ANTICIPATING THE ASTRONAUT: SUBJECT FORMATION IN EARLY AMERICAN SPACE MEDICINE, 1949-1959

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ABSTRACT

This project expands the scope of existing "Space Race" histories of the American astronaut—mostly focused on daring test-pilots in the 1960s—by examining a prior decade of research conducted by doctors and psychologists in the military field of space medicine on a surprising array of non-test-pilot subjects. Examining the historical, social, cultural, and political dimensions of space medicine's pre-NASA work, which began in 1949, reveals two key insights. The first is that the astronaut emerged in the immediate aftermath of World War Two and developed in concert with the Cold War for a decade before NASA began operations. The second is that the kind of person space medicine experts came to consider "right" for space was not solely determined by the requirements of spacecraft control and environmental systems, but also by cultural ideas about bodies, minds, technology, and extreme environments in post-war American society.

Based on research conducted at NASA, USAF, and NARA archives, this study examines four nearly-forgotten but revealing episodes in which non-test-pilot subjects were used to establish standards and practices for astronauts later adopted and adapted by NASA. This project's four main chapters each focus on work with a different type of subject: a young, non-flying airman's week-long ordeal playing the role of astronaut in the first "Space Cabin Simulator"; a mountain-based study of high-altitude Indigenous people for astronaut acclimatization; the post-flight lives of monkeys Able and Baker, America's first celebrity space animals; and the Lovelace Woman in Space Program, a comparative study of women pilots for space fitness.

Beyond the purely technical problem of "Who can survive a spaceflight?", this work developing the astronaut posed a more fundamental but unspoken question about Americans: "Who should fight the Cold War?" Critically examining space medicine's work with these non-test-pilot subjects defamiliarizes the astronaut, recasting this utopian hero of the civilian Space Race as an older Cold War military creation with a surprisingly dystopian origin. Moving beyond space-race mythologizing, or internalist scientific progress narratives, this approach challenges the enduring gendered and racialized vision of the white, male, military pilot at its origin in an effort to demilitarize the astronaut and human ventures in space.

DEDICATION

To my grandparents William and Phyllis Beech, and Elizabeth and Ernest Edwin Bimm.

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CHAPTER ONE: REINTRODUCING THE ASTRONAUT

What can the earliest scientific visions of the astronaut tell us about the iconic archetype NASA established in the 1960s? How do they challenge and change our understanding of which humans are considered "right" for space? This project offers four empirical case studies from military space medicine during the decade before the first human spaceflights in 1961 that each complicate the familiar figure of the white, male, military test-pilot with a degree in engineering that dominated the Space Race. Together, these episodes show the "proto-astronaut" later adopted and adapted by NASA emerged as a military creation in the immediate post-war period and developed in concert with the Cold War, embodying a constellation of concerns surrounding surveillance, technology, extreme environments, race and biological appropriation, and masculinity. Looking past the biographies of well-known test-pilots, this earlier research conducted by military doctors and psychologists on a diverse array of non-test-pilot subjects reveals the astronaut to be a socially-constructed, historically-contingent human product reflecting American Cold War values and virtues, not solely pre-determined by technical or environmental requirements of spaceflight.

To understand the origins of the astronaut, historians have focused on Project Mercury, the National Aeronautics and Space Administration's (NASA) first human spaceflight program, and the selection of seven military test-pilots in April 1959 to sequentially occupy the single-seat spacecraft.[1] Beginning with official NASA histories of Project Mercury that appeared in the early-to-mid 1960s, subsequent works have adopted and reinforced a "Space Race" periodization for the astronaut, taking the stunning launch of Sputnik by the Soviet Union in October 1957 as the beginning, and the post-Apollo pause in the mid-1970s as the end of this critical period of initial formation.[2] These works focus the selection procedure devised by NASA's Life Sciences Committee and the Space Task Group's (STG) Human Factors Branch in 1958-1959, as well as the biographies, training, and famous missions of well-known individual astronauts including Alan Shepard, John Glenn, and Neil Armstrong during the 1960s.[3] A small handful of others have recently examined the lasting cultural impact of NASA astronauts in national and international contexts, highlighting their linkages to older heroic figures, and how they act as screens for the

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[1] Colin Burgess. *Selecting the Mercury Seven: The Search for America's First Astronauts* (Springer, 2011).
[2] Matthew Hersch. *Inventing the American Astronaut* (Palgrave MacMillan, 2013).
[3] *Project Mercury: A Chronology* (NASA SP-4001, 1963); Link, Mae Mills. *Space Medicine in Project Mercury* (NASA SP-4003, 1965); Loyd S. Swenson, Jr.; James M. Grimwood; Charles C. Alexander. *This New Ocean: A History of Project Mercury* (NASA SP-4201, 1966).

projection of contemporary hopes and fears.[4] But Space Race histories that conflate Project Mercury with the origin of the astronaut leave a crucial earlier period unexamined (Figure 1).

For nearly a decade from 1949 to 1958, before the shock of Sputnik demanded the creation of NASA, experts in an emerging field of military research called space medicine anticipated, defined, and explored the physical and mental hazards of spaceflight. The challenges they predicted included acceleration, noise and vibration, intense heat and cold, weightlessness, isolation, confinement, monotony, radiation exposure, the effects of low-pressure environments, and the ever-present threat of a micro-meteor impact or other catastrophic failure. To understand and mitigate these hazards, military space medicine experts, mostly working within the United States Air Force (USAF), but with significant activity in the Navy as well, conducted years of studies and simulations involving low-pressure chambers, human centrifuges, rocket-powered rail-sleds, space cabin simulators, high-altitude balloon flights, zero-G parabolic jet maneuvers, and expeditions to analog space environments on Earth. These tests constructed space as one of the "hostile" extreme environments of the Cold War, and the astronaut as the type of person best-suited to live, work, and if need be, fight there.[5] But crucially, many of these formative early space medicine experiments were completed with non-test-pilot subjects, including regular enlisted men, mountaineers, high-altitude Indigenous people, monkeys and chimpanzees, women pilots, and scientists themselves. What can these more complex and contradictory figures from early space medicine tell us about the astronaut beyond the familiar story of test-pilots and Project Mercury?

Where existing histories of space medicine by Green Peyton (1968), John A. Pitts (1985), and Maura Phillips Mackowski (2006) have focused on institutional development, discipline formation, and scientific progress narratives, this project focuses on astronaut formation.[6] To examine the emergence of the astronaut as a new type of person, this project looks beyond NASA's first official *selection* and focuses instead on an earlier period of *astronaut creation*. It makes three related main arguments about the creation of the astronaut: the first is that the astronaut emerged before NASA's selection of the Mercury Seven in April 1959, during the first decade of military

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[4] Roger Launius. "Heroes in A Vacuum: The Apollo Astronaut as Cultural Icon" in *The Florida Historical Quarterly* (Vol. 87, No. 2, Fall 2008) pp. 174-209; Michael J. Neufeld (Ed.) *Spacefarers: Images of Astronauts and Cosmonauts in the Heroic Era of Spaceflight* (Washington, D.C.: Smithsonian Institution Scholarly Press, 2013).
[5] Matthew Farish. *The Contours of America's Cold War* (University of Minnesota Press, 2010).
[6] Green Peyton. *50 Years of Aerospace Medicine: 1918-1968* (AFSC Historical Publications Series No. 67-180, 1968); John A. Pitts. *The Human Factor: Biomedicine in the Manned Space Program to 1980*. (NASA History Series, SP-4213, 1985); Maura Phillips Mackowski. *Testing the Limits: Aviation Medicine and the Origins of Manned Spaceflight* (College Station, TX: Texas A&M University Press, 2006).

space medicine research, which began in earnest in 1949. The second is that the astronaut, the most-visible representative of America's civilian space agency, started out as a military creation of Cold War research and development aimed at enabling defense operations in newly-strategic extreme environments, that NASA later adopted. The third is that the astronaut was not only determined by straight-forward technical and environmental requirements of spaceflight, but also by cultural ideas about bodies, minds, and technology in post-war American society. For instance, a quick scan of every astronaut to visit space between 1961 and 1981 reveals all were white men, a projection of post-war cultural values, rather than simply a determination of which bodies and minds were right for space. Following Bruno Latour, if technology is society made durable, how then, is culture constituted not just in the design of space artifacts like capsules or spacesuits, but in the human itself?[7] The episodes analyzed in this project highlight four themes or aspects of culture embedded in the American astronaut from the earliest days of space medicine, which have been obscured by triumphalist historical treatments. The first is surveillance, and how a mistrust of humans operators of complex technological systems prompted doctors, engineers, and administrators to closely monitor astronauts, which produced a certain mode of subjectivity for humans in space, as well as frequently-tense relationship with ground controllers. The second is how military doctors viewed space as another "hostile" environment of the Cold War—and how this characterization of it as a "proxy enemy" to be staved off with protective technologies or physically resisted by strong and healthy astronauts became reflected in ideal bodies and minds for space. The third is biological appropriation, and how space medicine experts attempted to mobilize physiological aspects of high-altitude Indigenous people with the goal of replicating these in the bodies of heteronormative white, male, soldiers thought to be best-suited for space. The fourth is how gender and specifically masculinity framed space medicine as a male-focused discipline, practice, and epistemology, resulting in the construction of a male-normative medical model for humans in space as well as a manly culture for spaceflight in general. A hybrid, evolving, and multifarious construct that does not easily reduce to the figure of the test-pilot, the astronaut merits a longer and more complex social, cultural, and institutional history focused on these themes in early space medicine.[8]

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[7] Bruno Latour. "Technology is Society Made Durable" in *The Sociological Review*, 38 (No. 1, 1990) pp. 103-131.
[8] Rachel N. Weber. "Manufacturing gender in military cockpit design" in *The Social Shaping of Technology*. (eds. Donald Mackenzie and Judy Wajcman.) (Maidenhead: Open University Press; 1999).

Figure 1: (Left) A cutaway illustration of an imagined astronaut from 1953, based on input from SAM space medicine experts Hubertus Strughold and Heinz Haber. (Source: Cornelius Ryan. "Man's Survival in Space" in *Colliers*. February 28, 1953. pp. 45). (Right) Project Mercury astronaut Gordon Cooper in 1959. (Source: NASA).

The motto Air Force scientists chose for space medicine in 1949 was *astronautico subvenimus* (Latin for "we support the astronaut"). This was based on an existing motto in aviation medicine, *volanti subvenimus* ("we support the flyer"). But crucially, space medicine did more than merely support astronauts, it *made them up* by establishing standards and practices later adopted and imported by NASA.[9] Following Hacking, and Daston and Galison, types of people

[9] Ian Hacking. "Making Up People" in *The Science Studies Reader*. ed. Mario Biagioli (New York; Routledge, 1990) pp. 161-171.

are not ontologically preexistent, but come into being through "concrete acts" or practices.[10] So instead of focusing on something like evolving drafts of on-paper selection requirements leading to Project Mercury, this project looks at how practices—medical, experimental, and representational—in early Cold War space medicine developed the astronaut.[11] Right from the start, space medicine experts framed the astronaut as a "human component" in the kind of large, complex technological systems that have been explored elsewhere in the history of technology.[12] But they also fashioned a specific kind of person at the centre of spacecraft systems, a hybrid technological and environmental subject with important parallels to other emergent subjectivities investigated in history of science, history of technology, and history of medicine.[13] Seen in this way, the astronaut becomes an interesting case to examine how large technological systems not only created the vast infrastructures and networks of the post-war period, but how these, along with a desire to dominate newly-strategic extreme environments, produced an iconic and enduring figure of the Cold War.[14]

The process of person-making has already been explored in related histories of pilots, cosmonauts, and Cold War research. In "The Virtual Flyer", historian of technology Chihyung Jeon writes about how new kinds of people came into being in the context of early aviation. In the 1930s, the Link Trainer, an early kind of flight simulator, produced a new generation of rule-and-instrument-bound "mechanical pilots", who replaced the old barnstorming "natural pilot" of early

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[10] Lorraine Daston; Peter Galison. *Objectivity.* (New York: Zone Books, 2010).
[11] Robert K. Quinnell. "The Human Component in Extraterrestrial Flights" (1955-1956) IRIS # 1022643. pp. 21.; David. H. Beyer; Saul B. Sells. "Selection and Training of Personnel for Space Flight" in *The Journal of Aviation Medicine*, 28 (No. 1, February, 1957) pp. 1-6; S.B. Sells; Charles A. Berry. "Human Requirements for Space Travel" in *Air University Quarterly Review*, 10. No. 2 (Summer 1958). pp. 108-120. IRIS # 0482243.
[11] S.B Sells; Charles A. Berry. "Human Requirements for Space Travel" in *Air University Quarterly Review* 10, No. 2 (Summer 1958). pp. 108-120. IRIS # 0482243.
[12] Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880– 1930* (Baltimore, MD: Johns Hopkins University Press, 1983).
[13] For example, in their discussion of the emergence of the "scientific self" during the nineteenth century Lorraine Daston and Peter Galison write that "there was not some already-established, free-floating scientific self that simply found application in the practices of image-making… a will-based scientific self was articulated—built up, reinforced—through concrete acts." Daston and Galison. *Objectivity* pp. 38; Chihyung Jeon. "The Virtual Flier: The Link Trainer, Flight Simulation, and Pilot Identity" in *Technology and Culture*, 56. No. 1, 2015. pp. 28-50.; Annemarie Mol. *The Body Multiple: Ontology in Medical Practice.* (Durham: Duke University, 2002); Kurt Danziger. *Constructing the Subject: Historical origins of psychological research* (NY: Cambridge University Press, 1990).
[14] For a history of vast Cold War computing networks, see: Paul N. Edwards. *The Closed World: Computers and the Politics of Discourse in Cold War America*. Cambridge, MA: The MIT Press, 1996.

aviation.[15] But rather than reconfigure an existing type of person, early space medicine studies and simulations brought one into being. Likewise, Slava Gerovitch argues that cosmonauts were "designed" as part of spacecraft systems, with Soviet politics "inscribed" on their bodies and minds.[16] But more broadly, this project is interested in the mutually constitutive relationships between culture, military research, and humans in the Cold War, as explored by historian of technology Edward Jones-Imhotep, and historical geographer Matthew Farish.[17] Both have shown how the array of newly-strategic extreme environments, including the polar regions, tropics, deserts, deep seas, and space posed critical problems for the functioning of humans and machines, prompting revealing recalibrations of both.[18] The formation of the astronaut in early Cold War space medicine provides an exemplary case of how Cold War anxieties surrounding humans and machines manifested in a new type of person.

For many people, the astronaut is a familiar, benign, and aspirational figure, embodying a constellation of positive ideals including bravery, physical and mental fitness, elite technical training and expertise, patriotism, military service, heteronormative masculinity, personal and national achievement, and, perhaps most crucially, the future of humanity. This project aims to cast space medicine and the astronaut in a new, unfamiliar light. Through the lens of military research, space, often viewed as inherently liberating, becomes an elite restricted place, with a medicalized boundary strictly policed by military scientists. The astronaut becomes a historically contingent, and politically potent medical subject; a new kind of elite soldier representing a privileged few, while excluding many others.[19] In recent years, NASA officials like former-Administrator and Shuttle-era astronaut Charles Bolden, public intellectuals including the late Cambridge astrophysicist Stephen Hawking, and corporate leaders like SpaceX's Elon Musk, have made strong calls for colonizing space, and specifically the planet Mars, by conjuring the threat of

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[15] Jeon. For a cultural approach to early American aviation including pilots, see Joseph Corn. *The Winged Gospel: America's Romance with Aviation* (Baltimore: Johns Hopkins University Press, 1983).
[16] Slava Gerovitch. "'New Soviet Man' Inside Machine: Human Engineering, Spacecraft Design and the Construction of Communism" in *Osiris* (Vol. 22, 2007) pp.135-157.
[17] Edward Jones-Imhotep. *The Unreliable Nation: Hostile Nature and Technological Failure in the Cold War* (Cambridge MA: The MIT Press, 2017); Matthew Farish. *The Contours of America's Cold War* (University of Minnesota Press, 2010).
[18] Edward Jones-Imhotep. "Maintaining Humans" in *Cold War Social Science: Knowledge Production, Liberal Democracy, and Human Nature* (Eds. Mark Solovey; Hamilton Cravens) (Palgrave-Macmillan, 2012); Matthew Farish. "The Lab and the Land: Overcoming the Arctic in Cold War Alaska." *Isis* 104, no.1 (2013): 1-29.
[19] Anthropologist Lisa Messeri shows how planetary scientists craft a sense of "place" for other worlds using images and maps. This project looks at another way a sense of "place" is made in space: who is allowed to go there. Lisa R. Messeri. *Placing Outer Space: An Earthly Ethnography of Other Worlds*. (Duke University Press, 2016)

an extinction-level catastrophe occurring on Earth. The "multi-planet species" imperative implies that the future of humanity could be limited who is allowed to travel in space, a determination still made by space medicine.[20] As spaceflight transfers from large government agencies like NASA, to private corporations like SpaceX, Boeing, and Blue Origin, there is a unique opportunity to challenge and reshape elitist tendencies in space medicine, and the resulting hyper-masculine, hyper-militarized culture of spaceflight. Who is really included in these off-world visions of humanity's future? Who is excluded, and why? How did this happen? In what ways are the discourses and practices that have developed around astronaut bodies and minds political? Despite a push to diversify America's astronaut corps by actively recruiting women and certain visible minorities in the mid-to-late 1970s, space medicine and the management of astronauts remains conservative, reluctant to include LGBT people and people with disabilities, to name only two broad groups, in space crews. This project's focus on early military space medicine calls into question this filter of who is allowed to represent "all mankind" in space, and in the subsequent western-centric visions of the future. Without this perspective, the dominant assumption that those historically favoured for jobs in space are "naturally" most fit for spaceflight, or humanity's best, or humanity's necessary future, will continue the eugenic undertones that shaped the earliest ideas of the astronaut. Rather than simply heroes of the Space Race, astronauts must also be understood as value-laden human products of America's Cold War military-industrial-academic-complex.

Space history, the subfield of history concerned with space exploration, has been slow to engage deeply with the astronaut and the medical aspects of spaceflight. Beginning with publications in the early 1960s from NASA's History Office (established by law in The Space Act), space history emerged focused by mandate on the civilian space effort, ignoring or integrating the earlier story of military space medicine and the astronaut. Space history developed into a subfield of history of technology, directing attention toward Space Race framed chronicles of famous machines, men, management structures, and missions. However, in the past two decades, scholarship about space medicine and astronauts by Mackowski (2006), Gerovitch (2007), Launius (2008), Mindell (2008), Olson (2010), Hersch (2012), has appeared, with each

[20] "We Must Become a Multi-planet species." *BBC Future*. (November 12, 2013) Online: http://www.bbc.com/future/story/20131112-becoming-a-multi-planet-species; "NASA Chief: Humanity's Future Depends on Mission to Mars" in *TIME*. (April 24, 2014) Online: http://time.com/76178/nasa-chief-humanitys-future-depends-on-mission-to-mars; "Stephen Hawking Says Humans Have 100 Years to Move to Another Planet" in *TIME*. (May 4, 2017) Online: http://time.com/4767595/stephen-hawking-100-years-new-planet.

adding important elements to this new emerging historiography. Mackowski recounts the early organization of space medicine, but offers only an internalist, celebratory progress narrative. Gerovitch sees cosmonauts as constructed in conjunction with a larger technological system, but his work contends with the particularities of Soviet space history, which differ in important ways from the American context. Launius unpacks various cultural meanings accrued by NASA astronauts but focuses on the Mercury and Apollo programs. Mindell integrates the astronaut into a history of human-machine interactions in spacecraft control systems but highlights technology, and only showcases test-pilots. Olson's critical ethnography of space medicine provides a useful way for thinking about the universalization of American specificity, helpfully casting the astronaut as an "environmental subject" but leaves the Cold War military origin of this and other related understandings unexplored. Hersch's labour history of the Mercury Seven is an important step in social and cultural perspectives though it deals only with already-selected astronauts in the Space Race. The framework for this project builds on all of these but goes beyond their sum total to fill key gaps. This social, cultural, and institutional history the astronaut before Project Mercury puts a critical focus on early space medicine and takes into account the complex and sometimes contradictory historical subjects that helped produce it.

