keeping Apollo data accessible and usable for the 21st century, ARSP ensures that the essential contributions of the Apollo astronauts will continue to serve as a foundation for our expansion of human knowledge.

Accessing ARSP Data

The legacy datasets identified by ARSP are not yet available in digital form. Once they are digitized, they will be subject to LSDA's and LSAH's policies governing the privacy of human subjects. Researchers interested in using or learning more about undigitized data from this project should submit a data request through NLSP (https://nlsp.nasa.gov/explore/lsdahome/datarequest), including the phrase "Apollo Records Synthesis Project" in the data request description field.

Do you have any historic Apollo-era materials that could contribute to Artemis-era research? Please message **Devan Petersen, LSAH Epidemiologist (devan.k.petersen@nasa.gov)** or **Dr. Sara Jorgensen, LSDA Archivist (sara.c.jorgensen@nasa.gov)** to get in touch!

LSAH Epidemiologists' IWS Poster: ***Who's Been Up There?***

BY **SAM JACOBS, PHD** AND **JACQUELINE CHARVAT, PHD**

At the NASA Investigators' Workshop (IWS) Conference in February, LSAH Epidemiologists presented on the demographics of all NASA astronaut selection. At the end of 2023, the astronaut corps is comprised of 360 men and women. The corps is predominantly male (83%) and most were in the military or test pilots (75%) prior to becoming astronauts. Forty-nine astronauts are currently active, and 228 formers have retired from active flight status. NASA looks to add to the existing corps in the coming year by adding a new selection class. Look for more details on our NASA crewmembers in coming issues of the newsletter.

Purpose: As spaceflight continues to advance, understanding who has been to space in the past and what occurred during those missions can help us better create a contextual foundation for the data that has been collected. This foundation can in turn guide how data may be generalized and applied to future crew selections and mission programs.

Who They Are

Breakdown of astronauts and payload specialists by sex and status as of 12/31/2023

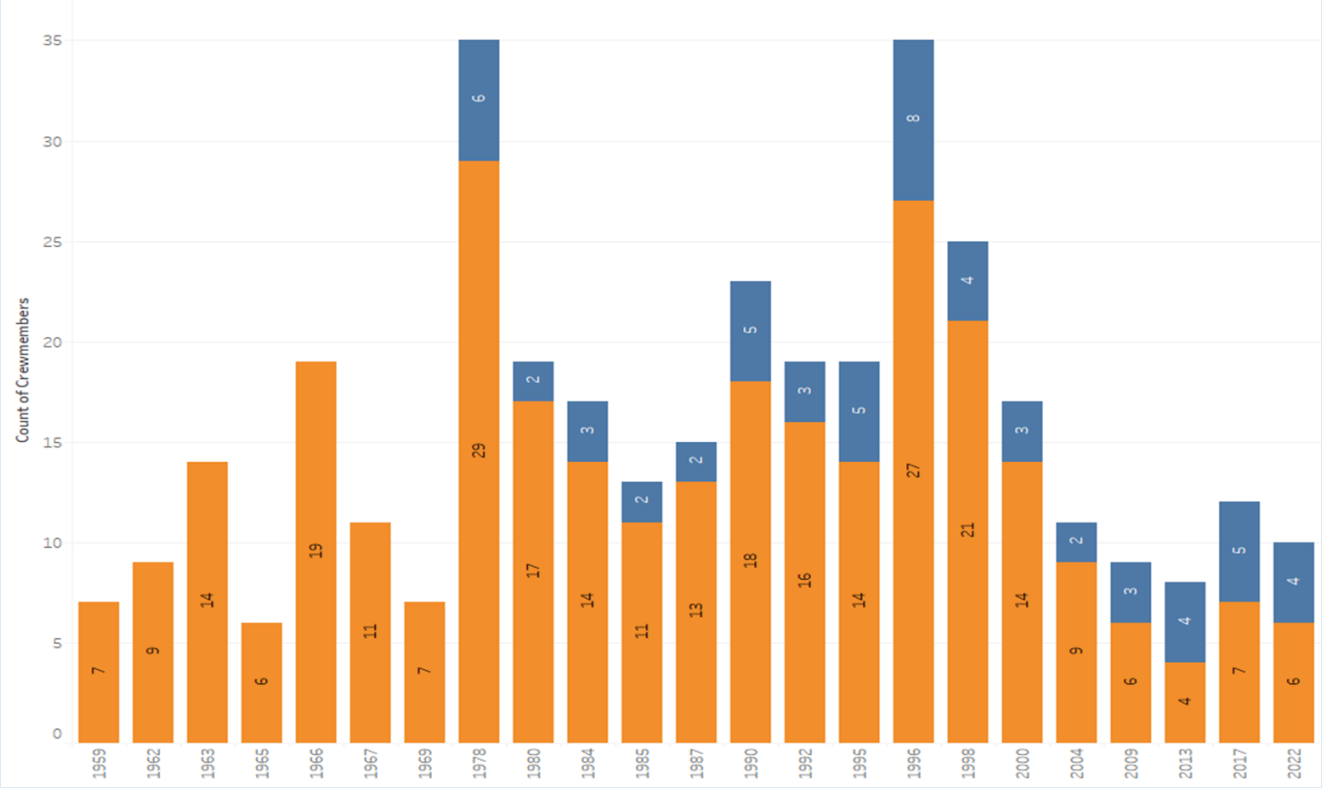
	Astronaut		Payload Specialist		Grand Total
	Male	Female	Male	Female	
Active	29	20			**49**
Former	194	34	22		**250**
Deceased	76	7	4	2	**89**
Grand Total	**299**	**61**	**26**	**2**	**388**

NASA began selecting crewmembers in 1959. Since then, 22 additional selection classes have identified 381 more individuals to be astronauts or payload specialists.

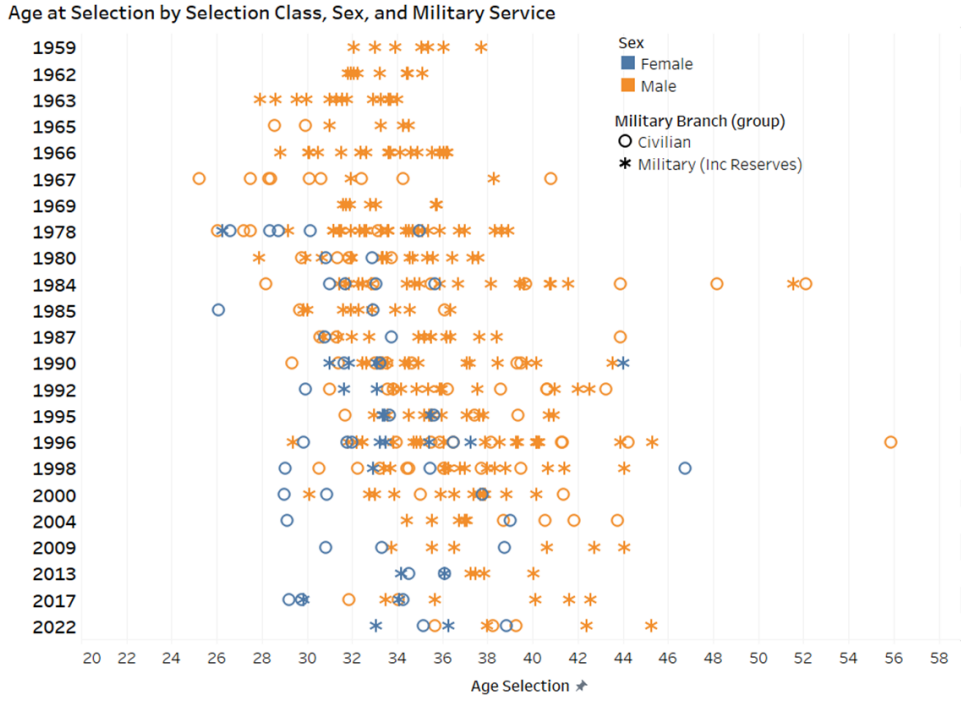
The first female crewmembers were selected in 1978. Selection of females has ranged from 11% to 50%. Since 2009, all classes selected were at least 30% female.