Only a very small handful of historians have written about pre-NASA space medicine.[21] They chronicle early personalities, events, and institutional changes, but are mostly internalist histories, celebrating their subjects, and uninterested in the social, cultural, and political dimensions of science, technology, and medicine at play. They trace similar pre-histories, of the field moving from early balloon flights in the late eighteenth-century, to high-altitude physiology in the nineteenth-century, the advent of military aviation medicine in the First World War, and its expansion in the Second World War, before landing, in the post-war period at the USAF School of Aviation Medicine (SAM), a military research and teaching facility in San Antonio, Texas.

Following the lead of early practitioners, histories of space medicine characterize the field as an extension of aviation medicine. Aviation medicine, the military practice of selecting and protecting pilots, emerged during the First World War (1914-1918), after patterns of costly airplane losses were attributed to the failure humans rather than machines. The facility that would become SAM (originally called the Medical Research Laboratory of the Army Signal Corps) was founded in early 1918, at Hazelhurst Field, on Long Island in New York, soon after America joined

[21] See: Peyton (1968), Pitts (1985), and Mackowski (2006).

the conflict in Europe.[22] In 1926, SAM was relocated to the relatively calmer skies of Texas, and by 1931 was renamed and settled at Randolph Field in San Antonio.[23] Following the Second World War, SAM became the leading centre in a network of military space medicine research, including the Aero Medical Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio, the Aero Medical Field Laboratory at Holloman Air Force Base in Alamogordo, New Mexico, and the Naval School of Aviation Medicine in Pensacola, Florida.[24] For early practitioners the "extension" characterization served to locate this emerging area of work within their expertise in aviation, but as a historical framework it obscures other contributing genealogies, and makes the astronaut seem like purely an extension of the pilot, when in fact it is much more.

Standard space medicine histories tend to focus on a single scientific leader at SAM, a revered but controversial mid-career physiologist and medical doctor named Hubertus Strughold. In early 1949, Strughold became head of a new forward-looking department at SAM, the Department of Space Medicine, tasked with solving "the aeromedical problems associated with… flight beyond the stratosphere".[25] Among his first assignments was "Project No. 21-02-069, 'Physics and physiology of Space Travel.'"[26] Like the famous rocket designer Wernher von Braun, Strughold was one of roughly 1,500 German scientists who emigrated to America in the aftermath of the Second World War as part of Operation Paperclip. Just as von Braun was considered the international leader in rocket design, Strughold was the leading authority in aviation medicine, and from 1935 to 1945 served as director of the Luftwaffe's Aviation Medicine Research Institute (LMFI) in Berlin.[27] Once in America, von Braun cultivated an unrivaled science celebrity building rockets for the U.S. Army and later NASA. In contrast, Strughold, hired by the Air Force and installed at SAM, worked mostly out of the spotlight on the humans that might ride inside them. Tellingly, the other three founding members of Strughold's Department of Space Medicine at SAM were also German Paperclip participants: noted astrophysicist (and later Disney presenter)

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[22] Harry G. Armstrong. "Space Medicine in the United States Air Force" in *Space Medicine: The Human Factor in Flights Beyond the Earth* (Ed: John P. Marbarger) (Urbana: University of Illinois Press, 1951) pp. 11-13.
[23] Green Peyton. *50 Years of Aerospace Medicine: 1918-1968* (AFSC Historical Publications Series No. 67-180, 1968) pp. 27; 63.
[24] Jordan Bimm. "Introduction to 'The Beginnings of Research in Space Biology at the Air Force Missile Development Center, Holloman Air Force Base, New Mexico 1946-1952'" in *Quest: The History of Spaceflight* (Vol. 23, No. 1, 2016) pp. 39-40.
[25] "Department of Space Medicine: School of Aviation Medicine".
[26] *School History: July 1948-June 1949*. pp. 71. AFHRA IRIS: 00153383.
[27] In 1965, Paul A. Campbell, one of SAM's American commandants, called Strughold, "the unquestioned father of Space Medicine." Campbell, pp. v.

Heinz Haber, his Junkers aircraft designer brother Fritz (no relation to the more-famous chemist), and Konrad Buettner, a bespectacled bioclimatologist and expert on radiation shielding. Once organized, Strughold, the Habers, and Buettner quickly formalized their new discipline through conferences, publications, and public relations.[28] In a 1952 interview titled "Man Against the Void", USAF Brigadier General and early aviation medicine researcher Harry G. Armstrong introduced this Teutonic quartet to the American public boasting, "This team could not be duplicated… to the Germans this space business was their main interest."[29]

In histories of space medicine and German research during the Second World War, Strughold has become a controversial and divisive figure. In the immediate post-war aftermath, German aviation medicine was linked to lethal human experiments conducted on prisoners at Dachau concentration camp.[30] Strughold, who was not a member of the Nazi Party or the SS, did not order, oversee, or participate in these now-infamous low-pressure and freezing water experiments. But historians have discovered documents placing him at a conference in 1942 where he learned of their existence and did not protest.[31] In the 1950s and 1960s, American biographies of Strughold sanitized or downplayed his connections to the Third Reich, celebrating him as "The Father of Space Medicine".[32] In the 1990s, after documents finally confirmed his knowledge of crimes, Strughold was recast as an "evil Nazi doctor" in conspiratorial accounts that exaggerated his culpability.[33] Iconoclasm followed: in 1995 his name was literally chiseled off the side of what had been the Strughold Aeromedical Library at Brooks Air Force Base, and in 2006 he was

[28] John P. Marbarger (ed.). *Space Medicine: The Human Factor in Flights Beyond the Earth* (Urbana: University of Illinois Press, 1951); Clayton S. White; Otis O. Benson (Eds.) *Physics and Medicine of the Upper Atmosphere* (Albuquerque, NM: University of New Mexico Press, 1952).
[29] James L. H. Peck. "Man Against the Void" in *TRUE* (March 1952), pp. 18.
[30] Jordan Bimm; Patrick Kilian. "The Well-Tempered Astronaut" in *Nach Feierabend: Der* Kalte *Krieg* (Zurich, Diaphanes, 2017) pp. 89.
[31] Maas, Ad, and Hans Hooijmaijeras. *Scientific Research in World War II: What Scientists Did During the War*. (New York: Routledge, 2009). Eckart, Wolfgang U., Hana Voldra. "Disregard for Human Life: Hypothermia Experiments in the Dachau Concentration Camp" in *Man, Medicine, and the State*. Edited by Wolfgang U. Eckhart. (Stuttgart: Franz Steiner Verlag, 2006); Rodway, George W. "Ulrich C. Luft and Physiology on Nanga Parbat: The Winds of War". *High Altitude Medicine and Biology*, 10, (No. 1, 2009) pp. 89-96.
[32] Shirley Thomas. "Hubertus Strughold: The Father of Space Medicine Whose Dramatic Advanced Planning Encompasses the Universe" in *Men of Space, Volume 4* (Philadelphia: Chilton Company, 1962) pp. 223-272.
[33] In "Paper Clip" (1995), a third-season episode of *The X-Files*, FBI agents Mulder and Scully investigate a fictional German-American physician named Viktor Klemper who is said to have been part of Operation Paperclip. Modeled after Strughold, Klemper is described by one of Mulder's associates as being, "the most evil Nazi to escape the Nuremberg Trials", and, by another, as having, "experimented on Jews. Drowned them, suffocated them, put them in pressure chambers all in the name of science". Later in that episode the agents discover a hidden archive documenting unethical medical experiments inside at the abandoned "Strughold Mining Company". [6:58]

removed from the International Space Hall of Fame.[34] In the 2000s, historians including Mackowski and doctors including Mark Campbell, and Viktor Harsch, and former SAM cardiologist Lawrence Lamb, attempted to rehabilitate Strughold's legacy, naively taking his excuses at face value.[35] They cast Strughold as an apolitical scientist, too focused on research to consider the wider situation—a picture of science bracketed from society that historians of science, technology, and medicine have mostly abandoned.[36] This project views the work of Strughold and his German space medicine colleagues as inherently political. It also widens the scope beyond a singular biographic focus on Strughold as the paternalistic stand-in for all German space medicine experts to include Hans-Georg Clamann, Siegfried Gerathewohl, Ulrich Luft, Bruno Balke, Dietrich Beischer, Buettner and the Haber brothers, who have received far less attention.

NASA histories of the astronaut begin with the formation of the Agency in 1958 and the immediate realization of a lack of medical facilities and expertise.[37] The Space Act established the Agency around the "organizational nucleus" of the existing National Advisory Committee for Aeronautics (NACA), meaning they had plenty of experienced aircraft engineers ready to design a spacecraft but needed outside experts from military space medicine to work out the astronaut. This need quickly led to the creation of the Life Sciences Committee, headed by Randolph Lovelace II, a well-connected Harvard University-trained medical doctor and World War Two aviation medicine researcher. The committee's membership also included his frequent and longtime collaborator, the USAF human factors chief Brigadier General Donald Flickinger. This committee oversaw and directed the work of the Human Factors Branch of the Space Task Group (the division of NASA working on putting a human in orbit), staffed by three "aeromedical consultants" drawn from the armed services.[38] Histories of the Project Mercury astronauts focus

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[34] Correspondence surrounding these decisions is in the New Mexico Museum of Space History's "Strughold" file.

[35] Maura Phillips Mackowski. *Testing the Limits: Aviation Medicine and the Origins of Manned Spaceflight* (College Station, TX: Texas A&M University Press, 2006); Mark R. Campbell; Stanley R. Mohler; Viktor A. Harsch; Denise Baisden. "Hubertus Strughold: The 'Father of Space Medicine'" in *Aviation, Space, and Environmental Medicine*, 78 (No. 7, 2007) pp. 716-719.; Mark R. Campbell; Viktor A. Harsch. *Hubertus Strughold: Life and Work in the Fields of Space Medicine* (Neubrandenburg: Rethra, 2013).

[36] "After his death, Dr. Strughold was accused of having been a war criminal... It is hard to imagine this kindly old professor, who was more philosopher than physician, really had any significant involvement in such events." Lawrence E. Lamb. *Inside the Space Race: A Space Surgeon's Diary*. (Austin: Synergy Books, 2006) pp. 57.

[37] *Project Mercury: A Chronology* (NASA SP-4001, 1963); Mae Mills Link. *Space Medicine in Project Mercury* (NASA SP-4003, 1965); Loyd S. Swenson, Jr; James M. Grimwood; Charles C. Alexander. *This New Ocean: A History of Project Mercury* (NASA SP-4201, 1966).

[38] William Augerson, Robert B. Voas, Stanley C. White. "Outline of Proposed Research Astronaut Selection and Training Program for the NASA Manned Satellite Project" pp. 1.

on three crucial moments in the selection process. First, President Eisenhower's decision in late 1958 to back a proposal to limit NASA's search for astronauts to active duty military test-pilots with degrees in engineering.[39] Next, the infamously invasive and exacting medical examinations at Lovelace's large, pueblo-styled Clinic in Albuquerque, New Mexico, that were followed by psychological and simulation tests under Flickinger at the Aero Medical Laboratory at Wright-Patterson Air Force Base.[40] And finally, the debut of the seven military test-pilots selected for Project Mercury at a packed press conference in the auditorium of Dolley Madison House, the old colonial-style mansion one block north of the White House serving as NASA's first headquarters on April 9, 1959. This period from October 1958 to April 1959 is often considered the beginning of the story of the American astronaut. But for this project, it will serve as the end.

Until recently, the astronaut was treated as one component in big-picture administrative, political, or technical histories of spaceflight. Early NASA histories integrated the story of space medicine and astronaut selection in Project Mercury into broader program-scoped chronologies. In his 1986 Pulitzer Prize-winning account *...the Heavens and the Earth: A Political History of the Space Age*, Walter A. McDougall includes the astronaut as merely one part (albeit a highly visible one) of the larger sociotechnical system he describes.[41] When Howard E. McCurdy discusses astronauts in his 1998 cultural survey of spaceflight, *Space and the American Imagination*, he does so in the context of the Space Race, beginning with the Project Mercury selection and building to Apollo.[42] He explains how the Mercury Seven's sudden fame, which was quickly on par with "movie idols or rock music stars", surprised and irked NASA officials who failed to anticipate their broad appeal. McCurdy notes that "as military test pilots, the astronauts recalled the sacrifices required to produce the Allied victory in World War Two," but also observes that they harkened

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[39] *This New Ocean*, pp. 132; Memo from George M. Low to Abraham Silverstein. "Change of Manned Satellite Project name from 'Project Mercury' to 'Project Astronaut'" December 12, 1958. NASA History Office, Folder: "Project Astronaut". Memo: George Low to NASA Administrator. "Status Report No. 6, Project Mercury, Feb 3, 1959" (NASA History Office, Folder: "Project Mercury"). See also *Project Mercury a Chronology*, pp. 35-36. *This New Ocean*, pp. 131.

[40] "Seven to Enter Mercury Training Program" National Aeronautics and Space Administration, NASA Release No. 59-111, April 7, 1959. pp. 2. NASA History Office, Folder: "Project Mercury".

[41] Walter A. McDougall *...the Heavens and the Earth: A Political History of the Space Age* (Basic Books, 1985). See also, Loyd J. Swenson. "The 'Megamachine'" Behind Project Mercury" in *American Quarterly*, 21 (No. 2, 1969) pp. 210-227. "These first cosmonauts and astronauts as everyone knew, did not actively propel themselves into space. Rather, they passively were boosted by a different kind of "megamachine"—ballistic missiles called rockets-and by intricate governmental, industrial and technological organizations-in short, by "megamachines" of their nation-states." pp. 211.

[42] See: McCurdy, pp. 99-101 in the chapter "Apollo".

back to an earlier moment: "the myth of frontier law enforcers, whose grit filled the substance of Hollywood matinees and television screens".[43] In the pages of *LIFE* magazine, which bought exclusive rights to the Mercury Seven's stories, the astronauts presented themselves to the public as "brave, God-fearing, patriotic individuals… the personification of the clean-cut, all-American boys".[44] McCurdy calls this "the boy scout image", which stood mostly intact through Apollo, until a number of retrospective memoirs began appearing in the late 1970s alongside Tom Wolfe's famous non-fiction account *The Right Stuff*, which reoriented the masculinity of astronauts from boy scouts and family men, to "hard-living, hard-drinking" daredevil flyboys.

In the 2000s, space historians slowly began to focus on the astronaut as a figure worthy of attention apart from wider surveys. For the most part, these studies maintain a "Space Race" periodization, and concern themselves with the cultural image and impact of the astronaut. For example, Roger Launius's 2008 article, "Heroes in a Vacuum: The Apollo Astronaut as Cultural Icon", tracks multiple strands of meaning attached to astronauts "from the first unveiling of the Mercury Seven in 1959 through Project Apollo until the present".[45] Launius offers a range of perceptive insights into how Americans came to view a very specific type of person—white, male, middle class—as representative of America, and indeed by the summer of 1969 of "all mankind". Drawn to the icon-forging power of spacesuit technology, Launius argues the public saw astronauts as "American gladiators against the unknown", and with their reflective visors obscuring their faces, as anonymous warriors akin to Medieval knights.[46] Importantly, Launius highlights the essential masculinity of the early astronaut, arguing that it presaged the "hardbody" American manliness that proliferated in the 1980s. He also touches on the astronaut's complex relationship to the cyborg, indicative of a tight coupling of human and machine, especially in the Apollo moon suit.[47] Galison locates the military origin of the cyborg (short for "cybernetic organism") in World War Two anti-aircraft technology, but the term itself was first deployed at a space medicine conference in 1960 to describe a human altered by pharmaceuticals to withstand

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[43] ibid, 100.
[44] ibid, 101.
[45] Launius, 174.
[46] ibid, 203; 209.
[47] Launius, 203; 209. See also: Susan Jeffords. *Hard Bodies: Hollywood Masculinity in the Reagan Era* (New Brunswick, NJ: Rutgers University Press, 1994), and Donna Haraway. "Outer Space: The Extraterrestrial" in *The Haraway Reader* (New York: Routledge, 2004) pp. 92-95.

the rigors of space.[48] Likewise, Nicholas De Monchaux has written a far-reaching design history of the Apollo spacesuit, but stops short of considering the design of the human that inhabited it.[49] These observations capture the astronaut's iridescent character (following Megan Stern's analysis, Launius notes that astronauts comprise "a screen on which anyone might project any attribute from fantasies of heroism to submission") and show how already-selected astronauts interacted with culture.[50] But these leave aside a crucial question: how did culture and politics shape astronauts-in-the-making in pre-NASA space medicine? How did ideas about race, sex, gender, and the nation imprint on the human products of space medicine?

In *Inventing the American Astronaut*, historian Matthew Hersch offers a labour and employment history of NASA's astronauts from Project Mercury to the late 1970s. He argues that the Mercury Seven were more successful than expected in leveraging their sudden celebrity to shift the Agency's engineering, training, and operational cultures toward their pilot-and-cockpit comfort zones. Hersch's unconventional focus on their organizational lives, and sharp analysis of their multifarious personas, casts these mythologized figures as more complex and more human than ever, noting that in addition to being skilled pilots, they also turned out to be skilled organization men, adept at navigating and shaping the kind of large institutions that characterized the Cold War military-industrial-academic complex. This project's focus on earlier pre-NASA space medicine, and on figures other than test-pilots and famous astronauts, serves as productive prologue and generative foil for Hersch's work. When the Mercury Seven were selected, far from being in unchartered territory, they were confronted by earlier conceptions of the astronaut, based partly on non-pilot models, which they had to either conform to, or attempt to alter.

Beyond space history, astronauts have recently appeared in broader historical and sociological studies about co-constructive relationships between humans and machines, and humans and environments. In *Digital Apollo: Human and Machine in Spaceflight*, David Mindell shows how engineering choices in the division of control between humans and machines defined the Apollo-era astronaut as a technological subject.[51] Design decisions aimed at keeping astronauts

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[48] Peter Galison. "The Ontology of the Enemy." *Critical Inquiry* (Autumn, 1994) pp. 228-266; Clynes, Manfred E.; Nathan S. Kline. "Cyborgs and Space" in *Astronautics* (September, 1960) pp. 26-76.
[49] Nicholas De Monchaux. *Spacesuit: Fashioning Apollo* (The MIT Press, 2011).
[50] Recently, attempts have been made to integrate the history of astronauts and cosmonauts, while still adhering to the "Space Race" periodization and "cultural impact" models. See: Michael J. Neufeld (Ed.) *Spacefarers: Images of Astronauts and Cosmonauts in the Heroic Era of Spaceflight.*
[51] David Mindell. "Chauffeurs and Airmen in the Age of Systems" in *Digital Apollo: Human and Machine in Spaceflight* (Cambridge: The MIT Press, 2008) pp. 17-40.

"in the loop" appeared in Project Mercury, but expanded significantly afterward and climaxed in complexity during the Apollo flights to the moon in the late 1960s and early 1970s, when astronauts worked closely with the Apollo Guidance Computer to complete dockings and lunar landings. Mindell begins his study of astronaut-control relationships with the figure of the test-pilot, threatened by the encroaching automation of pilotless intercontinental ballistic missiles. He assesses their transition from active "throttle jockeys" fearing replacement by missiles in the 1950s, to relatively passive systems managers and computer experts disciplined to ride inside them by the late 1960s. My project also explores Cold War technological subjectivity in the agency versus autonomy debate, but within the earliest space medicine simulations of spaceflight, where the astronaut was assumed to be a passive push-button solider or radar operator, rather than a pilot.

Peder Anker and Valerie Olson have both written about how artificial spacecraft environments produce novel forms of subjectivity for populations and individuals. Anker describes how early space cabin ecology was expanded into a model for the entire planet and everyone on it. Exemplified by "whole earth" visions like R. Buckminster Fuller's "Space Ship Earth" and James Lovelock and Lynn Margulis's "Gaia Hypothesis", it produced modes of subjectivity like "whole Earth perspectives" that guide self-described "Terranauts".[52] This project makes a similar claim for the astronaut at the center of space cabin ecology; it too was built-up in concert with these early designs, but later became a representative and paragon for "all mankind". Also thinking about the formative relationship between humans, space medicine, and artificial environments, medical anthropologist Valerie Olson asks, "What kind of medical subject is the astronaut?"[53] Citing Georges Canguilhem and his student Michel Foucault, she argues that space medicine defines the astronaut in terms of relationships to the surrounding artificial spacecraft environment—the "milieu" missing from modern life-based biomedical conceptions of normal and pathological. Space medicine's outlier focus on "milieu" (or "environment" or "system"), and particularly the limits and interactions at the body-environment interface, produces what Olson calls an "environmental subjectivity". She defines space medicine as "a branch of environmental medicine focused on human life in extreme and artificial environments" that seeks to "keep

[52] Peder Anker. "The Ecological Colonization of Space" in *Environmental History* (Vol. 4 10, No. 2, April 2005) pp. 239-268; Jordan Bimm. "Rethinking the Overview Effect" in *Quest: The History of Spaceflight* (Vol. 21, No.1, 2014) pp. 39-59.
[53] Valerie A. Olson. "The Ecobiopolitics of Space Biomedicine" in *Medical Anthropology* (29, 2, 2010) pp. 170-193.

astronauts alive and productive, despite their routine transition into impairment on entering the inhuman domain of outer space".[54] Olson's work draws attention to a crucial yet under-explored theme in space medicine: the breakdown of Earth-based conceptions of normal and pathological in space. She notes the "irony that astronauts launch into space as exemplary normates but become automatically impaired or disabled there".[55] Olson explains that the "ecobiopolitics" of space medicine present themselves in attempts to establish new physiological "normals" for space environments, and also in the way that space medicine experts conceive of humans as at-risk system components. This project adds the specificity of the American example to Olson's work with episodes from early space medicine showing how experts first went about establishing certain physiological norms for space, and their conception of humans as failure-prone system components.

In the background of any history of the American astronaut is the Soviet cosmonaut. Indirect adversaries, cosmonauts and astronauts struggled by proxy, facing threatening environments and technical challenges rather than each other. A sort of near-doppelganger, the early cosmonaut shared many similarities with the astronaut. Like the Mercury Seven, the first group of cosmonauts were all white, male, healthy military pilots, chosen in a rigorous selection process. But there were also telling differences. For example, they were not required to be test-pilots or engineers, and therefore tended to be younger.[56] Unlike NASA's astronaut team, which was publicly unveiled days after their selection, the identities of the cosmonauts, and the details of their launches were closely guarded state secrets, revealed only after flights had been successfully completed. Slava Gerovitch argues that the cosmonaut represented the construction of a new self which aligned nearly perfectly with the socialist ideal of "new Soviet man", "a harmonic combination of rich spirituality, moral purity, and physical perfection".[57] Crucially, Gerovitch highlights the cosmonaut as a historical product. "Soviet cosmonauts were 'designed' as part of a larger technological system; their height and weight were strictly regulated, and their actions were thoroughly programmed. Soviet space politics… was inscribed on the cosmonauts' bodies and

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[54] Olson, 170.
[55] ibid, 182.
[56] "As has been repeatedly demonstrated in our automated flights and those with animals on board, our technology is such that we do not require, as the American Mercury project does, that our early cosmonauts be skilled engineers." Asif Siddiqi. *Challenge to Apollo: The Soviet Union and the Space Race* (Washington D.C.: National Aeronautics and Space Administration, 2000) pp. 244.
[57] Gerovitch, 135.

minds, as they had to fit, both physically and mentally, into their spaceships."[58] Unlike the future-gesturing "new Soviet man", Mindell argues the astronaut referenced America's past, noting it was necessary to "show that the classical American hero—skilled, courageous, self-reliant—had a role to play in a world increasingly dominated by impersonal technologies."[59]

To offer a deeper and broader critical history of the astronaut, this project focuses on four revealing episodes from the early history of space medicine based on research conducted at: the NASA History Office (Washington D.C.), the National Archives and Records Administration (Washington D.C. and College Park, Maryland), the Smithsonian National Air and Space Museum (Washington D.C. and Chantilly Virginia), the Air Force Historical Research Agency (Montgomery Alabama), the U.S. Space and Rocket Center (Huntsville, Alabama), the New Mexico Museum of Space History (Alamogordo, New Mexico), Mount Evans (Idaho Springs, Colorado), and the International Women's Air and Space Museum (Cleveland, Ohio). At each site, I looked for moments when longstanding practices appeared early on, or when the question of who might model or become an astronaut was answered differently than in Project Mercury. I have avoided focusing on a singular institution or figure, preferring to move between the vast networks of researchers, facilities, and subjects involved. When possible, I have placed these episodes within longer transnational histories of science, technology, medicine in the nineteenth-century to highlight how space medicine was more than an extension of twentieth-century aviation medicine, and the astronaut more than an extension of the test-pilot. Where existing histories of space medicine and the astronaut have tended to bracket off certain aspects, like psychology, human factors engineering, and sex and gender, this project integrates these across all four chapters.[60]

The first chapter introduces the USAF School of Aviation Medicine and the Department of Space Medicine by examining one of their earliest tools for fleshing out the astronaut: the space cabin simulator. Conceived by Strughold in 1952, this tiny purpose-built sealed-cabin arrived in 1954, and was designed to test three aspects of future spacecraft together: the environmental

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[58] ibid, 136. Gerovitch notes that, "in the 1960s the cosmonaut quickly supplanted the aviator as a top model for the Soviet self." pp. 140.
[59] Mindell, 5. See also: Hersch. "'Capsules Are Swallowed': The Mythology of the Pilot in American Spaceflight".
[60] For space psychology see: Patricia A. Santy *Choosing the Right Stuff: The Psychological Selection of Astronauts and Cosmonauts* (London: Praeger, 1994), and Douglas Vakoch (editor) *The Psychology of Space Exploration: Contemporary Research in Historical Perspective* (Washington D.C.: NASA History Office, 2011). For human factors engineering, see: Layne Karafantis. "Sealab II and Skylab: Psychological Fieldwork in Extreme Spaces" in *Historical Studies in the Natural Sciences*, 43. (No. 5, 2013) pp. 551-588. For gender see: Margaret A. Weitekamp. *Right Stuff, Wrong Sex: America's First Women in Space Program* (Johns Hopkins University Press, 2005).

system, the communications system, and a human occupant. Beginning in 1956, SAM doctors placed young airmen in the simulator for increasing periods, and studied their reactions to the artificial environment, but also to monotonous technical work, a new work/rest cycle, and total isolation. In early 1958, in the wake of Sputnik, these tests culminated in a high-profile week-long simulated "flight to the moon and back". The subject selected to play the role of astronaut was not a test-pilot, but a twenty-two-year-old accounting clerk from the base's comptroller's office. Sealed in the simulator, and cut off from the world via a communications blackout, he was monitored closely by scientists who observed him via TV and still cameras, concealed microphones, one-way portholes, and biometric sensors attached to his skin. Psychologists provided mock "work" for the subject to perform at regular intervals thought to be similar to an astronaut's tasks in space. This "work" did not resemble the piloting of an aircraft, but rather the monitoring of a radar scope or automatic weapons system. Indeed, SAM psychologists went to great lengths to define and measure their subject's vigilance—one of the supreme virtues of the Cold War.[61] The prototype astronaut that emerged along with the first space cabin simulator was not a brave test-pilot, but a lower-skilled, non-flying enlisted man, who was a assigned a very limited role in the system paralleling other push-button soldiers of the early Cold War.

The second chapter is a transnational history of the Mount Evans Acclimatization Experiment, a space medicine study conducted high in the Colorado Rockies in the summer of 1958 by SAM physiologist Bruno Balke. Leading the very first expedition-style Earth analog environment study in space medicine, Balke took a team of six young airman and a mobile pressure chamber to the summit of Mount Evans where he hoped a period of rigorous exercise at altitude would improve their oxygen efficiency in low-pressure spacecraft environments. The chapter explores the origin of space medicine's interest in altitude acclimatization in Balke's past as a German mountaineer, high-altitude physiologist, and Luftwaffe researcher. In 1938 he completed a secret acclimatization study for the Luftwaffe as part of the 1938 Nazi-funded German expedition to summit Nanga Parbat, one of the tallest mountains in the Himalayas. Once installed at SAM in the early 1950s, Balke conducted similar experiments on high-altitude Indigenous miners in Peru, attempting to understand and reproduce their oxygen efficiency in future astronauts. Balke's Peruvian hosts promoted the Indigenous miners as examples of a pre-colonial "Andean Man", a sort of exceptional human unique to the region that confounded traditional medical categories of

[61] Edwards, 4.

normal and pathological. Balke, on the other hand, viewed them as useful curiosities, whose unique physiology held clues for constructing the astronaut as a new kind of military "superman". In addition to the test-pilot and the flight surgeon, the astronaut has important connections to mountaineers, high-altitude physiologists, and high-altitude Indigenous people. This alternate genealogy showcases longer transnational, colonial, and expeditionary practices present in early space medicine obscured by a focus on aviation medicine. It also opens a new avenue for thinking about race and space, which has so-far focused on African Americans during the U.S. Civil Rights Movement in the 1960s. In this earlier moment, an ex-Luftwaffe doctor and high-altitude Indigenous people labouring in pressure chambers set standards for astronaut bodies.

The third chapter detours from human to animal astronauts and the case of Able and Baker, the first primates successfully recovered from a spaceflight. Following intense publicity, they became America's first celebrity space animals in May, 1959. Presented to the public at a packed press conference at NASA headquarters, these two monkeys drew uncomfortable comparisons with the just-selected human Mercury Seven. The chapter focuses on this tension between humans and animals in space medicine and how this has been expressed through anthropomorphism, the attribution of human qualities to animals. At first, Able and Baker were anonymous, expendable research animals, assuming the risks of rocket flight in place of a human. But in their post-flight publicity, they quickly became portrayed as anthropomorphic caricatures of Cold War citizens. Even though both Able and Baker were female monkeys, one of them was cast as a masculine male astronaut—the stereotypical "Cold Warrior"—while the other was fitted into the image of a feminine suburban housewife. Paired with a monkey "husband", and confined to a "bungalow", she was expected to reproduce. The case of Able and Baker showcases the role of animals in establishing early gender stereotypes surrounding astronauts before the first human spaceflights. More than just scientific models of the human physiological system in space, Able and Baker became cultural models for astronauts in public, ones that both challenged and reinforced aspects of their human counterparts.

The Fourth chapter examines The Lovelace Woman in Space Program, an unofficial and incomplete study of women pilots for "space fitness" initiated by NASA space medicine advisor Randolph Lovelace II, and USAF human factors chief Donald Flickinger in 1959. Their plan was to subject a group of exceptional women pilots to the same set of medical, psychological, and simulation tests taken by the all-male test-pilots in Project Mercury. Their goal was to discover if women's bodies offered any efficiencies or other advantages for spacecraft systems. After their first test subject, pilot Geraldyn Cobb, passed the tests, the privately-funded program was scaled-up to include at least twenty other women pilots. However, Lovelace cancelled the program after his personal assessment of Cobb ignited a public debate about gender discrimination in the selection of the Mercury Seven that NASA sought to avoid. This chapter locates Lovelace and Flickinger's interest in women as potentially-efficient astronauts within the longer history of their frequent collaboration on personnel selection for top secret high-altitude government projects in the early Cold War. It also examines a system of machine-readable medical punch cards the pair developed for Project Mercury, how sex and gender were encoded into these paper representations, and how this "othered" women applicants. Finally, a review of the only scientific publication produced by the Lovelace Woman in Space Program shows how space medicine experts portrayed women's bodies as unreliable system components, a machine metaphor used to medically justify maintaining an all-male astronaut group. This calls into question current understandings of the Lovelace Woman in Space Program (sometimes called "The Mercury 13") that portray space medicine as a progressive science stymied by conservative American culture. Instead, space medicine was shot through with conservative politics—even at the level of medical representations of the body— and this constructed and policed the gender of early astronauts.

Responding to calls for "new aerospace histories" that move beyond internalist chronicles and Space Race myth-making, and part of a growing collection of scholarship Messeri terms "the social studies of space", this project endeavours to deepen and broaden historical perspectives on space medicine and the astronaut.[62] Focusing on the earlier period of military space medicine research from 1949 to 1959, and a range of nearly-forgotten non-test-pilot experimental subjects, leads to two separate but related claims. First, the astronaut came into being before Project Mercury, during a decade of military space medicine research in the early Cold War. Second, the astronaut later established by NASA was not uniquely predetermined by purely technical and environmental factors, but rather reflected a social and political values embedded in the various strands of science, technology, medicine, and psychology that came together in early space medicine. To cast the astronaut in a productive new light, this project avoids old understandings

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[62] See: Steven J. Dick; Roger Launius (Eds.) *Critical Issues in the History of Spaceflight* (Washington D.C.: NASA History Series, SP-4702, 2006); Lisa R. Messeri. *Placing Outer Space: An Earthly Ethnography of Other Worlds*. (Duke University Press, 2016) pp. 16.

rooted in test-pilots, NASA, and the Space Race, and instead considers a set of virtually unknown scientists and subjects that helped produce it.

CHAPTER TWO: SPACEMEN IN THE BASEMENT: SIMULATING THE ASTRONAUT

In February 1958, during the post-Sputnik but pre-NASA period, Hubertus Strughold and some colleagues at the United States Air Force (USAF) School of Aviation Medicine (SAM) in San Antonio, Texas, sealed a young airman named Donald G. Farrell inside a device they called "the space cabin simulator".[1] Farrell's job during the seven-day "flight to the moon and back" was to simulate the job of astronaut by living inside the sealed cabin with no direct communication with the outside world. With the major omissions of weightlessness, radiation exposure, and an extreme environment outside, the interior of the cramped, purpose-built cabin modeled many aspects expected of life in space, including an artificial low-pressure atmosphere, isolation, confinement, and stressful technical work. Regarded primarily as tests of the cabin's environmental and communication systems, these experiments were also the debut of what these space medicine experts called "the human component". Until this point, astronauts existed only as characters in science fiction, or as speculative lists of physical, mental, and experiential requirements.[2] After Farrell's simulated flight, a real person had modeled a kind of astronaut, and had been widely publicized and celebrated for doing so.

This chapter explores the history and design of the space cabin simulator to understand what type of person—what sort of astronaut—emerged along with it. Despite the image of the heroic military aviator associated with the astronaut, the subject in the space cabin simulator was initially not a pilot—Farrell, as it turns out, was an accountant clerk from the base controller's office. The simulated work designed for the subject by the school's German space psychologist, Siegfried Gerathewohl, did not resemble the flying of an aircraft. Gerathewohl's "work" replicated the monotonous task of monitoring automatic systems for long periods of time.[3] The mental quality he was most interested in was "vigilance"—could the subject remain alert and responsive to electronic commands after hours, days, or weeks in the windowless cabin? This chapter argues that the space cabin "astronaut" emerged not as a heroic aviator, but as a passive, decentered

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[1] The simulator was first used for short tests in January, 1956. *School of Aviation Medicine, USAF, History, 1 July – 31 Dec. 1955*, 35.

[2] Robert K. Quinnell "The Human Component in Extraterrestrial Flights", 1955-1956; and S.B. Sells and Charles A. Berry, "Human Requirements for Space Travel", 1958.

[3] Siegfried J. Gerathewohl, "Work Proficiency in the Space Cabin Simulator", 722.

system component, similar to other Cold War-era "push-button" soldiers dispatched to missile silos, command bunkers, and radar stations in extreme environments.

For the origins of America's astronauts, space historians often turn to the early debate at NASA over the Project Mercury selection process.[4] In late December 1958, three months after the new agency began operations, President Dwight D. Eisenhower signed off on an executive order from NASA's first administrator T. Keith Glennan that settled a fierce disagreement over just what types of people America should consider sending to space.[5] A wide call to soldiers and civilians alike for the position of "research astronaut-candidate" was rescinded at the last minute, and replaced with a much narrower request for experienced military test-pilots with college degrees in engineering.[6] However, once selected, the Project Mercury astronauts famously balked at the passive role they were expected to fill. In *Inventing The American Astronaut* (2012), Matthew Hersch shows how the Mercury Seven used their celebrity status to tweak the astronaut's job description and public image—even the design of the capsule—toward their aviator comfort zone.[7] In *Digital Apollo* (2008), David A. Mindell examines compromises between human and computer control in the digital guidance computer for the Apollo spacecraft.[8] The story of the Mercury Seven's push-back against NASA engineers' plans for automation has attained mythic status in astronaut lore, conjured by the protest catch-phrase "Spam in a can".[9] But what about elements of the job they could not change? Or that they accepted? They were not stepping into a void; the space cabin simulator had already established a "passive" astronaut that they were reacting against.

These pre-NASA tests are important because rehearsals with a real person playing the role of astronaut initiated a set of practices and relationships that carried over into actual spaceflight. These include how astronauts relate to spacecraft systems, to ground controllers (especially flight surgeons), and perhaps most importantly, to themselves. Key to the formative power of these

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[4] *Project Mercury: A Chronology*, 34-36.
[5] William Augerson, Robert B. Voas, Stanley C. White. "Outline of Proposed Research Astronaut Selection and Training Program for the NASA Manned Satellite Project" pp. 1-5.
[6] A NASA announcement soliciting applicants for what was then called "Project Astronaut" was to have been sent out on December, 22, 1958. The document invited civilians and soldiers alike—as long as they met age, height, weight restrictions, had a college degree in science, engineering, or medicine, and experience in some dangerous job like test pilot, submarine crew, deep-sea SCUBA diver, parachutist, mountain climber, polar explorer, or soldier.
[7] Matthew Hersch. *Inventing The American Astronaut* (New York: Palgrave MacMillan, 2013). Hersch's labour history of astronauts at NASA includes a comprehensive overview of the 1958 Project Astronaut debate.
[8] See David A. Mindell. *Digital Apollo: Human and Machine in Spaceflight*. (Cambridge, MA: The MIT Press, 2008).
[9] Their social protest over automatic control is often characterized as not wanting to be "spam in a can".

rehearsals was the simulated work, but also, and perhaps most importantly, surveillance. Designed into the simulator by the German space doctors were multiple forms of surveillance: closed circuit television cameras, one-way viewing portholes, concealed microphones, biometric sensors, and subjective self-reports the subject was ordered to record in a diary. For the subject inside, knowledge of this surveillance affected their behaviour. Cameras, microphones, and one-way portholes produced a kind of self-policing of anything others might consider abnormal, and the diary entries encouraged a reflective contemplative state.