The average age at selection for each class has trended older over time, in both male and female crewmembers.

Sex of crewmembers by selection class

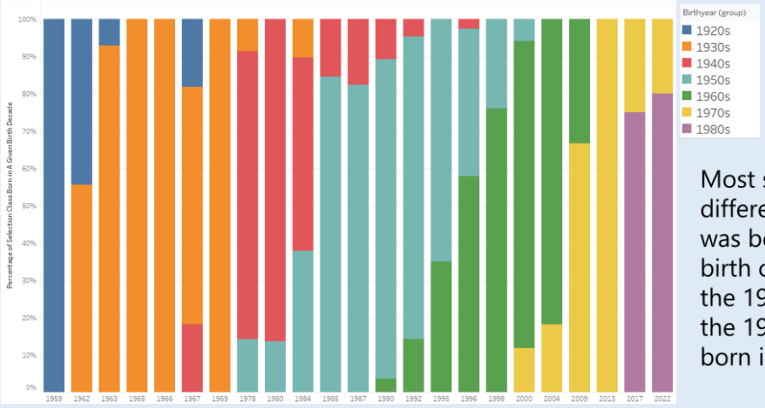


Average age of crewmembers at selection by sex, military status, and selection class



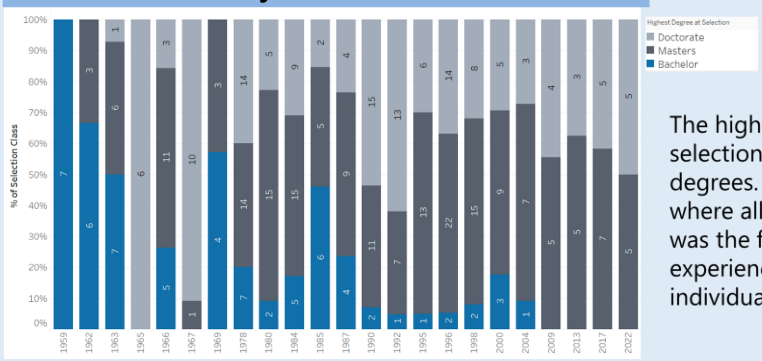
	Female	Male
1959		34.74
1962		33.03
1963		31.48
1965		31.92
1966		33.30
1967		31.62
1969		33.22
1978	29.18	33.24
1980	31.87	33.21
1984	32.86	37.67
1985	29.49	32.66
1987	32.27	34.83
1990	34.15	35.41
1992	31.55	37.27
1995	34.32	36.38
1996	33.68	37.76
1998	36.04	36.61
2000	32.55	36.30
2004	34.06	38.41
2009	34.31	38.87
2013	35.21	38.16
2017	31.44	37.05
2022	35.83	39.80

Birth cohort breakdown of each selection class



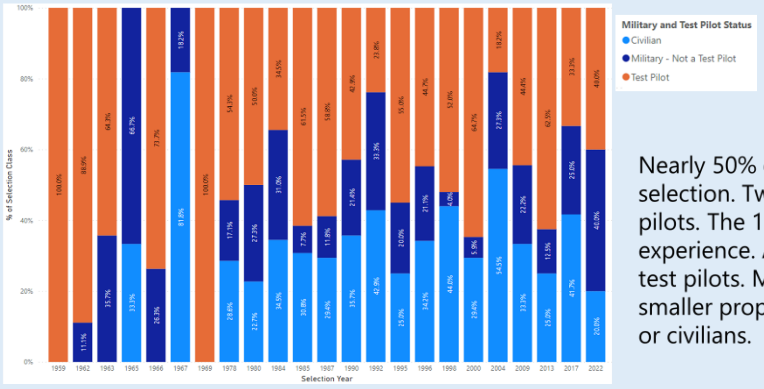
Most selection classes contained between two to three different birth cohorts, or the decade in which someone was born. Five other selection classes contained only one birth cohort. Everyone in the initial 1959 class were born in the 1920s. Three classes contained only individuals born in the 1930s, and one class only contained crewmembers born in the 1970s.