Hersch and Mindell have studied how spacecraft design shaped and was shaped by astronaut professional identity and public persona. The space cabin simulator was also a site for these human-machine negotiations, but it is important to extend their analysis to subjectivity and subject formation. Recent work in surveillance studies has taken up the question of how surveillance produces modes of subjectivity in those being watched.[10] The astronaut provides a good historical example of this since it was one of the first types of worker to be monitored so closely in training and on the job. In the early 1950s, surveillance became a central Cold War practice for monitoring military and domestic activities—from numbers of warhead-tipped rockets, to the private telephone calls of everyday people.[11] In space medicine, the desire to monitor "the human component" shaped both the interior of the simulator, and the "inner life" of the astronaut themselves. The mental virtue of "vigilance" that seemed crucial to the psychologists was gauged through proficiency at simulated tasks, but also through these modes of surveillance.

Space histories organized around Sputnik, NASA, and the so-called "Space Race" often underappreciate the Air Force's near-decade of preparations prior.[12] Work at SAM was not simply America's "other" astronaut training enterprise, it was the original astronaut endeavor that later became the core of NASA space medicine. When the space cabin simulator does appear in space histories, Farrell's test is often misrepresented as a complete success, a narrative hastily established by powerful space boosters in the press at the time.[13] However, a closer examination reveals this

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[10] David Harper et al. "Surveillance and Subjectivity: Everyday Experiences of Surveillance Practices" in *The Surveillance Industrial Complex*. (Abington: Routledge, 2013).
[11] Paul N. Edwards. *The Closed World: Computers and the Politics of Discourse in Cold War America*. (Cambridge, MA: The MIT Press, 1996)
[12] A USAF press release from April 1, 1958, with the heading "Space is the Air Force's Natural Element" shows how the service lobbied and expected to lead America's space efforts.
[13] Maura Phillips Mackowski. *Testing The Limits: Aviation Medicine and the Origins of Manned Spaceflight* (College Station, TX: Texas A&M University Press, 2006). Mackowski offers this kind of brief summation of the Farrell experiment, as do Harsch and Campbell in their eponymous biography of Hubertus Strughold, and Jacobsen in her account of Operation Paperclip. See: Mark R. Campbell; Viktor A. Harsch. *Hubertus Strughold: Life and Work in the*

episode was actually considered a failure of the human component, one that prompted SAM doctors to select their next test subjects more carefully, limiting their choice to experienced military pilots—a move that presages Eisenhower and Glennan's decision months later in Project Mercury. In this sense, Farrell can be seen as pioneering the role of both astronaut, and washout.

In general, simulators produce more than just analog situations, they instill new values, virtues, and behaviours in their users. Their military history dates back to World War One when ground-based apparatuses were used to teach aerial gunners the practice of "deflection shooting", aiming their shots ahead of intended targets. The history of flight simulation begins with the Link Trainer, a device invented by American flier and organ manufacturer Edwin Albert Link in the late 1920s to indoctrinate new pilots in the practices of instrument and radio flying. Beginning in the mid-1930s and culminating during World War Two, the Link Trainer replaced the daring flyer of the early air-age with the modern, rule-bound, instrument-reliant operator.[14] Since pilots and planes both existed before aircraft simulators, the Link trainer altered a set of preexisting pilot virtues.[15] But the space cabin simulator predates actual spaceflight, so work here established, rather than altered, astronauts. More than just a research tool to test systems and establish baseline medical and psychological data, the space cabin simulator was also designed for use in the selection and training of actual astronauts.[16]

During the 1950s, a number of different USAF centers conducted human experiments with low-pressure chambers, rocket-powered sleds, human centrifuges, high-altitude balloon flights, and experimental research aircraft to simulate specific (and usually experimentally isolated) physiological stresses expected in spaceflight.[17] Daring flight surgeons at Holloman Air Force Base in New Mexico soared high into the stratosphere in encapsulated balloon gondolas. At Edwards Air Force Base in the California desert, military test-pilots took rocket-powered planes

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Fields of Space Medicine (Neubrandenburg: Rethra, 2013); Annie Jacobson. *Operation Paperclip: The Secret Intelligence Program That Brought Nazi Scientists to America* (New York: Back Bay Books, 2014).

[14] Chihyung Jeon. "The Virtual Flier: The Link Trainer, Flight Simulation, and Pilot Identity. *Technology and Culture*, 56. No. 1, 2015. pp. 30.

[15] Jeon, 30.

[16] Paul A. Campbell. "The Present Space Medicine Effort at the School of Aviation Medicine" in "Tenth Anniversary of Space Medicine Research in the U.S. Air Force" in *United States Armed Forces Medical Journal*, 10 (No. 4, April 1959) pp. 394. "A space cabin simulator will be an extremely necessary selection and indoctrination device for manned space flight."

[17] David Bushnell. "History of Research in Space Biology and Biodynamics at the Air Force Missile Development Center, Holloman Air Force Base, New Mexico, 1946-1958." (Historical Division, Office of Information Services, NASA, 1958)

to extreme altitudes and velocities. However, the space cabin simulator was unique in its dual physiological and psychological purpose, its long-duration period, and its comprehensive attempt at realism.

Simulations have become a central practice in preparing astronauts for spaceflight. In the 1960s, the tiny one-person USAF space cabin simulator was expanded, improved, and duplicated many times over, spreading from its niche in the Air Force to NASA, and military defense contractors like Boeing, Honeywell, and Vought where it joined a growing list of other types of space simulators. From the beginning of Project Mercury, simulation was seen as a key practice for training and indoctrinating astronauts. During Gemini and Apollo, astronauts spent increasing numbers of hours in an array of different simulations, everything from complex spacecraft mock-ups, to expeditions to analog environments.[18] Today, simulation has become an important if routine facet of astronaut life. More than just technical acts of preparation, simulations are also social models, and useful public relations tools. As the reception of airman Farrell's 1958 test shows, simulations of speculative space missions, (like the Mars Society's Mars Desert Research Station, the European Space Agency's Mars500 psychosocial isolation studies, and NASA's year-long Hawaii Space Exploration Analog and Simulation) double as advocacy for their real-life counter-parts.[19] In this way, simulations can evoke and instill an entire approach to human involvement in space, the specificity of which is not always obvious. Put simply, they indoctrinate the wider public as well as astronauts.

This chapter begins with a look inside the simulator; at its military origin, its environmental and information loops, and the mutual shaping between these cabin systems and the human supposed to live inside. The second half of the chapter recounts the most famous experiment with the simulator, the week-long "flight to the moon and back" with airman Farrell in February, 1958. While the first section deals more with details in and around the cramped simulator—which was first set up in the basement of an obscure research building—the second section broadens the story to situate SAM's work on astronauts within the wider history of the American south in the early Cold War.

[18] North, Warren J. "Astronauts Training At the Ph.D. Level" in *The New York Times* (July 17, 1969) pp. 39. The average number of hours NASA astronauts were required to spend working in various simulators was 50 hours for Project Mercury, 195 hours for Gemini, and 380 hours for Apollo. Neil Armstrong famously used simulators obsessively, practicing critical sequences right up until the day before launch. In 1967, the entire crew of Apollo 1 died during a simulated launch.
[19] "Information Kit: Mars500 Isolation Study" (European Space Agency, 2011)

ORIGINS OF THE SPACE CABIN SIMULATOR

In February 1949, at Randolph Air Force Base near San Antonio, Texas, Major General Harry G. Armstrong, a legend in American aviation medicine, created a new department at the USAF School of Aviation Medicine (SAM).[20] He called it "The Department of Space Medicine". The first anywhere in the world, it was staffed by four German scientists participating in Operation Paperclip, and led by Strughold. Their task was to anticipate and overcome the various physical and mental stresses of space travel: acceleration, low pressure, weightlessness, radiation, isolation and confinement, just to name a few. "The team could not be duplicated in the country today," Armstrong boasted during a magazine interview in 1952. "Even to approach their capabilities, we would have to pull top men out of our universities or industry who might not be interested professionally in space medicine. To the Germans, this space business was their main interest."[21]

With little funding or serious interest in "space" beyond his small niche, Strughold cleverly reframed the team's research interests in terms of problems already facing the Air Force. "Space", he argued in an early paper, actually begins at a much lower altitude from the functional perspective of physiology. At 80,000 feet—where USAF planes were beginning to reach—there is no longer enough ambient air for cabin pressurization systems to keep humans alive.[22] Survival at this altitude requires a completely sealed cabin equipped with an independent oxygen supply—the same as in space.[23] Strughold defined "space" in terms of human survival; space begins where the surrounding environment cannot contribute to life sustaining processes. In this sense, space

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[20] The organization which eventually became the School of Aviation Medicine was created to support American military aviation in the First World War. Established in early 1918 as the Medical Research Laboratory of the Army Signal Corps at Hazelhurst Field, on Long Island in New York, the training and research facility was relocated to the relatively calmer skies of Texas in 1926, and by 1931 was renamed SAM and settled at Randolph Field in San Antonio. Following the massive expansion of aviation medicine during the Second World War and the independence of the Air Force in 1947, SAM became the leading centre in post-war space medicine research, which also included work at the Aero Medical Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio, the Aero Medical Field Laboratory at Holloman Air Force Base in Alamogordo, New Mexico, and the Naval School of Aviation Medicine in Pensacola, Florida. For a chronicle of SAM's development, see Peyton's base history *50 Years of Aerospace Medicine: 1918-1968*.

[21] James L. H. Peck. "The Physical Problems of Space Travel Are Being Solved" in *The Mystery of Other Worlds Revealed* (Lloyd Mallan, ed.) Fawcett Book No. 166. (Greenwich, CT: Fawcett Publications, 1952) pp. 17-18.

[22] In 1956, Strughold wrote that "The Air Force experimental sealed cabin is a prototype of the cabin that may be built into future space ships. This type of cabin will also be required in the coming phase of 'global space-equivalent flight' at supersonic speed through the space-equivalent regions of the atmosphere." See: Hubertus Strughold. "The U.S. Air Force Experimental Sealed Cabin" in *Journal of Aviation Medicine* 27 (February, 1956) pp. 52.

[23] Shirley Thomas. "Hubertus Strughold: The Father of Space Medicine Whose Dramatic Advanced Planning Encompasses the Universe" in *Men of Space: Profiles of the Leaders in Space Research, Development, and Exploration: Volume 4* (Philadelphia: Chilton Company, 1962) pp. 264.

was figured as a "hostile" environment, a sentiment captured by USAF space medicine popularizer Donald A. Wollheim, "space is an enemy that must be conquered".[24] As Strughold explained, "To keep a man alive and alert in a completely sealed compartment is the *suprema lex* in the space medical efforts."[25] Still, funding for their efforts was "meager", and the group's output was initially theoretical.

On March 3, 1950, one of the first conferences on the topic of space medicine was held at the University of Illinois in Chicago. Speakers included Strughold, rocket scientist Wernher Von Braun, the Haber brothers, and Buettner. The basic problem, as Strughold explained it, was that humans enclosed in small, sealed environments quickly ruin the atmosphere. They produce heat, humidity, and carbon dioxide that if left unmanaged make the chamber lethal.[26] Clearly, if astronauts were to spend significant amounts of time in space, countermeasures would be needed. Strughold distilled the required research into two related questions: how does the presence of a human change a sealed environment over time? And, how can these changes be counteracted?[27] Buettner explained that early experiments in pressure chambers and flights in high-altitude balloon gondolas gave some indication of the answers, but he hinted that a new kind of research tool—an "experimental sealed cabin"—was at the top of the new Department's wish list. "Let us assume that we had such a cabin," he mused. "It would consist of a closed metal chamber in which normal conditions would have to be maintained by technical means."[28] In an interesting inversion of purpose, the new sealed cabin would attempt to create habitable conditions, analogous to the interior of future spacecraft, while traditional low-pressure chambers were used to produce dangerous conditions analogous to high altitudes. At that time, no such device existed, and the Air Force's priorities were far from space travel; the start of the Korean War in 1950 marked the first real test for the newly-independent service. Still, Strughold lobbied hard for this sealed cabin. In

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[24] Donald A. Wollheim. *Mike Mars Around The Moon* (New York: Paperback Library, 1964) pp. 124.
[25] Hubertus Strughold. "Space Medicine of the Next Decade as Viewed by a Physician and a Physiologist" in "Tenth Anniversary of Space Medicine Research in the U.S. Air Force" in *United States Armed Forces Medical Journal* 10 (No. 4, April 1959) pp. 402.
[26] Willy Ley. "For Your Information: The Spaceship in the Basement" in *Galaxy Science Fiction* 15 (No. 2, December, 1957) pp. 66.
[27] George R. Steinkamp; Willard Hawkins; George T. Hauty; Robert Burwell; Julian E. Ward. "Human Experimentation in the Space Cabin Simulator: Development of Life Support Systems and Results of Initial Seven-Day Flights" in *Supporting Documents: Historical Report: School of Aviation Medicine, USAF* 29 (Randolph AFB: Air University, School of Aviation Medicine, 1959). pp. 2.
[28] Konrad Buettner. "Bioclimatology of Manned Rocket Flight" in *Space Medicine: The Human Factor in Flights Beyond The Earth* John P. Marbarger (ed.) (Urbana: The University of Illinois Press, 1951) pp. 70.

1952, he along with Fritz Haber, the former aircraft designer for Junkers, constructed a wooden mock-up, and invited the School's Director of Research, Colonel Henry M. Sweeney to help them test it out. Converted to their cause, Sweeney secured funding from the USAF Research

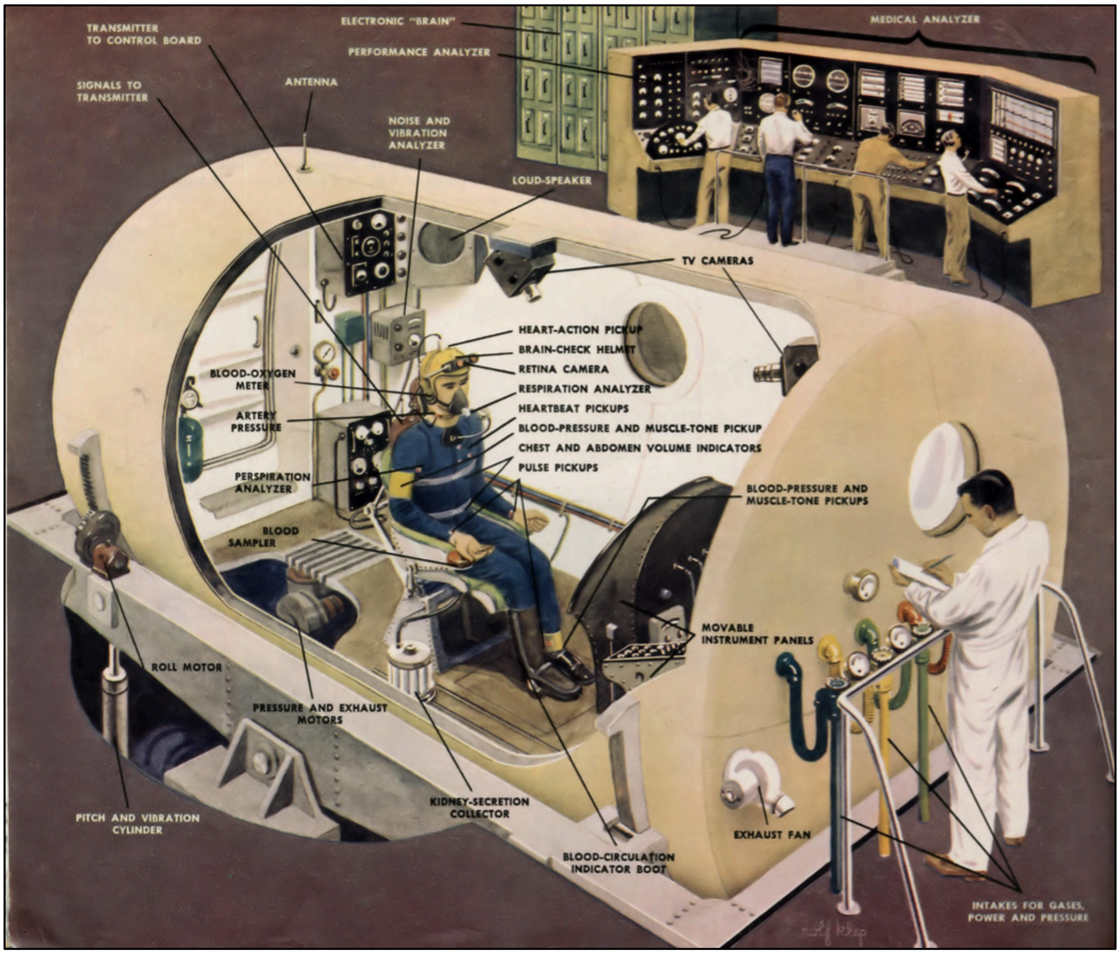

Figure 2: Illustration of the proposed "experimental sealed cabin" from *Collier's* (1953). (Source: (Source: Cornelius Ryan. "Man's Survival in Space" in *Colliers*. February 28, 1953. pp. 44).