Education status by selection class



The highest education ascertained by crewmembers at selection has shifted to include more master's and doctorate degrees. The 1965 selection class was the only class to date where all those selected had doctorates. Further, this class was the first class without a requirement for pilot experience. The last four classes have all only included individuals with a master's or doctorate degree.

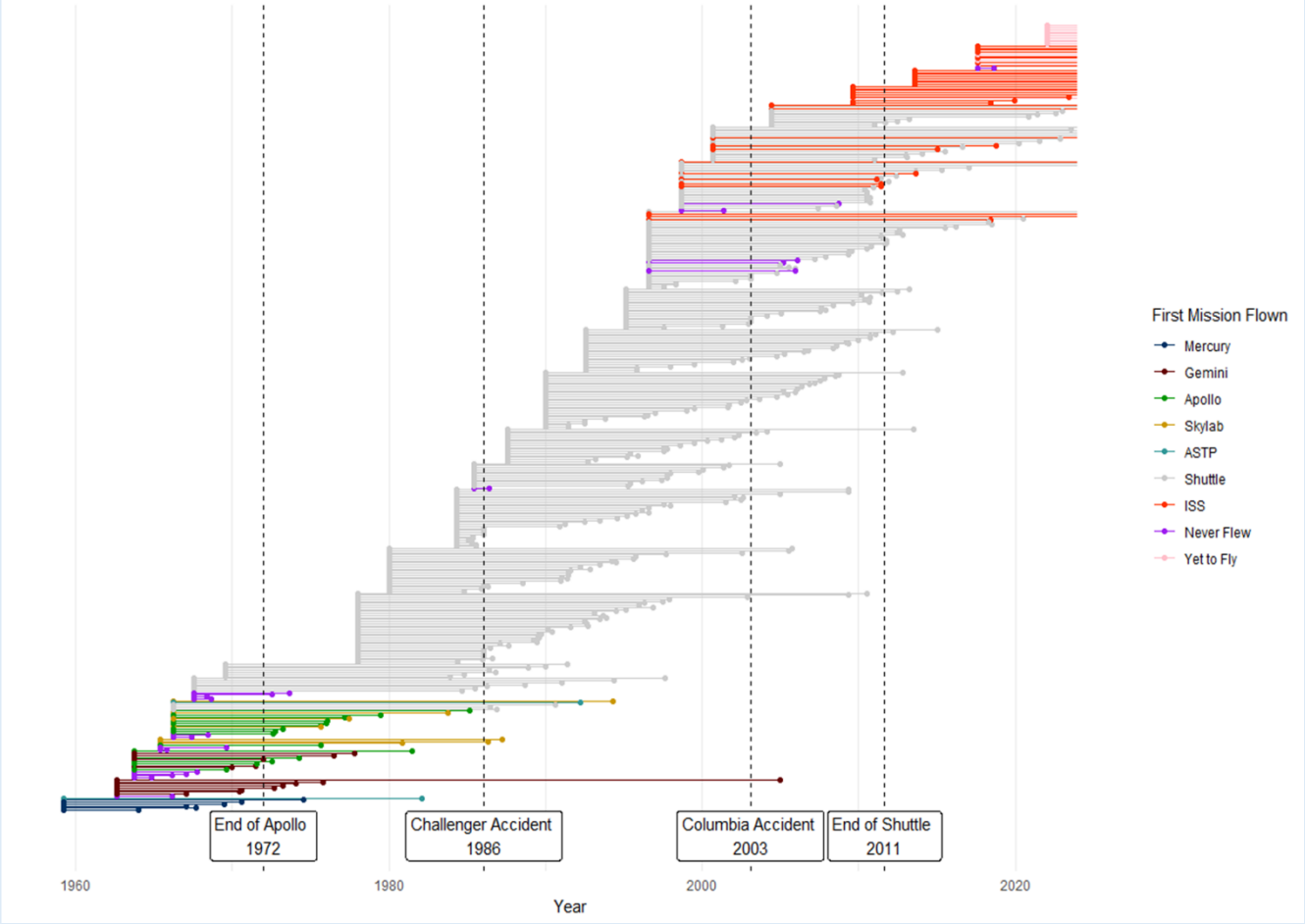
Military and test status by selection class