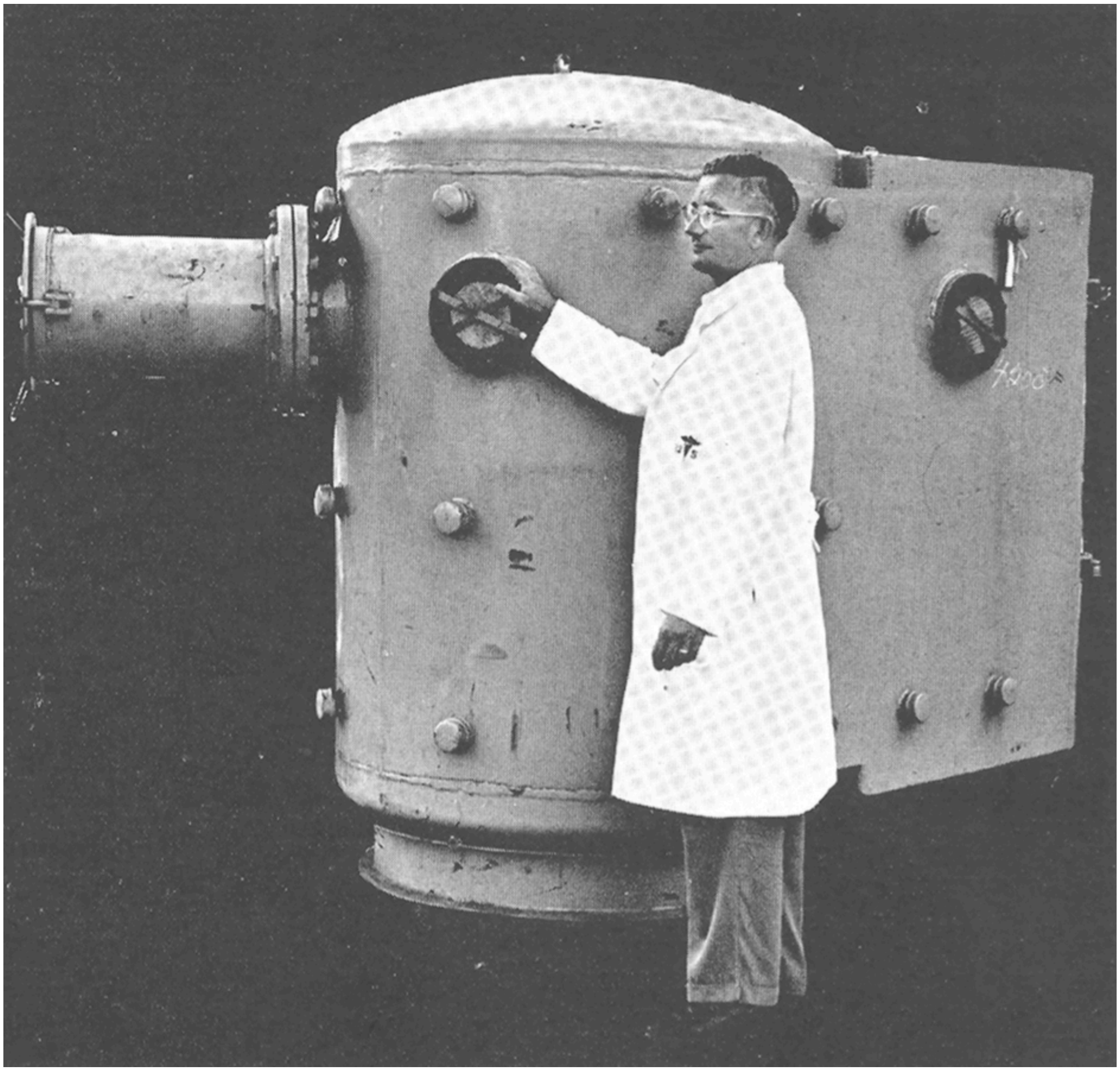

Figure 3: Strughold's German assistant Hans-Georg Clamann receives the experimental sealed cabin at the School of Aviation Medicine in August 1954. (Source: Space Medicine Association, online archive, 1954-1958).

Council, and again Strughold and Haber set to work on blueprints—this time for the real thing. Just like Von Braun's rockets, America's first space cabin was a German design.

In 1953, SAM issued a contract to the Guardite Corporation in Chicago to produce a one-person sealed cabin based on Haber and Strughold's design. Guardite was selected in part because of the company's experience manufacturing low-pressure chambers regularly used to train pilots. This new sealed cabin became the first tool created specifically for space medicine research and represented a transition in the nascent field from theoretical to practical work.

Also, in early 1953, Strughold introduced the space cabin concept to the public when he collaborated with Von Braun and journalist Cornelius Ryan on a famous series of articles in *Collier's* magazine aimed at convincing Americans that space travel was fast becoming a reality.[29] Strughold's cabin was trumpeted as one of many technologies required to "make a space man out of an earth man" (Figure 2).[30] "The chamber will be like the interior of a rocket ship—functional, pressurized and cramped." In more advanced versions, "ten to 15 men at a time will spend several consecutive weeks in the chamber, getting used to the cramped quarters—and to one another."[31] This grandiose vision guided by Von Braun's big thinking also stressed the need to select "superbly engineered" men for jobs in space, and that sealed cabins would be used not only as research tools, but also during selection and training "to pick the top men."[32]

In August 1954, Guardite delivered the sealed cabin to the School of Aviation Medicine. Strughold, away in Europe attending conferences, asked Hans-Georg Clamann, the School's German expert on artificial atmospheres who had served as Strughold's assistant back in the Luftwaffe days, to temporarily take over the job of installing the bulky, awkwardly-shaped contraption. (Figure 3) The only space available was the basement of SAM Research Building 661.[33]

The first 24-hour test with a human sealed inside the cabin occurred in April 1956. As the most senior member of the department, Strughold's role was to think broadly and identify lines of inquiry that younger staff could carry out experimentally.[34] So two younger American medical doctors, James G. Gaume, and Emanuel M. Roth joined him in the basement to closely monitor the run. The person they had selected—mainly because he was willing and available—was Dalton F. Smith, a nineteen-year-old Air Force technician who worked on the base and had volunteered. This initial 24-hour test was primarily to check the basic environmental systems, with the plan to further modify the cabin for their desired week-long tests. The doctors kept vigil outside the cabin, monitoring a tabletop setup of various instruments, while Smith read and slept inside. The main

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[29] Howard E. McCurdy. *Space and the American Imagination* Second Edition. (Baltimore: The Johns Hopkins University Press, 2011) pp. 46.
[30] Cornelius Ryan. "Man Will Conquer Space Soon: Man's Survival in Space: Testing the Men" in *Collier's* (March 7, 1953) pp. 57.
[31] Ryan, 63.
[32] ibid, 58; 63.
[33] Betty J. Evans (ed.) S*emi-Annual Historical Report – School of Aviation Medicine, USAF. 1 January – 30 June 1957* 24 (Randolph AFB: Air University, School of Aviation Medicine, 1957) pp. 52.
[34] Green Peyton. *50 Years of Aerospace Medicine: 1918-1968* (AFSC Historical Publications Series No. 67-180, 1968) pp. 180.

difference between this test and the future week-long tests was that Smith and the doctors could communicate freely via a telephone connection. A crucial detail of future tests was that the subject was not allowed to talk directly with anyone on the outside. Everything went as planned until the eighteenth hour. Smith—at this point struggling to stay awake—accidentally disconnected the carbon dioxide absorber and dozed off. Gaume and Roth knew something was wrong when their instruments began to show both the CO2 level, and Smith's pulse and respiratory rate, begin to rise.[35] Recognizing the potential danger, they used the telephone to wake Smith, and after some initial confusion—they later described Smith as "stuporous" and "very uncooperative"—guided him through the process of repairing the broken absorber connection.[36] Conditions soon returned to normal inside the cabin, and the first 24-hour test was competed without further incident.

FROM SEALED CABIN TO SPACE CABIN

After the first 24-hour test, the first thing Strughold wanted to change was the name. Few seemed to grasp the significance of a "sealed cabin" the way he did. For example, in August, 1954, Texas daily *The Victoria Advocate* described the cabin's awkward shape as, "more like a house furnace than a scientific device".[37] Likewise, in 1956, a writer for the periodical *Michigan Technic* called it "a cramped, dismal capsule".[38] Others struggled to convey its capabilities and specific purpose: "a complicated piece of non-flying apparatus" was one attempt.[39] "Enthusiasm for what we were doing was lacking," Strughold admitted in a 1961 interview with science writer Shirley Thomas. "Our sealed cabin did not attract sufficient interest. So I called in my two assistants and said to them, 'From tomorrow on, this cabin has another name. Officially, in all our papers or requisitions, this project is to be called the 'Space Cabin Simulator.'"[40] In addition to this, Strughold also encouraged the use of operational flight language when working with the simulator. Experiments

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[35] *School of Aviation Medicine, USAF, History, 1 July – 31 Dec. 1955* 21 (Randolph AFB: Air University, School of Aviation Medicine, 1956) pp. 35-36.
[36] *School of Aviation Medicine, USAF, History, 1 July – 31 September. 1959* 24 (Randolph AFB: Air University, School of Aviation Medicine, 1959) pp. 4.
[37] "Air Force Gets New 'Space Ship'" in *The Victoria Advocate* (Texas: Sunday, August 8, 1954) pp. 2A.
[38] Michael Kentosh. "The Human Body in Space" in *Michigan Technic* 73-74 (April, 1955) pp. 56.
[39] Peyton, 181.
[40] Thomas, 265. See also: Swenson, Loyd S.; James M. Grimwood; Charles C. Alexander. *This New Ocean: A History of Project Mercury*. (Washington, 1966) pp. 48.

were routinely called "flights" or "journeys", and the attending staff referred to as "ground crew"—even though no one ever left the basement.[41] These metaphors heightened the sense of realism in the simulations, and also helped the public relations effort. SAM press releases now advertised the duration of each "journey" as converted into Earth orbits, or the distance traveled to the Moon.[42] By focusing on simulating a voyage to the Moon, SAM scientists successfully predicted what would become NASA's goal throughout the 1960s. The "flight model" for these simulations was essentially sending a one-person Mercury-style capsule around the moon on an Apollo 8-style mission. An article that appeared in the August 1956 issue of *Popular Science* was more in line with how Strughold wanted his work described; Smith's 24 hour "flight" in "The Space Cabin Simulator" was "the time it would take to go one-third of the way to the moon."[43] By the time German-American space writer Willy Ley visited the Department on May 31, 1957, Strughold was quick to offer a tour of his "spaceship in the basement".[44]

These metaphors were central to the practice and popularization of early space experiments. In addition to renaming the device, Strughold also came up with an official-sounding name for the program: "Operation Terrella", meaning "little Earth".[45] "I called it 'Terrella' because we used the atmosphere like on earth, like on 'Terra'," Strughold reminisced during an 1982 oral history interview. "It is a small, little Earth, 'Terrella.'"[46] In his 1957 article "Living Room In Space", Strughold wrote that, "the sealed cabin is, in fact, a miniature replica of the Earth… a tiny planet built as the habitation of a single man in space."[47] Others shared this metaphor of the cabin as a separate "little world". In 1959, SAM official Paul A. Campbell called it a "little encapsulated

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[41] Steinkamp et. al., 16.
[42] This practice continues today with the Mars500 test being conceived and promoted as the number of days required to reach Mars.
[43] "Chamber Simulates Space Flight" in *Popular Science* (August, 1956) pp. 234. In Green Peyton's history of the School of Aviation Medicine, he describes the duration of Smith's "flight" as "comparable to about sixteen orbits around the Earth in a space craft". Peyton, 180.
[44] Ley, 65.
[45] Willard R. Hawkins; George T. Hauty. "Space Cabin Requirements As Seen By Subjects in the Space Cabin Simulator" in *Reports on Space Medicine – 1958* (Randolph AFB, TX: Air University, February, 1959) pp. 7n. "Terrella – term introduced by Dr. H. Strughold meaning 'Little Earth.' All simulator flights conducted at the School of Aviation Medicine, USAF, Randolph Air Force Base, Texas, come under Operation Terrella, and are numbered consecutively."
[46] Strughold, Hubertus "Institute of Texan Cultures Oral History Program: Hubertus Strughold" Ingrid Kokinda (interviewer), May 23, 1982. pp. 9. "Terrella" also appears to be a reference to the name sixteenth-century English natural philosopher and physician William Gilbert gave to small metallic spheres he constructed out of lodestone to simulate the Earth's magnetic field.
[47] Hubertus Strughold. "Living Room in Space" in *Epitome of Space Medicine: 1950-1957* (Randolph AFB: Air University, USAF School of Aviation Medicine, 1957) pp. 9.

world," and in 1961 future NASA flight surgeon Charles Berry wrote that, "the sealed cabin must be a complete synthetic world."[48]

Historian of science Peder Anker has shown how NASA research into sealed cabin ecology in the 1960s created the model for "Whole Earth" environmental perspectives in the 1970s, starting with R. Buckminster Fuller's famous conception of "Spaceship Earth" in 1969, upon which "we are all astronauts."[49] This metaphorical mixing of spacecraft and planet is very similar to Strughold's "Terrella", his view of the simulator as a "small, little Earth". As Anker nicely illustrates, Fuller expanded the military's sealed cabin to encompass the entire planet, arguing that the solutions of space capsule ecology were also solutions to environmental problems on Earth. This vision of a global sealed cabin created a new type of person: the citizen astronaut of Spaceship Earth, an environmental steward constantly thinking with a cosmic perspective, and in closed ecological loops. In 1989, within the frame of his so-called "overview effect", American engineer and author Frank White fashioned a name for this Earth-bound astronaut: "Terranaut".[50] If NASA's sealed cabin ecology resulted in the Terranauts of Spaceship Earth, what type of person did earlier USAF space cabin research suggest? To understand the subject created in this "synthetic world" it is helpful to sketch the interior systems and fixtures of the tiny space cabin simulator. But before we step inside the simulator, it is important to understand how the surprise of Sputnik boosted Strughold's space cabin.

SPUTNIK AND SPACE MEDICINE

Everything changed with the launch of Sputnik on October 4, 1957. The story of how the ensuing national outcry fast-tracked overall American space development is well-known.[51] Lyndon B.

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48 Campbell, 394; Berry, Charles A. "The Environment of Space in Human Flight" in *Epitome of Space Medicine* (Randolph AFB: Air University, USAF School of Aviation Medicine, 1957) pp. 10.

49 R. Buckminster Fuller. *Operating Manual For Spaceship Earth* (Carbondale: Southern Illinois University Press, 1968) pp. 14. Fuller, the inventor of geodesic dome architecture and a strong Navy supporter, was the first popularize sealed cabin ecology as a wider environmental concept to a large popular audience.

50 Frank White. *The Overview Effect: Space Exploration and Human Evolution*. (American Institute of Aeronautics and Astronautics Inc, 1998) pp. 70.

51 For a classic account, see Walter A. McDougall ... *The Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1984) pp. 141. For more recent scholarship, focused particularly on the impact of Sputnik on the course of American scientific and technological development, see: Audra Wolfe. "Big Science" in

Johnson, then the powerful Senate Majority Leader from Texas where the School of Aviation Medicine was located, quickly sprang into action, making sure every American understood that Soviet space feats also advertised threatening new nuclear capabilities.[52] "Our country is disturbed over the tremendous military and scientific achievements of the Soviets", Johnson roared when convening his high-profile Senate Inquiry into Satellite and Missile Programs a little over a month later.[53] America's response was an unprecedented government investment in science, technology, academia and the military. This heady new epoch in American space science put to end the days of Strughold begging after a single machine, and promptly got the space cabin simulator taken up out of the basement.

The SAM's bi-annual report for July-December 1957 records the impact of Sputnik: "developments abroad, namely; the launching of the first Russian satellite, brought about a complete reversal of the austerity measures."[54] The department was reorganized, enlarged, and moved to new quarters at the south end of Randolph. This meant hauling the unwieldy simulator from the basement of Building 661 and re-installing it on the more spacious main floor of Building S-760.[55] Strughold was made "Advisor for Research" to the school's commandant, General Otis O. Benson Jr., and former SAC flight surgeon George R. Steinkamp became head of the Department of Space Medicine, taking over day-to-day work with the space cabin simulator.

Now in the Sputnik spotlight, the School was inundated with more interview requests than they could handle. Americans were anxious that they were also behind the Soviets in space medicine. By December, 1957, Strughold was reassuringly enumerating his research program to the readers of *The New York Times* in an interview titled "Expert Sees Man Ready For Space."[56] The article included a large photograph of Strughold posed at the simulator's open hatch. In a set of three articles prepared for United Press International Dallas, SAM commandant Benson

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Competing with the Soviets: Science, Technology, and the State in Cold War America. (Baltimore: Johns Hopkins University Press, 2013) pp. 40-54.

[52] McDougall, 141.

[53] ibid. For the American political response to Sputnik, see McDougall chapter 6: "A New Era of History and a Media Riot", 141-156, and McCurdy, 71. McCurdy notes that "Majority leader Lyndon B. Johnson assembled a Senate preparedness investigating committee that held hearings from November to January and issued recommendations to strengthen the nation's missile and satellite programs." pp. 71.

[54] "Department of Space Medicine – School of Aviation Medicine" (San Antonio: School of Aviation Medicine, 1958) pp. 4. Another SAM report from December, 1957, notes that, "Intensified international interest in the fields of satellites, missiles, and other space vehicles led to increased emphasis on the work of this department. It underwent a considerable physical expansion during this six-month period." Evans, 1958, 52.

[55] Evans, 52. Peyton, 182.

[56] Harold M. Schmech Jr. "Expert Sees Man Ready For Space" in *The New York Times* (November 12, 1957) pp. 22.

confirmed that "if we were asked right now to provide a liveable cabin for a craft built to operate in outer space, we could write specifications which the engineers would be able to meet."[57]

Political attention from Washington soon followed. On Christmas Eve 1957, Strughold found himself providing a statement to Johnson's committee, explaining why space medicine research had not progressed faster, and what could be done to accelerate the program.[58] To dispel the implication that he and his department had been sitting on their hands, Strughold pointed to the space cabin simulator. "For the past two years in a special space cabin simulator at the School of Aviation Medicine, experiments have been made to keep [a human] alive in an artificial atmosphere in a sealed cabin."[59] Referencing a recent, well-publicized news story he hoped the politicians had read about, he noted that work in the SAM simulator had contributed to USAF Major David G. Simons's 32-hour "Manhigh" high-altitude balloon flight, which ascended to 101,516 feet (well into Strughold's region of functional space equivalence).[60] In early 1958, Strughold responded to a similar prompt from Johnson's newly-minted House Select Committee on Astronautics and Space Exploration, noting that "a great deal of research has been devoted to human engineering of the space cabin as carried out in space cabin simulators."[61] The simulator was held up as a symbol of the USAF's space medicine competencies to politicians, the press, and public.

The reaction to Sputnik also helped get a long-awaited relocation and expansion of the School back on track. A new all-encompassing "Aeromedical Center" (later "Aerospace Medical Center") had been approved by Defense officials back in 1949, and a new site at nearby Brooks Air Force Base, only sixteen miles from Randolph Field, was selected for development.[62] However, congressional will to fund the massive move and build languished, and by the time ground was broken in May, 1957, many of the planned facilities including an onsite hospital, library, and special laboratories had been cut.[63] The new fervor around space science helped Johnson, a long-time champion of the Texas-based School, restore the full vision.[64] On November

[57] "One of three articles on SAM prepared exclusively for the United Press International Dallas" (Office of Information Services, School of Aviation Medicine, U.S. Air Force, 6 October, 1958) pp. 6.
[58] "Department of Space Medicine – School of Aviation Medicine", 5.
[59] ibid, 5.
[60] ibid, 5.
[61] Hubertus Strughold. "Space Medicine and Astrobiology" (Washington, DC: Report to House Select Committee on Astronautics and Space Exploration, 1958) pp. 2-3.
[62] Peyton, 160.
[63] ibid, 160.
[64] Lawrence E. Lamb. *Inside the Space Race: A Space Surgeon's Diary* (Austin, TX: Synergy Books, 2006).

14, 1959, Johnson personally dedicated the new facility at Brooks, warning in this speech that "space is not a side street of the security of the West. Space is the main street of freedom's survival."[65] With new facilities and newfound funds came plans to scale-up the simulator. In 1957, Honeywell was contracted to build a two-person version, which they delivered to Brooks in 1959.[66]

Back in in *The New York Times* in December, 1957, Strughold stated that the tiny one-person simulator at the School's present Randolph Field location was finally ready for a week-long test. Within the next two months, he promised, someone would attempt a seven-day "flight to the moon and back."[67] But who would that be, and what would it be like inside?