Nearly 50% of astronauts were military test pilots before selection. Two selection classes (1959 and 1969) were all test pilots. The 1965 and 1967 classes did not require pilot experience. All other classes included a large proportion of test pilots. Military astronauts who were not test pilots were a smaller proportion of most selection classes than test pilots or civilians.

What They've Done

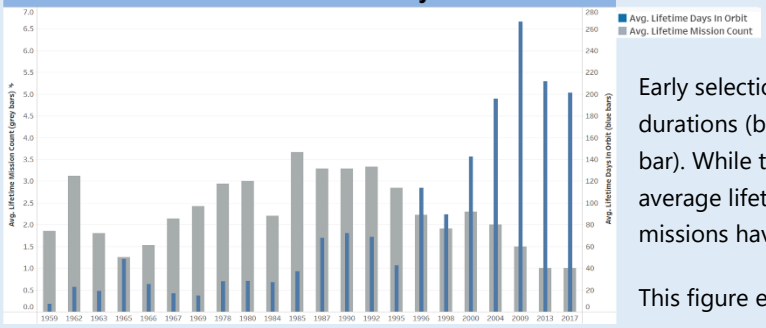
Career length from selection to retirement in years by first mission program



This figure looks at the career lengths of the selection classes to find potential clustering of retirements around mission breaks and the end of programs.

The mission break due to the Challenger accident appears to result in a disproportionate number of retirements. Similar effects do not seem to appear after the Columbia accident. With crewmembers whose first mission was on the Shuttle, clustering occurred at the end of the Shuttle program due to several individuals not continuing with the ISS program.

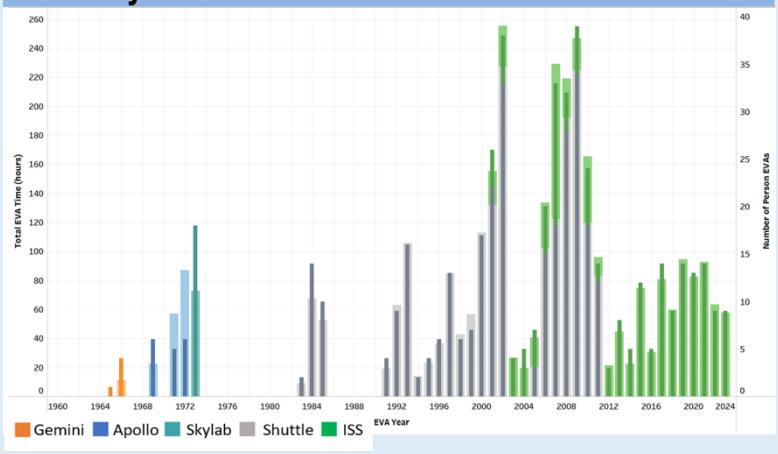
Cumulative mission time and count by selection class



Early selection classes were selected for missions with very short durations (blue bar), but on average they flew more missions (grey bar). While the average number of missions never exceeded four, the average lifetime days in space has greatly increased as long duration missions have become an increased focus.

This figure excludes individuals who had no spaceflight experience.

Number of Person-EVAs and total time of EVAs by mission year



Each bar represents the number of Person-EVAs, and the shading represents the total EVA time by year.

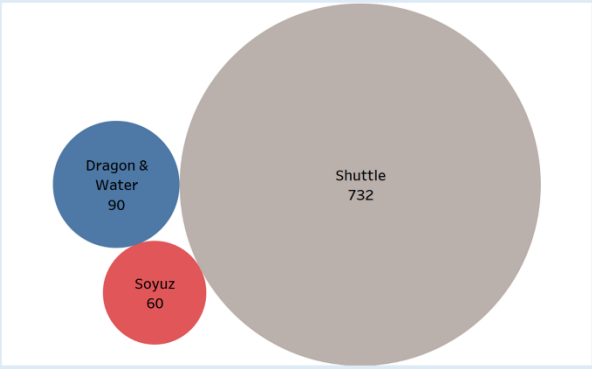
The first EVAs were conducted during the Gemini program. However, the height of historical EVA usage in terms of number and time came during the concurrent ISS and Shuttle programs, as ISS was being built.

Why Is This Data Important

As NASA exploration and commercial Low Earth Orbit (LEO) efforts expand, understanding who has been a part of the history of space flight is imperative. Tools like IMPALA can help with understanding this historical data and provide context to our research and surveillance efforts, such as the Human System Risks.

One area in which this shift will occur is within landing types. To date, Shuttle landings make up most landings that have taken place. However, current mission efforts are a return to water landings. Information gleaned from Shuttle landings may need to shift.

Landing types for NASA astronauts



Acknowledgments: This data was pulled and generated using the IMPALA platform; effort funded by NASA Crew Health and Safety.

HRP Corner:

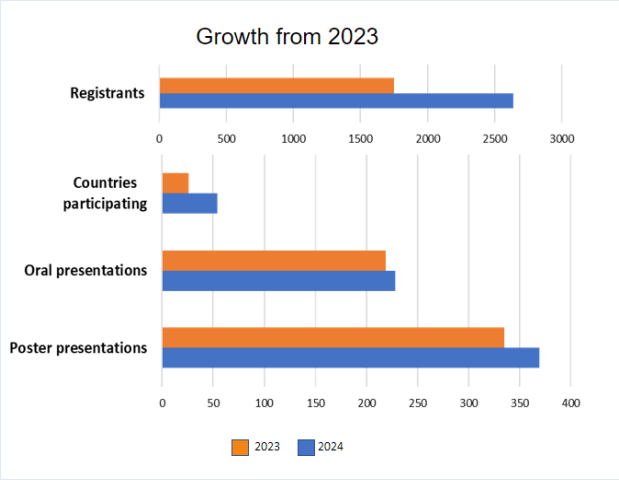
Highlights from the 2024 HRP Investigators' Workshop

By **Mohi Kumar**

NASA's Human Research Program (HRP) held its annual Investigators' Workshop (IWS) earlier this year in Galveston, Texas. From February 13–16, researchers from around the world convened at IWS 2024 to discuss a swath of topics related to keeping astronauts safe and healthy in space!

Here's a breakdown of the workshop by the numbers:

- 2,639 registrants
- 54 countries represented
- 228 oral presentations
- 369 poster presentations
- 55 sessions live-streamed
- 875 virtual attendees



A breakdown of how HRP IWS 2024 grew since last year.

The workshop featured a new addition: the inaugural John B. Charles Memorial Lecture and Award. The 60-minute plenary presentation will be given annually. It allows for a deeper dive into the crucial research impacting the success of NASA's missions. This year's lecture was presented by Dr. Alex Huang, an eye specialist and surgeon at the University of California, San Diego. His talk focused on the causes of and countermeasure development for spaceflight-associated neuro-ocular syndrome (SANS), a condition characterized by ocular changes due to persistent exposure to weightlessness. He is developing SANS diagnostic and risk assessment tools driven by artificial intelligence. You can watch his lecture here.