SPACE CABIN ECOLOGY

In early 1958, Hans-Georg Clamann, the School's German expert on atmospheres, summarized the work of the space cabin simulator's environmental system: "Basically, the task of keeping a person alive in a hermetically sealed cabin seems simply to consist of providing enough food, water, and oxygen on one side, and on the other, to remove feces and urine and to absorb carbon dioxide, water vapor, potentially harmful gases and odors."[68] For these problems, Strughold and Clamann reduced the human to an energy and gas convertor requiring supplies and countermeasures.

During the early Cold War, keeping humans alive in small, dispersed, self-contained, artificial environments became an urgent concern for military medicine. Space vehicles joined the fleet of other interconnected Cold War technologies designed to fight and survive a nuclear war, including command bunkers, missile silos, submarines, and fallout survival shelters. Underground, underwater, in the arctic, or in orbit, Americans could not rely on Earth's environment to sustain them in these newly-strategic places.[69]

Synergy Books, 2006) pp. 89.

[65] Lamb, 92-93.

[66] Betty J. Evans. (ed.) S*emi-Annual Historical Report – School of Aviation Medicine, USAF. 1 January – 30 June 1957* 24 (Randolph AFB: Air University, School of Aviation Medicine, 1957) pp. 100.

[67] Schmech, 22.

[68] Hans G. Clamann. "Continuous Recording of Oxygen, Carbon Dioxide and Other Gases in Sealed Cabins" in *Journal of Aviation Medicine* 23 (August, 1952) pp. 330-333..

[69] For a history of human factors engineering approaches to enclosed spaces in extreme environments in the Cold War including Sealab and Skylab, see: Layne Karafantis. "Sealab II and Skylab: Psychological Fieldwork in Extreme Spaces" in *Historical Studies in the Natural Sciences*, 43. (No. 5, 2013) pp. 551-588.

"Containment" was also the U.S. military's broad strategy for opposing Soviet expansion. Developed by American diplomat George F. Kennan and made policy by President Harry S. Truman in 1947, the plan required the United States to develop the means to check Soviet imperialism anyplace on the planet. This resulted in an array of globally-scaled technological systems of surveillance and control that physically and metaphorically encircled the Earth. Historian of technology Paul N. Edwards has characterized this network of ideas and machines as "the closed world".[70] As Edwards points out, the Cold War was the first to be fought from "sealed claustrophobic spaces", like Strategic Air Command. Just as the threat of imminent nuclear attack resulted in the decentralization of populations, the fear of losing the ability to launch a counter-attack led experts to advocate the geographic dispersal of the nation's nuclear arsenal to remote locations. Many of these required a "containment" of their own, a self-contained artificial environment to keep a human operator alive.

Edwards shows how computers became central to both the physical and discursive architecture of the Cold War, attending to both their social construction, and how they constructed new social worlds, structuring human thought and action around metaphors of information and computing. In this context, the sealed cabin research at SAM should not be viewed in isolation, but within what Wiebe Bijker calls a "technological frame"—a "combination of concepts, theories, goals and practices used by groups attempting to solve technological problems."[71] The space cabin simulator was conceived as part of a larger vision of national security, nuclear war, and the USAF's anticipated role in in space: soldiers spying from orbit, weaponized space planes, and a lunar base. This tiny closed world was part of Edwards's larger closed world.

For Strughold and Clamann, the task of maintaining a human inside a tiny sealed-off world was complicated by significant size and weight restrictions. Early Cold War rockets like the Army's Redstone were designed to lift nuclear warheads, not cumbersome sealed cabins, so an ever-present economy of weight informed many aspects of space vehicle design. Most importantly for Clamann, this meant thinning the atmosphere inside. The idea was that a low-pressure atmosphere would reduce the mass of the structure required to contain it, resulting in an overall lighter craft. From their work in Germany, Strughold and Clamann knew that humans could survive in a range

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[70] Edwards, xiii. Wiebe Bijker. *Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change*. (Cambridge, MA: The MIT Press, 1995).
[71] ibid, 33.

of different pressure environments. Here they wanted to secure what they called the “physiological minima”—the lowest point the pressure could be without producing negative effects for the subject. Their answer, based on years of studying pilots in low pressure chambers, was 380 mm Hg, equivalent to 18,000 feet in altitude. However, this required altering the ratio of gases. The concentration of oxygen—normally 21% at sea level—was increased to 40% to compensate. In 1967, the composition of spacecraft atmospheres became a major issue at NASA when the investigation into the fatal Apollo 1 fire found that the command module’s 100% oxygen environment had fueled the deadly inferno that engulfed the crew in under ten seconds. Even at 40% oxygen back in 1957, SAM staff worried about, “the fire hazard from a random spark or short circuit in the cabin’s wiring or equipment.”[72]

[72] Peyton, 179; Ley, 67. When Strughold tried to convince Ley that “there is no greater hazard that a fire may start just because there is more oxygen,” Ley included an ominous caveat: “But once a fire has started, the rate of combustion is much faster.” (Ley, 67) Only days after the fatal Apollo 1 fire in 1967, two test subjects (William Bartley Jr. and Richard G. Harmon) were killed in a sealed cabin fire at the School of Aerospace Medicine at Brooks Air Force Base. See Peyton, 251-252.

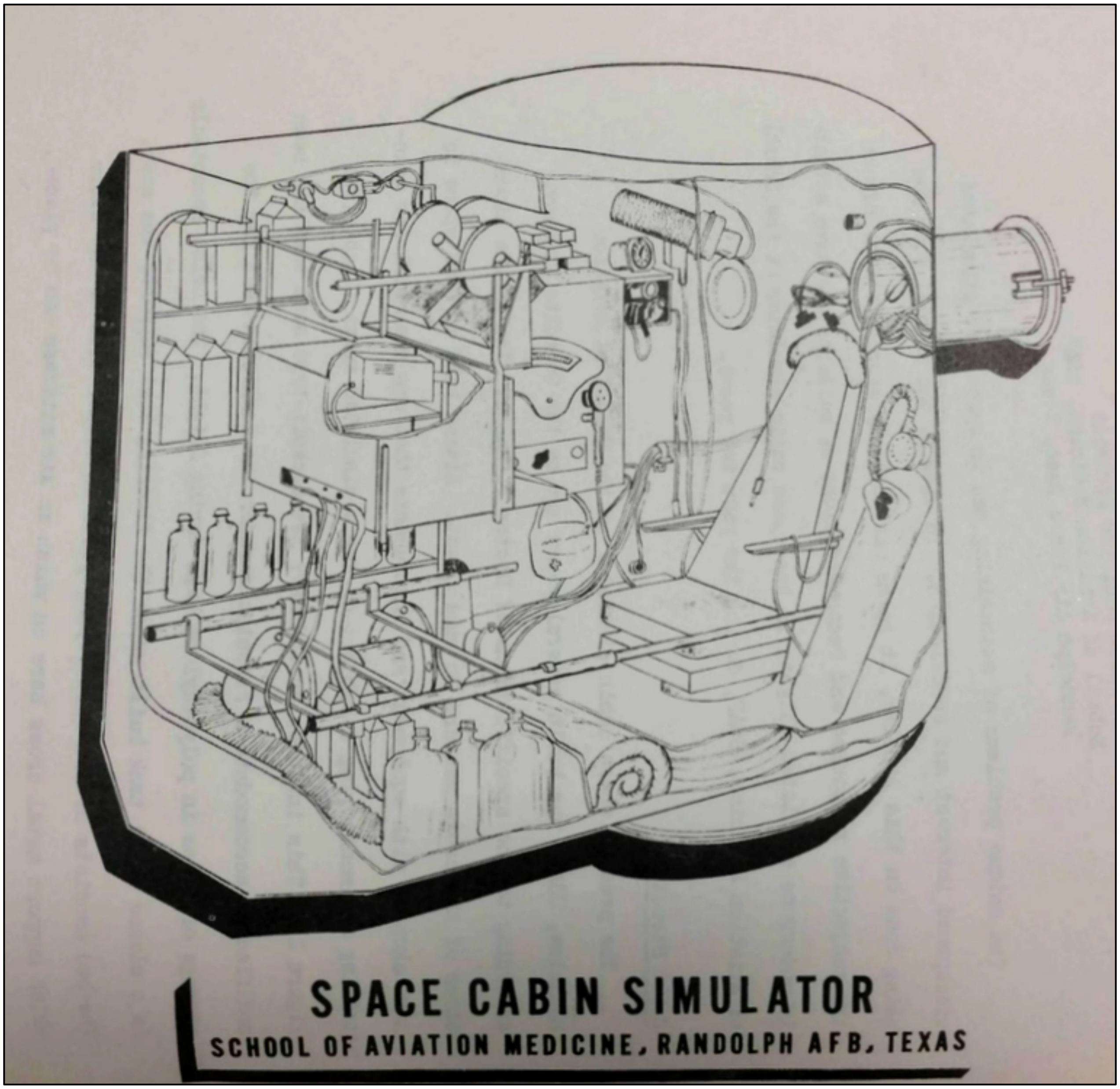

Figure 4: A cut-away illustration of the SAM Space Cabin Simulator based on Strughold and Fritz Haber's design. Note the CCTV camera facing the seat, and long support bars for the air mattress. The hatch, normally at left, is obscured by the cut-away. (Source: Willard Hawkins; George T. Hauty. "Space Cabin Requirements as Seen by Subjects in the Space Cabin Simulator" in *Reports on Space Medicine: 1958.* San Antonio: School of Aviation Medicine, 1959. pp. 2).

Another environmental threat came from the build-up of carbon dioxide. In 1956, the school commissioned a long-running study conducted by Arizona State University microbiologist Jack Myers on using algae as a gas exchanger to convert exhaled carbon dioxide back into breathable oxygen—a true self-sustaining loop. In the meantime, Strughold recommended the use of chemicals for absorbing excess CO2, eventually settling on a system utilizing Baralyme, which the subject inside needed to replenish periodically. The buildup of heat and humidity in the cabin was controlled by an air conditioning system.[73] Bulky analyzers kept Strughold and Clamann informed about any changes to the ratio of gases inside.

After his visit to SAM in May 1957, Ley struggled to convey the simulator's odd shape to his readers: "The main part of it is a wide steel cylinder standing on end. In front, a boxlike shape is attached to this cylinder. You enter through this section."[74] The entrance he was referencing was a rectangular metal hatch with a large wheel at the center, like something off of a submarine. Once inside, it was a claustrophobic experience. Completely empty, the cabin contained about 96 cubic feet of space, but filled with all the fixtures and instruments this was effectively reduced to 50 cubic feet. Practically, this meant that the lone subject could sit, and stretch out into a sleeping position, but not stand up or walk around.[75] Cramped to say the least, 50 cubic feet was actually the estimated size of the interior for early space capsules and was comparable to the limited space afforded Mercury and Gemini astronauts.[76]

For keeping an eye on the subject, a closed-circuit television camera was installed facing the seat, along with a still camera that could be programmed to automatically snap photographs at regular intervals. Six peephole-like viewing ports, that could only be opened by sliding a covering on the outside, dotted the walls of the cabin, offering the ground crew a one-way view in. There were no windows, as they wanted the subject to experience the effects of isolation. The interior was brightly lit at all times "to maintain a constant level of illumination throughout the flights for photographic documentation and TV monitoring of the subjects."[77] The subject was supplied with a sleep mask.

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[73] Steinkamp, 372.
[74] Ley, 66.
[75] Hawkins and Hauty, 3.
[76] ibid, 3 "In terms of early space flights, 50 cubic feet would seem to be a realistic figure." NASA astronaut Michael Collins famously compared his tiny two-seat Gemini capsule to living in the front seat of a Volkswagen. For fellow Gemini astronaut Pete Conrad, it was "eight days in a garbage can." See: W. David Compton; Charles D. Benson. *Living and Working in Space: A NASA History of Skylab*. (Mineola: Dover Publications, 2011).
[77] Hawkins and Hauty, 13.

A modified cockpit seat facing the hatch was where the subject spent the vast majority of their time. For rest periods, two telescoping arms could be extended from its base to support an inflatable air mattress. Removing the seat's cushion revealed the simulator's toilet. Feces were sealed inside polyethylene bags (a similar method was used during NASA's Apollo flights) and stowed in the base of the chair. Urine was collected separately in bottles and also stowed. Odor was a common complaint.

Directly in front of the seat was a television monitor mounted on an array of switches—together called the "instrument panel". This provided simulated work for the subject. To the left of this was the "command panel", a series of indicator lights arranged on a board in a four by six grid, each one corresponding to a different task in the cabin. To the right of these fixtures was a port where the subject connected the leads to their biomedical monitoring apparatus. The cabin was also equipped with an aircraft-type microphone that the subject used to transmit one-way reports every eight hours.[78]

Sealed inside, the subject was completely surrounded by technology, enclosed in a totally artificial environment, cut off from the rest of humanity, with their only interaction being with the command and instrument panels. Without the veneer of Strughold's operational space metaphors, "Terrella" quickly seemed like a high-tech prison cell, an angle captured by a 1958 *LIFE* magazine photo-spread titled "Man Alone in His Space Cage."[79] It was this subjugation of man to machine that made Lewis Mumford worry that Project Mercury was a preview of a dystopian technocracy, in which automation would drastically reduce human agency. In *The Pentagon of Power*, he described Alan Shepard, the first American in space, as "the archetypical proto-model of Post-Historic Man, whose existence from birth to death would be conditioned by the megamachine, and made to conform, as in a space capsule, to the minimal functional requirements by an equally minimal environment—all under remote control."[80] This passage captures some of the broad aspects of life in the simulator that carried over into Project Mercury and later spaceflights: isolation, automation, and surveillance.

[78] Steinkamp, et. al include a "sample transmission": "SAM cabin to ground. The humidity is 56 percent; the temperature is 80F.; body temperature, 98.6. Over and out." Steinkamp, et. al., 29.
[79] "Man Alone in His Space Cage" in *LIFE* (March 3, 1958) pp. 97.
[80] Lewis Mumford. *The Myth of the Machine: The Pentagon Of Power* (San Diego: Harcourt Brace, 1970) pp. 14.

THE HUMAN COMPONENT

For physiologists, the subject was an energy and gas converter, but for the team of SAM psychologists led by Siegfried Gerathewohl, the human was also an information processor linked to electronic spacecraft systems. Putting a human "in the loop" raised uncomfortable questions about what exactly their role should be, and whether this would raise or lower the overall reliability of the system. Gerathewohl, who had worked for the Luftwaffe and BMW before Operation Paperclip landed him in Texas, was not optimistic; his overarching concern was human error. He pointed to a recent Stanford Research Institute study of American missile system operators which found that "50 per cent of all malfunctions reported were initiated by human beings."[81] He was doubtful that humans could function reliably under the psychological stresses of isolation, confinement, and monotony without some degree of degradation in their work over time.[82] Gerathewohl was assigned the task of designing a routine for the cabin subject including simulated work that could act as a gauge of "vigilance".[83]

By seeking to instill and measure vigilance, the simulated work figured the astronaut as a passive systems monitor, rather than an active controller. In *Inventing the American Astronaut*, Hersch shows how the Mercury Seven positioned themselves as active "pilots flying the capsule", as opposed to the notion that they were mere passengers. In *Digital Apollo*, David Mindell examines how daredevil military test-pilots evolved into the passive systems monitors and computer repairmen of the Apollo Program.[84] This nagging question of what role the astronaut should play in the spacecraft system was part of the wider debate over automation and defense systems in

[81] Siegfried J. Gerathewohl. *Principles of Bioastronautics* (Englewood Cliffs, NJ: Prentice-Hall, 1963) pp. 470.
[82] Gerathewohl, *Principles of Bioastronautics*, 466.
[83] Hauty, 409.
[84] Mindell, 29.

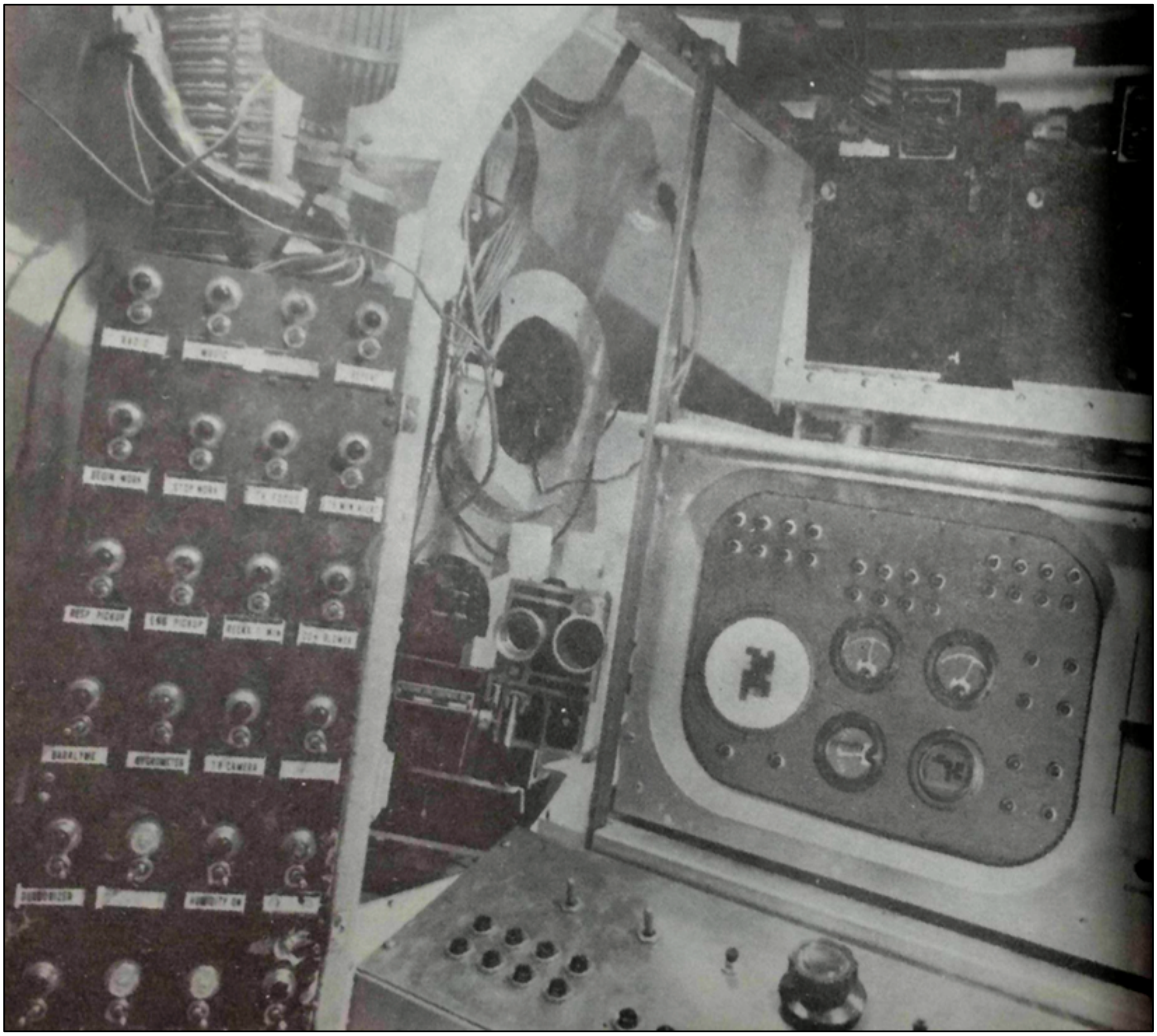

Figure 5: The subject's view from the simulator's seat. To the left is the "command panel" where orders were received, at center is the "instrument panel" on which simulated work was performed. (Source: George Steinkamp; et. al. "Human Experimentation in the Space Cabin Simulator: Development of Life Support Systems and Results of Initial Seven-Day Flights" San Antonio: School of Aviation Medicine, Report. pp. 12).

the 1950s and 1960s. Should control of America's nuclear weapons be trusted entirely to humans, entirely to machines, or a combination of both?