The workshop also featured a plenary talk given by NASA astronaut Kjell Lindgren. He spoke about the path that led him to becoming an astronaut, from a heartbreaking setback in flight school, to medical school, and then to NASA. He discussed his participation in research aboard the International Space Station during Expedition 67 and the scalability of these experiments to help support long-duration space missions. He also provided a glimpse at life in space, from launch and docking, to working on the station and landing back on Earth. You can watch his talk here.

NASA Astronaut Kjell Lindgren, delivering a plenary talk at IWS 2024

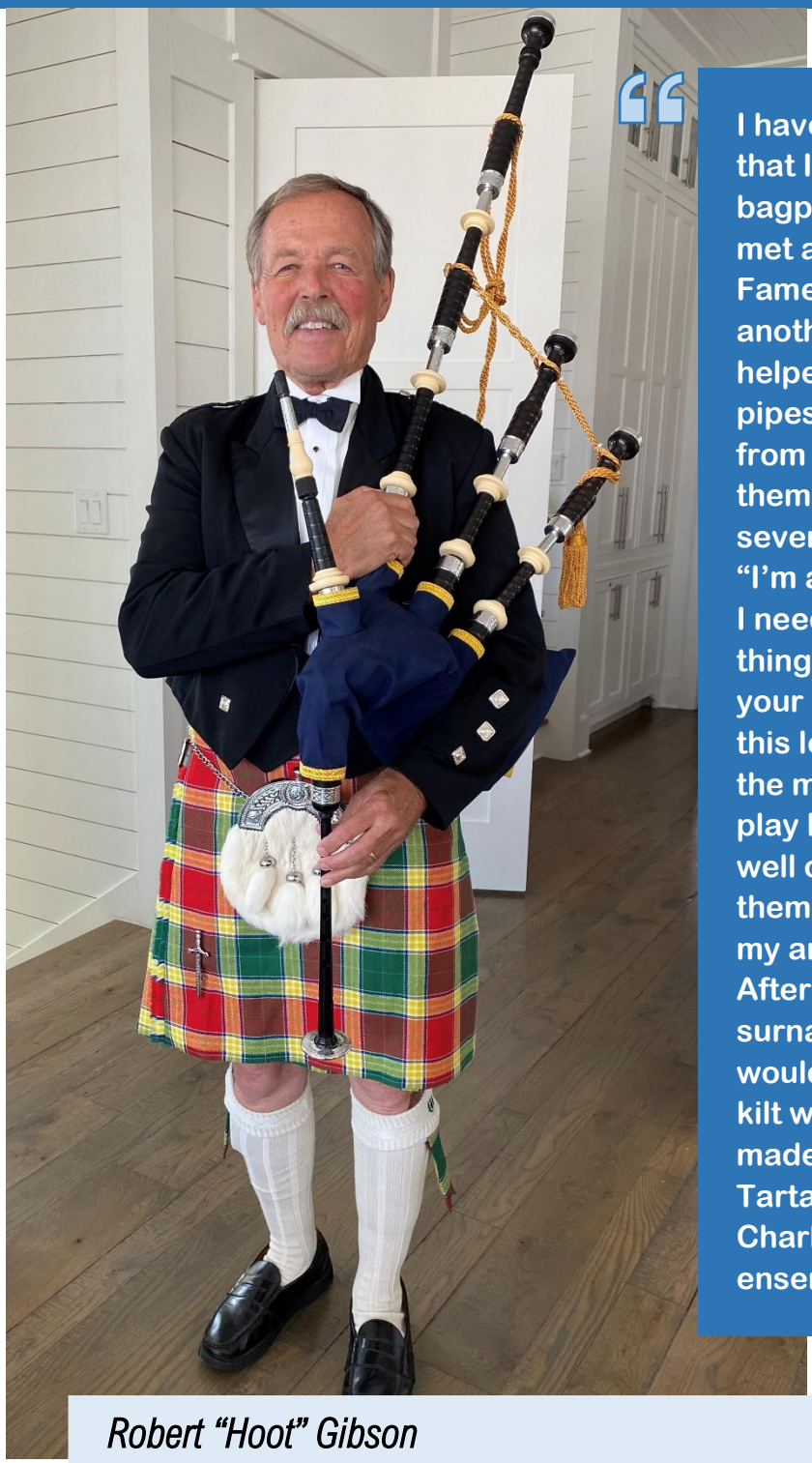
Amit Kshatriya, deputy associate administrator for the Moon to Mars program, presented another notable talk at IWS 2024. He discussed NASA's multi-faceted approach to bringing humans to the Moon first and leveraging that position to bring humans closer to landing on Mars. Using data-gathering satellites and robotic missions to explore asteroids, the lunar surface, and other celestial bodies, NASA's Moon to Mars program is committed to pushing the boundaries of human exploration and better understanding how life on Earth arose. Kshatriya put human research into context within broad agency goals, provided an update on the progress of the Artemis program, and mapped out key milestones needed for future Artemis missions. You can watch his talk here.