To Gerathewohl, Strughold added the expertise of Americans George T. Hauty, and Bryce O. Hartman, both psychologists working at the School on problems of fatigue and diurnal variation. "The astronaut is not going to be a space vehicle 'pilot'" Hartman wrote bluntly in 1958.

"He is going to function as the operator of a complex, semi-automatic system."[85] Hauty observed that traditional pilot skills, like "the coordinated manipulation of stick, rudder bar, and throttle" were no longer needed. "At present, advances in mechanical, hydraulic, and electronic supplementary systems have reduced these functions essentially to those of information processing and decision making."[86] Hauty framed the issue of human fallibility in engineering terms; the human was not merely a "biological test specimen" but "an integral component for performing the functions of monitoring, information processing, and decision-making."

Hartman explained that Hauty's key contribution here was to reframe the question of human error as one of component reliability in a technological system.[87] In early 1958, Hauty warned that if given "highly repetitious work… the human could become the most aberrant component."[88] Hauty had spent years studying how and when humans broke down. Previously, he had made groups of military volunteers monitor simulated aircraft controls and radar screens for extended period of time. Staring at these objects for hours on end, Hauty's subjects eventually reported vivid hallucinations. One recalled that "the instrument panel kept melting and dripping to the floor."[89] Another said that "the bank indicator showed a hippopotamus smiling at me."[90] Gerathewohl did not think the SAM's space cabin would produce such dramatic results, but still worried about the steady build-up of minor annoyances. For a human parked in orbit for days or weeks, "anxiety, irritability, overload, lack of communication or understanding" could produce absentmindedness, impaired judgment, and delayed decision making.[91] However, under Hauty's 'system component' conception, anything that affected the human—physiological or psychological—affected the entire system. Gerathewohl agreed, writing that "testing of the human-factors components is undoubtedly as critical as the testing of any hardware."[92] For Hauty,

[85] Hartman, Bryce O. "Experimental Approaches to the Psychophysiological Problems of Manned Space Flight" in *Lectures in Aerospace Medicine, 1961* (San Antonio: School of Aviation Medicine, Brooks AFB, 1961) pp. 15.
[86] George T. Hauty. "Human Performance in the Space Travel Environment" in *Reports on Space Medicine – 1958* (Randolph AFB, TX: Air University, February, 1959) pp 1.
[87] Hartman, 12. In this sense, they were engaging in what Edwards refers to as "cyborg discourse", the conceptualization of humans and machines in similar terms, first envisioned by MIT mathematician Norbert Wiener in 1948. The broad purpose of this, Edwards notes, was to facilitate the integration of humans into complex technological systems, so that together they could function as "one seamless web." Edwards, 1-2.
[88] Hauty, 8.
[89] ibid, 7.
[90] ibid, 7.
[91] Gerathewohl, 471.
[92] ibid, 471.

it was crucial that the entire system—human and hardware—be tested together as a total system.[93] George Steinkamp, the new head of the Department of Space Medicine, summed up the role of the human in the space cabin simulator: "In these flights, more is required of subjects than to serve as passive physiologic specimens. They are committed as an integral component of a man-machine system."[94]

But what job, exactly, did they decide on for their subject? The simulated work the psychologists designed took two main forms. The first involved different monitoring tasks on the instrument panel. The subject had to solve simple problems displayed on the television monitor by "pressing buttons and depressing gauges."[95] (Figure 5) Similar to a complex coordinator test, the practice assumed that "the monitoring of instrumentation will be the chief task of the man in a space vehicle."[96]

The other bit of simulated work was a simple, repetitive, pencil-and-paper math test selected by Gerathewohl to measure degradation in attention and proficiency over time. In Germany during the 1930s, one of Gerathewohl's colleagues, the Luftwaffe aviation psychologist Heinrich Lottig, developed a writing test to gauge the onset of hypoxia in human subjects in low-pressure chambers. In psychology, the adding of strings of digits had been used in various forms for years as an "attention test". After considering tests by American and Japanese psychologists, Gerathewohl decided to use the Kraepelin Test, named for the influential German psychiatrist Emil Kraepelin who invented it in 1902. Kraepelin's legacy as founder of the modern classification of mental illnesses, as well as his advocacy for eugenics and racial hygiene—which included training Ernst Rüdin, the architect of the Nazi forced sterilization program—was apparently not known to the American space cabin subjects, who simply referred to it as "the math test."[97] In the test, subjects were given a sheet of paper containing 80 vertical columns of 51 randomly-selected single digits between 2 and 9. The subject added the first two numbers together, then took the resulting total and added that to the next number in the sequence, and so on. Any time the sum exceeded 9, the 1 from the tens column was dropped, so in effect the subject continually added numbers between 1 and 9 over and over. The test lasted exactly one hour. Every three minutes the subject

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[93] Hauty, 1.
[94] Steinkamp, et. al., 1.
[95] Steinkamp, 372.
[96] ibid, 372.
[97] Siegfried J. Gerathewohl. "Work Proficiency in the Space Cabin Simulator" in *Journal of Aerospace Medicine*, 30 (October, 1959) pp. 724.

was told to underline their current result so that their proficiency (conceived of as "performance vs. stress") could be graphed over time. Gerathewohl liked the test because he considered it to be "particularly sensitive to changes in proficiency at a long monotonous task."[98]

There would be no normal day/night distinction in the simulator (or in actual space), so Gerathewohl and Hauty decided to radically alter the subject's work/rest cycle. Instead of a normal twenty-four hour schedule, once inside the simulator the subject's life became an eight-hour cycle: four hours work, followed by four hours rest. Alternating this way, the subject completed three work/rest cycles in a twenty-four hour period.

The subject was prompted to switch between work, rest, and other tasks by the light-up "command panel" next to the "instrument panel". Controllers on the outside pressed a button associated with the next desired task, and a corresponding light lit up on the command panel inside. The subject then pressed a button next to the light to acknowledge the command. Some of the options on the command panel could be used for a rudimentary form of communication. For example, one of the 22 "commands" was labeled "I'm O.K."; "When this light is turned on by the station [ground crew] it is asking the question 'Are you alright?' If your answer is *yes* turn off the light. If not, explain over your microphone."[99] Another, labeled "Repeat" could be activated by the subject, prompting the team outside to resend the command. During the work or rest periods, the subject could touch a button marked "Music" to have the ground crew pipe in selections picked in advance by the subject. As Hauty noted in one of his reports, "All the subjects enjoyed music during the work period but soon found that their favorite recordings were highly irritating as they were repeated."[100] This was all in lieu of direct verbal communication. The idea behind the total communications blackout was to see how a person would fare without human contact for extended periods of time.

In preparation for the beginning of the work period, a rousing alarm sounded with one hour to go in the rest period. This let the subject know they had 30 minutes to wash, use the toilet, and prepare and consume a meal. This was followed by another signal indicating that the work period would commence in 15 minutes. 60 seconds later, another signal is given to change the Baralyme in the CO2 absorber system. Another light then prompted the subject to use the aircraft-style

[98] Hartman, 13.
[99] "SAM history July-September 1959", 30.
[100] Hawkins and Hauty, 10.

microphone to deliver a quick verbal report of the cabin temperature, their oral temperature, and the relative humidity. At the top of the hour, the "Begin Work" signal was given and at the same time the monitor on the instrument panel was activated from the outside. Four hours later, the signal was given to stop work, and a three hour uninterrupted rest period began. Once every three cycles a special "Emergency" alarm was sounded, which simulated a hull breach by a micrometeor. The subject was required to quickly don a special mask connected to a portable tank of oxygen and monitor the pressure inside the cabin. Also, once every three cycles the final hour of the work period was devoted to taking the Kraepelin Test.[101] Among subjects, there were varying degrees of acceptance of this "4:4" work/rest cycle. Two subjects reported they could continue indefinitely, while another, on the second day of the week-long test became disorientated and could not determine if he had been in the simulator for two days or six days. Eventually, he resorted to counting his discarded meal containers, to discover, to his dismay, that he still had five days remaining.[102]

The social world constructed for the subject in the system was bleak in its automation and many limitations. With their actions determined by the light-up command panel, the subject was being conditioned to obey automatic signals, not necessarily coming from another human. It would not have taken much to simply eliminate the "ground crew" and connect the subject's command panel to a computer. In fact, the design of the cabin ensured that the subject inside would be unable to perceive the difference. Similar to Michel Foucault's discussion of Jeremey Bentham's famous panopticon, the subject's knowledge that they were under constant visual, audio, and biometric surveillance, meant that they would conduct themselves as such even if no one outside was actually watching, or even present. In this way, there was a tremendous imbalance of power between the ground crew and the subject. The occupant of the space cabin was paradoxically isolated but never alone.

In the popular imagination of Cold War America, spaceflight was figured by some as a utopian solution to the technological problems of the day—a means of escaping the nuclear showdown that threatened the planet. This vision of life in space drew on American Manifest

[101] The itinerary as given in Steinkamp et. al.: 0810: Alarm; 0845: 15-minute alert; 0846: Baralyme change; 0855: Report; 0900: Begin work; 1300: Stop work; 1301: Emergency; 1305: Off duty; 1610: Alarm; 1645: 15-minute alert; 1646: Baralyme change; 1655: Report; 1700: Begin work; 2100: Stop work; 2101: Off duty; 0010: Alarm; 0045: 15-minute alert; 0046: Baralyme change; 0055: Report; 0100: Begin work; 0500: Stop work; 1501: Off duty; 0810: Alarm." Steinkamp el. al, 17.
[102] ibid, 23.

Destiny and promised increased freedom, opportunity, and prosperity, as new worlds were opened up by unfettered exploration and colonization, just like the American West. But the practices developed in and around the space cabin simulator offered stark contrast. Rather than escaping threatening technological systems, astronauts were cocooned within one, conditioned to obey commands stripped of any trace of humanity. Rather than freedom and autonomy, Strughold and the SAM doctors' vision of life in space required total submission to a rationalized technological existence.

SPACE CABIN SUBJECTS

What type of person did this device and its regimen produce? Alongside the debut of the space cabin simulator in the 1953 *Collier's* series, space medicine experts set the human standards for space astronomically high. Strughold predicted that the job of astronaut would be extremely competitive: for every 200 applicants, 199 would be eliminated. The "top men" left standing would possess a "degree of perfection", meeting rigid physical, psychological, educational, and age requirements. "He must be between the ages of twenty-eight and thirty-five; he must have a college education; he must be of medium weight, and between five feet five and five feet eleven inches tall."[103] According to the article, successful candidates then embarked upon five years of training including graduate level classroom instruction in "rocket and instrument design, physics, astronomy, navigation, and basic medicine."[104]

Unlike Von Braun's grand vision of military exploration and colonization, laid out in the rest of the *Collier's* series, the cramped one-person space cabin simulator Strughold eventually built evoked a more modest, even more militaristic vision of humans in space.[105] By 1956, space medicine experts assumed that the capsule would be part of a weapons system, and that it would be manned exclusively by USAF officers—soldiers. In early 1958, just months before NASA was established as a civilian agency, Steinkamp wrote, "It is reasonable, also, to assume that for many

[103] Ryan, 57.
[104] ibid, 57.
[105] For Von Braun's vision, see Michael Neufeld. *Von Braun: Dreamer of Space, Engineer of War* (New York: Alfred A. Knopf, 2007) pp. 277.

years to come space flight will be more or less a military controlled operation."[106] A SAM research report written in the wake of Sputnik describes the "biologic problems anticipated in manned space vehicles" as "problem areas pertinent to current and future weapons systems."[107] In late 1957, Hauty drew parallels between "Human Performance in the Space Travel Environment" and "the concomitant evolution of human functions required by manned weapons systems."[108] Of future astronauts, Hartman wrote, "he is going to function as the operator of a complex, semi-automatic system in a manner much like operators of many other advanced weapons systems."[109] Anker has shown how space cabin environmental systems heavily resembled those also in submarines, missile silos, command bunkers and fallout survival shelters.[110] The same could be said for the human—a Cold War technological subject was constructed along with these small, enclosed, instrumented spaces. In this early moment, when the Air Force was seriously contemplating "The Military Potential of The Moon" as a missile silo, the space cabin occupant was assumed to be a button-pushing solider, either an alert reconnaissance officer, watching a radar screen for evidence of enemy activity, or an ever-vigilant launch control officer, ready to unleash a warhead at the illumination of an indicator light.[111] This dark vision conjured up by the space cabin scientists extended beyond missilemen targeting warheads from low earth orbit, and may partly explain the lunar destination of the simulations. Gerathewohl found Von Braun's grand paradigm unrealistic, but still assumed a permanent Air Force presence would soon be established beyond the Earth. "Although it seems improbable that much larger settlements will be erected on the Moon, bases of a limited size will definitely be set up."[112]

Before it was even built, the sealed cabin was assumed to be a military, and therefore masculine, space. Rachel N. Weber has shown how USAF cockpit simulators designed exclusively for men ended up effectively excluding women from jobs as fighter pilots even after the official ban against them was lifted.[113] When Strughold introduced the simulator in *Collier's*, the piece included the bold headline "Reasons for Ban on Women." Women, he wrote, "won't go along on

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[106] Steinkamp, 375.
[107] Evans, 31.
[108] Hauty, 1.
[109] Hartman, 15
[110] Anker, 239.
[111] S. E. Singer. "The Military Potential of the Moon" in *Air University Quarterly Review*, 11 (No. 2, Summer 1959) pp. 31.
[112] Gerathewohl, 466. During this same period, the Air Force was secretly drawing up plans for "Project Lunex", a permanently-manned Air Force base on the Moon.
[113] Weber, 372.

interplanetary journeys, where privacy will be lacking for long periods. So they'll take the chamber tests separately, and briefly, in preparation for the shorter flights they will make."[114] In reality, it ended up being worse than that. No women were ever tested in the SAM space cabin simulator. The only surviving photograph of a woman in the simulator is a gag shot taken years after the last tests: an aging Strughold sitting inside, with his arm playfully draped around space writer Shirley Thomas. It was emblazoned on the back of volume four in her popular *Men of Space* series, which included her treatment of Strughold, by then known in America as "the Father of space medicine".[115]

Access to the space cabin simulator was limited to military men, but what types of men? The German aviation experts who founded the Department of Space Medicine were obviously most familiar with pilots. But they also studied a number of other analog situations for insight into what life in a tiny, artificial capsule might be like. For Strughold and his colleagues, the practice of testing humans in low-pressure chambers was routine. While the set-up was superficially similar (person sits in sealed box), the purpose was opposite. Low-pressure tests were meant to study deleterious reactions to extreme altitudes. The job of the space cabin was to maintain a habitable environment free from negative physiological and psychological effects. In this sense, the subject was similar to the occupant of a submarine—inhabiting an enclosed, artificial, military-oriented environment, like that on the USS *Nautilus*, the first nuclear powered submarine launched in 1954. That same year, Strughold acknowledged that "a sealed cabin in space resembles a submarine in many respects," but he also highlighted key differences. Simply extrapolating from years of Navy research was not enough.[116] In 1958, Hauty explained that spacecraft would be much smaller and even more confining than submarines. They would have greater weight restrictions, a smaller crew, and could not "surface" in event of an emergency.[117] Pressurized high-altitude balloon gondolas pioneered by the Piccards in the 1930s were seen as important precursors to the space cabin, but for an analog of long-duration isolation, space medicine experts looked to the cramped confines in Antarctica where explorer and Navy Admiral Richard E. Byrd spent several winters.[118]

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[114] Ryan, 63.
[115] Thomas.
[116] Strughold, "The U.S. Air Force Experimental Sealed Cabin", 50.
[117] Hauty, 2. "In a closed ecological system on extended space operations, the crew will be much smaller, restriction of mobility far greater, and the duration of confinement considerably longer."
[118] Strughold, Steinkamp, and Hauty all reference Byrd's autobiography *Alone.* On his second expedition to Antarctica in 1934, Byrd left his small team to spend five months by himself at a tiny meteorological station called

In addition to the pilot, the low-pressure test subject, the high-altitude native, the submariner, the aeronaut, the mountaineer, and the polar explorer, perhaps the most surprising analog Strughold and his colleagues discussed in the context of the space cabin was the prisoner of war. The end of the Korean War in 1953 brought rumours that American soldiers had been kept in tiny, windowless cells to facilitate "brainwashing" by communist captors. In 1961, Hartman wrote that "historically, the current interest in isolation and confinement problems arose during the Korean War. A national concern developed over the behaviour of American prisoners-of-war."[119] In her 1962 survey *Space Medicine*, pathologist Ursula Slager noted that "prisoners of war, especially those in China and Korea were kept in severe social and emotional isolation and confinement… these situations may be considered as more nearly 'space equivalent.'"[120]

But the specter of the prisoner of war in space medicine needs to be understood in a special way, not only in the context of the Korean War, but also World War Two. As the former head of the Luftwaffe's Aviation Medicine Research Institute in Berlin for the entire length of the Second World War, Strughold knew about lethal low-pressure and hypothermia experiments carried out by some of his colleagues on concentration camp prisoners, including Polish prisoners of war at Dachau.[121] These experiments were justified as generating useful data that would help German pilots survive rapid decompression and bail-out into the freezing North Atlantic.[122] After the fall of Berlin in 1945, Strughold himself became a prisoner of war, kept under house arrest by American forces at Heidelberg. Putting the brightest possible spin on what was a stressful and uncertain period, Strughold later recalled that, "with occupation, I became an American prisoner of war and was confined to the building. Actually, this was very good. I am convinced that every scientist should be confined for one year, if possible—to read the history of his profession. I read during this time three volumes on the history of medicine. This was very valuable to me."[123]

Advance Base. His team had to mount a risky rescue operation when they determined that his increasingly bizarre radio transmissions were symptoms of carbon monoxide poisoning.

119 Hartman, 25.

120 Ursula T. Slager. *Space Medicine* (Englewood Cliffs, NJ: Prentice-Hall, 1962) pp. 342.

121 Karl Heinz Roth. "Flying Bodies - Enforcing States: German aviation medical research from 1925 to 1975 and the Deutsche Forschungsgemeinschaft" in *Man, Medicine, and the State: The Human Body as an Object of Government Sponsored Medical Research in the 20th Century*. ed. Wolfgang U. Eckart (Franz Stein Verlag) pp. 107-127

122 Data from these callous experiments on prisoners was often stripped of its cruelty when cited in the literature. Writing in *Space Medicine*, Slager notes in passing that, "At Dachau, nude, non-medicated men immersed experimentally for 1 h in water at 4.6 C (40 F) died at an average of 6 min after removal from the water… the men died with an average rectal temperature of 26.8 C." Slager, 79.