Other talks overviewed the current status on a range of topics, including blood clot formation during parabolic flight, portable sensorimotor disorientation devices that can be used as an analog for postflight recovery, immune responses to spaceflight, predicting in-mission resilience to stressors using biomarkers, the effects of caffeine on sleep in space, details on the effects that ionizing radiation may have on pharmaceuticals, whether lunar dust can act as an allergen, and much, much more!

Additional highlights from IWS 2024 include:

- A career development mixer
- Student travel awards given to four undergraduates, in collaboration with the Minority University Research and Education Project (MUREP)
- The release of HRP's Annual Publications Results Highlights (2023). Scan the QR code at the left to access the document, or click here.

FORMERS CORNER



"I have been saying for some years that I wanted to learn to play the bagpipes. Through the piper that I had met at the National Aviation Hall of Fame, I made the acquaintance of another professional piper who helped me select an excellent set of pipes from Scotland. I picked them up from him and started trying to play them on December 30, 2022. After several days, I called him and said, "I'm astounded at how much pressure I need to generate to play these things!" He replied "Hoot, never in your life have you needed to produce this level of pressure." That factor is the most difficult part of learning to play bagpipes. It is said that it takes well over a year to be able to play them. After I started playing, I traced my ancestry to Scotland in the 1500s. After all, "Gibson" is a Scottish surname. I, therefore, decided it would be appropriate for me to wear a kilt while playing, so I bought a tailor-made kilt from Scotland in the "Gibson Tartan" plaid, as well as the "Prince Charlie" jacket and the entire ensemble."

Robert "Hoot" Gibson
NASA Astronaut (Ret.), Captain, USN (Ret.)
Piper

Link to NASA Bio

Let us know how you're doing!

How are you spending your retirement? Please feel free to send us any pictures you would like to share, along with a brief description/quote, and we will be happy to publish it here for all your fellow formers to enjoy! Email us at jsc-lsah@mail.nasa.gov and include "**Formers Corner**" in the subject line. Looking forward to hearing from you!

Ask LSAH…

Do you have any questions you would like the LSAH team to answer? We would love to hear from you! Please send your question(s) for us to answer in the upcoming issues of the LSAH Newsletter. Email us at jsc-lsah@mail.nasa.gov and include **"Q&A: Crew Questions"** in the subject line. Looking forward to hearing from you!

Did you move? New email address? Remember to update us so we can continue to send you the LSAH Newsletter, LSAH invitational physical exam letters, and any other news we may need to share with you. Contact Denise Patterson at 281-244-5195 or denise.a.patterson@nasa.gov.

You may also write us at

Lifetime Surveillance of Astronaut Health (LSAH)
Flight Medicine Clinic/SD3C
NASA Johnson Space Center
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Or email us at Jsc-lsah@mail.nasa.gov

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