123 Thomas, 249.

Along with the operator of an advanced weapons system, and a prisoner, the space cabin set-up also figured the occupant as a medical and psychological subject. During simulations, the subject was dressed in green surgical scrubs, and covered in biometric sensors relaying respiratory and pulmonary data to the doctors outside. A "shirtsleeve environment" is how NASA later referred to the practice of not wearing a protective suit in a pressurized spacecraft. Tests in the space cabin simulator with subjects wearing full pressure suits were conducted, but the suits were exceedingly uncomfortable and later abandoned. NASA astronauts were also biomedical test subjects, and Apollo crews similarly went suit-free for the transit portions of their voyages.

Gerathewohl also suggested that the subject be given a journal and encouraged to record subjective experiences to significant events during the test. This required the subject to spend portions of their rest period in a reflexive, contemplative state. The subject's diary also ended up being a place where frustrations brought on by the claustrophobic, technocratic environment were vented, but not without the ground crew eventually finding out. In this sense, the diary marks the beginning of the practice of self-reporting in space psychology, an imperfect method long considered unreliable and subject to manipulation by astronauts concerned with preserving the appearance of sound mental health, so as not to jeopardize their flight-ready status.

Who would be tested first? Despite a long-standing tradition in aviation medicine of self-experimentation, experts decided to select a subject from the ranks of young enlisted men on the base. In 1956, when it came time for short tests with human subjects, space travel was not a high enough priority to attract "top men". Strughold had to make due with who was around, and available. Despite these limitations, the subjects they chose were still heavily pre-screened, healthy, young, white, military men. The first short tests lasting only a few hours were to check systems and establish operating procedures. These were performed by Joseph A. Dupraw, a young first lieutenant, and Fred W. Childress, who held the rank of airman, second class, and was brought in from neighbouring Lackland Air Force Base.[124] The first subject for the 24-hour test, Dalton F. Smith Jr., was a 19-year-old technician, with the rank of airman, third class.[125] When the hatch door was wheeled open from his day-long stay—which included the dramatic CO2 incident—Smith was personally greeted by Strughold and Gaume, one of the attending doctors. A photo of

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[124] Photographs of the two men practicing tasks in the simulator with the door open can be found in between pages 53 and 54 in S*emi-Annual Historical Report – School of Aviation Medicine, USAF. 1 July – 31 December 1957*.
[125] S*emi-Annual Historical Report – School of Aviation Medicine, USAF. 1 July – 31 December 1955*, 35.

this moment ran in the August, 1956 issue of *Popular Science*, and for his trouble Smith received a commendation ribbon.[126]

Describing those eventually selected for the week-long tests, Steinkamp wrote, “Without exception, the subjects were athletically inclined and possessed a vigorous physique.”[127] The first space cabin subjects were younger, less skilled, less educated, and less experienced than the elite test-pilots initially slotted into NASA’s Mercury capsule, but they still represented a very thin slice of the American population: healthy, white, male soldiers. In early 1958—with the world suddenly watching—Strughold, along with resident doctors Steinkamp, Roth, Gaume, and psychologists Gerathewohl, Hauty and Hartman, had to decide who to select for their seven-day simulated “trip to the Moon and back.”[128]

[126] Ibid, 35.
[127] Steinkamp, 18.
[128] “Spaceman Fatigue: He Enters Final 48 Hours of Simulated Trip to Moon” in *New York Times* (February 15, 1958) pp. 4.

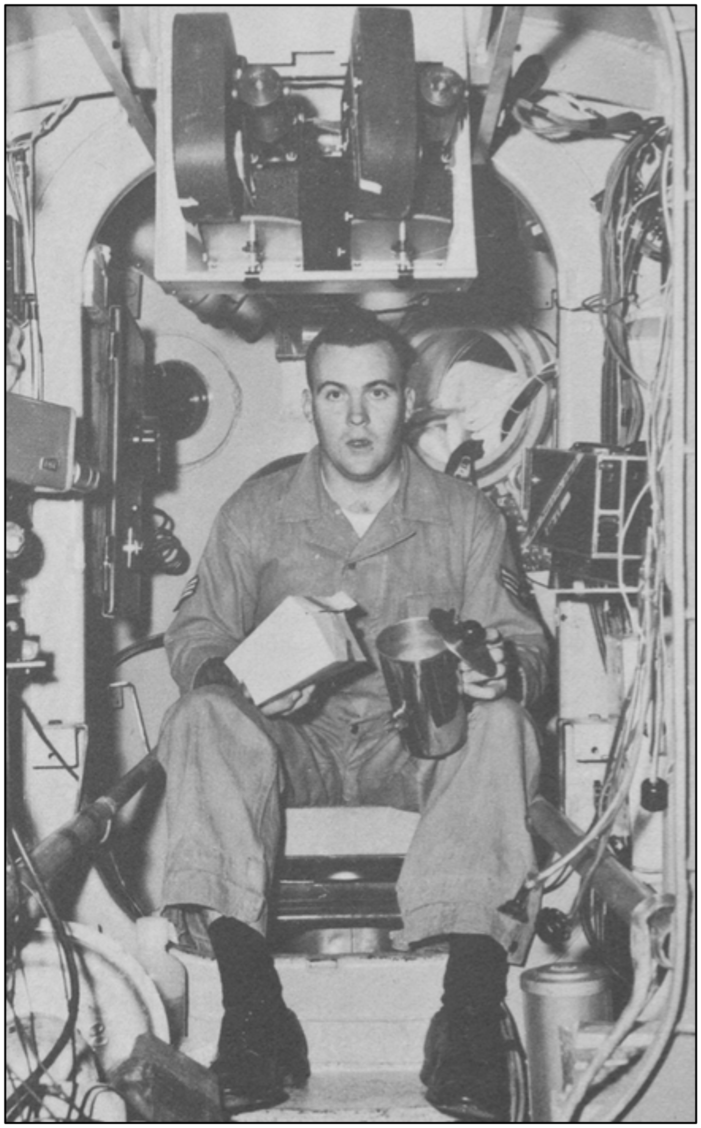

Figure 6: Airman Donald G. Farrell in training the day before starting his week-long stay in the simulator. He holds the electric hot cup used to prepare meals. (Source: Space Medicine Association, Online archive, 1954-1958).

DONALD G. FARRELL

Donald G. Farrell, a twenty-three-year-old Airman (third class) originally from the Bronx, was selected for the high-profile week-long test. Unlike future astronauts, Farrell was not a pilot, or even college educated. He was an accountant clerk in the SAM Controller's Office who was healthy. He had passed the Air Force's physical and mental requirements for pilots, but had washed out during training due to bad allergies, and was now busy as a bookkeeper.[129] Steinkamp wrote that Farrell had been picked from a small pool of volunteer applicants "on the basis of general superior physical condition and a superior adult level of intelligence."[130] But admitted that the choice was also guided by the fact that he was "easily available within our resources and had participated voluntarily in other human experimentation."[131] The psychologists added that they admired his "patina of sophistication beyond that to be expected of his age group."[132]

In late January 1958, Farrell began two weeks of intensive preparation for the simulation. This included "a complete physical, psychiatric, and psychologic evaluation" to "ensure his fitness for the test", as well as "a period of initial familiarization with the SAM Space Cabin Simulator and allied equipment."[133] Two days before the test, Farrell made a two-hour practice run, with the first hour devoted to getting to know the interior, and the second to working on the instrument panel. The next day brought a full-dress rehearsal. One of the doctors dotted Farrell with physiologic sensors and explained the tricky process of reapplying them. If the ground crew lost a signal from any of these sensors, they would activate a light on the command panel marked "ECG PICKUP", instructing Farrell to "check out [the] system to see that electrodes are in place and you are still plugged into ECG pickup."[134] If the ground crew still could not read the ECG signal they could make the light on the command panel blink, which was the sign for Farrell to "remove, clean, and reapply [the] electrodes", a complicated and uncomfortable ordeal.[135] Inside the cabin, Farrell again tested the instrument panel workstation, and even prepared and consumed one of his packaged meals using the cabin's electric hot-cup (Figure 6). After one final test of the inflatable air mattress, the rehearsal was concluded.

That night, Farrell met with Raymond F. Coleman, the base's Catholic Chaplin, to discuss the challenge he was about to face. After a long discussion, "Father Coleman pronounced him spiritually prepared and sent him into 'space' with a blessing."[136]

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[129] Steinkamp, 22.
[130] ibid, 22.
[131] ibid, 22.
[132] ibid, 22.
[133] Steinkamp, 13; "Department of Space Medicine – School of Aviation Medicine", 6.
[134] Steinkamp, 30.
[135] ibid, 30.
[136] "Gets Spiritual Advice Prior To 'Blast Off'" in *The Bulletin* (February, 22, 1958) pp. 6. Farrell's family was Catholic, and he attended Holy Cross Grammar School, and Cardinal Hayes High School in the Bronx.

FROM THE EARTH TO THE MOON

Throughout his career, Strughold often referenced the works of American science-fiction pioneer Jules Verne.[137] Space historians have long noted the many similarities between Verne's 1865 novel *From The Earth to the Moon*, which follows American preparations for a voyage to the Moon, and NASA's Apollo missions a little over a century later. Despite the major difference of the enormous cannon used in the story, both feature a crew of three launched from Florida on a voyage through space lasting roughly a week. A less noted parallel is the sealed cabin test included in Verne's story. As the "projectile-vehicle" is nearing completion, one of the American artillery engineers, J. T. Maston, volunteers to live inside the "air-tight enclosure" to test the system devised "to renew the air". "Since I am not to go," offers Maston, "I may at least live for a week in the projectile."[138]

"After strictly informing them not to open his prison before the 20th, at six o'clock p.m., he slid down the projectile, the plate of which was at once hermetically sealed. What did he do with himself during that week? They could get no information. The thickness of the walls of the projectile prevented any sound reaching from the inside to the outside."[139]

* * *

The School of Aviation Medicine had never seen anything like it. Journalists from all over the country descended on Randolph Field hoping to report on another American space success: Farrell's "mythical, week-long trip to the Moon."[140] Only nine days earlier, Wernher von Braun had launched America's first satellite, Explorer I. The SAM history records that, "News reporters and magazine writers converged on the School in such numbers that it was difficult to keep them out of the way of the scientists monitoring the experiment."[141] At 7:30 am, final preparations got

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[137] Mackowski, 176; Hubertus Strughold, Strughold, Hubertus. *Your Body Clock: Its Significance for the Jet Traveler* (New York: Charles Scribner's Sons, 1971) pp. 47. Strughold also provided an epilogue to a 1963 reprint of Verne's 1872 story *Dr. Ox's Experiment*.
[138] Jules Verne. *From The Earth To The Moon* (New York: Scholastic Book Services, 1965) pp. 163.
[139] Verne, 164.
[140] "One of three articles on SAM prepared exclusively for the United Press International Dallas" (Office of Information Services, School of Aviation Medicine, U.S. Air Force, 6 October, 1958) pp. 6.
[141] "Department of Space Medicine – School of Aviation Medicine", 6.

underway. The cabin was stocked with a long list of supplies including prepackaged food, toiletries, and cartons of Baralyme for the CO2 absorber system. Farrell donned one of his three sets of green surgical scrubs and was again dotted with the biomedical sensors. The doctors weighed him and offered him one last chance to ask questions or clarify instructions before the week-long communication blackout. Seated in the modified cockpit chair, Farrell plugged his ECG leads into a port on the cabin wall and made one last check of the biomedical telemetry setup. After this, the ground crew wished him luck, and wheeled tight the metal hatch. Inside, Farrell could hear a hissing noise as the pressure in the cabin was reduced to a simulated altitude of 18,000 feet. The ground crew then covered the five peephole-style viewing ports, and Farrell's week-long "flight" was underway.

For the first two days, things went well. Farrell developed "a highly efficient system of work, housekeeping, eating, toiletry, recreation, and sleep."[142] During his 4 hours on, he attended to the program of the instrument panel, took Gerathewohl's "math test", switched out the Baralyme, and made regular reports over the microphone.[143] Problems began to crop up on the third day. All of a sudden, the ground team noticed that the feed from the CCTV camera had cut out. Farrell knew something was up when he began to hear signs that the ground crew was resorting to manual checks. "Can't help but notice the tiny one-half inch square peephole opening and closing rather frequently," he noted in his log. "Guess they're checking on me visually in lieu of TV monitoring."[144] A few hours later, Farrell got testy when his work was interrupted by the ECG light on the command panel. This meant he was to change the electrodes attached to his body. "Signaled back that I would accomplish same after finishing what I was presently doing," he wrote in his log. "Such inconsiderate people." Once he had the sensors back in place, the ground crew gave the "OK" signal, and he resumed work.

On the fourth and fifth days, right when the imaginary spaceship would have been rounding the Moon headed back to Earth, Farrell's performance on the radar screen-style instrument panel tasks underwent what Steinkamp characterized as a "profound decline in proficiency."[145] That "efficient system of work and rest" had "gradually reduced to the minimal essential effort required

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[142] Gerathewohl, 734.
[143] Hauty, 4.
[144] ibid, 2.
[145] Steinkamp, 22.

for working, eating, and sleeping."[146] Farrell had not adjusted to the 4:4 cycle. He was not sleeping well under the harsh bright lights. His rest periods were described as "restless" and "aimless".[147] Hauty was sure that the effects of boredom and fatigue had set in—space cabin fever. On the sixth day, a number of "little things subjects would normally consider trivial" became a major source of annoyance. An audible "click" made every three minutes by the still camera was getting to him, as was the feeling of constant surveillance. "HA! Just caught someone peeping thru the peephole in the porthole covering," he recorded in his journal. "What a ridiculous situation. People sneaking around and peeping thru tiny holes at me!"[148] After finishing the one-hour Kraepelin test with three minutes to spare, Farrell, the accountant, turned his mounting frustration on Gerathewohl. "Math test finished. Completed it with 3 minutes to spare in addition to doing the complete test. Gerathewohl said: 'Even a genius couldn't do the entire thing in one hour.' Pardon me, all to hell."[149] The end was in sight, and Farrell could not wait for it all to be over. "Sharpened the pencils for tomorrow's test (last one). Getting a little anxious to get the hell out of this box."[150]

On the seventh day, hours from completing the mission, the ECG light began to blink again. This time Farrell lost it:

> *HA! I knew it. Got the change electrodes signal. It never fails, 17 hours left in this abortion and now they want me to change electrodes. Got a good mind to tell them — — — — ... I only yank out about 99,000 hairs from my back and shoulders every time I remove that — adhesive tape. ——, might as well get started on it —*
> .
>
> *1650: finished with reapplying the ECG electrodes. Nice and raw back there on both shoulders like beefsteak. Oh, well, maybe I'll get disability out of this—one percent. That'll be all I'll get. ——won't even give me hazardous duty pay for this "ride." Chintzy slobs!* [expletives redacted in original][151]

[146] Hauty, 4.
[147] Steinkamp, 24.
[148] Hauty, 3.
[149] Gerathewohl, "Work Proficiency in the Space Cabin Simulator", 724.
[150] ibid, 724.
[151] Hauty,

At this point, Farrell was ready to quit the biomedical monitoring altogether. “The talk of removing the adhesive tape that held the electrodes in place became so distressing that one subject threatened to jerk out all the leads so he would not have to bother with it.”[152]

Farrell’s apparent agitation was a growing concern for the ground crew. Some argued that keeping him in there was dangerous.[153] Instead, in an effort to alleviate some of his hostility, the decision was made to break radio silence and establish direct verbal contact for the first time since the experiment began six days prior. According to Steinkamp’s report, “the subject was congratulated for a job well done, questioned on his physical condition and then told of the group of individuals that would be present at the termination of his flight.”[154] After this, Farrell seemed better, and produced his highest score yet in his last go at the Kraepelin test. “Did the entire test again today, and had 5 minutes to spare. Wait 'till Gerathewohl sees that. I'll have him calling me ‘genius’! Ha!”[155]

After seven days, and 21 eight-hour work/rest cycles, the metal hatch was unsealed, and Farrell gingerly stepped out into a room now packed with journalists, scientists, military brass, and politicians. With flash blubs popping, Farrell was greeted at the door by Julian C. Ward, one of the School’s young flight surgeons who had served on the ground crew. Ward guided the wobbly Farrell over to eight dignitaries seated on folding chairs set up next to the simulator. The first to rise and offer a hearty handshake was Lyndon Johnson, the powerful Senate majority leader, who had just wrapped up his three-month inquiry into American space readiness. Perfectly positioned for the cameras, Farrell and Johnson mugged for the throng of reporters, with Strughold looking on. “This is the single greatest opportunity for peace that has come in our time,” said the senator. Still overwhelmed by the circus he had stepped into, all Farrell could get out was, “thank-you very much” (Figure 7).[156]

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[152] Hawkins and Hauty, 11-12.
[153] Steinkamp, 22.
[154] ibid, 22.
[155] Gerathewohl, “Work Proficiency in the Space Cabin Simulator”, 724.
[156] “Airman Successfully Ends 7-Day Test ‘Flight’ to Moon” in *The New York Times* (February, 17, 1958) pp. 1.

Figure 7: Moments after stepping out of the simulator, Farrell is greeted by then-Senate Majority Leader Lyndon B. Johnson. Strughold, at center, looks on. Benson is over Johnson's left shoulder. (Source: United Press Telephoto).

LBJ AND SAM

Johnson had a long and personal relationship with the School of Aviation Medicine, starting at Randolph Field, and intensifying after the facilities were moved to Brooks Air Force Base in 1959. Work at the School first caught the tall Texan's attention in 1951 when Strughold organized a symposium called "Physics and Medicine of the Upper Atmosphere". The event attracted more attention than expected, and raised the profile of the San Antonio-based School. Impressed by this far-sighted research in his home state, Johnson became a regular visitor, promoting their work as a part of the "technological infusion" that would "call to life a new South."[157] Following Sputnik, Johnson—who had become Senate majority leader one year earlier—took the lead in challenging

[157] McDougall, 376. For a history of the Cold War shift of the military-industrial-academic-complex from the American Northeast to the Southwest, see Ann Markusen; Peter Hall; Scott Campbell; Sabrina Deitrick. "The Military Remapping of America" in *The Rise of the Gunbelt: The Military Remapping of Industrial America* (Oxford: Oxford University Press, 1991).

the Eisenhower administration's tepid response. After organizing the so-called "Johnson Committee" hearings in late 1957 and early 1958, which included testimony from Strughold, Johnson emerged as one of the main architects of the National Aeronautics and Space Act that established NASA in October 1958. Described by historian Walter A. McDougall as "the biggest" of the Cold War technocratic "Big Operators", Johnson knew the value of good publicity, privately boosting the Air Force's space programs while publically touting "peaceful uses".[158]

After presiding over the release of Farrell in Feburary 1958, Johnson was the guest of honor at the School's late 1958 follow-up to their successful 1951 symposium. After dedicating SAM's new facilities at near-by Brooks Air Force Base in November 1959, Johnson sought treatment for his heart condition from the School's young cardiologist, Lawrence Lamb, who later gained infamy for disqualifying Project Mercury astronaut Donald "Deke" Slayton for minor arterial fibrillation.[159] Lamb conducted a routine checkup on the senator, who had survived a major heart attack at age 49. He also constructed a small wallet-sized copy of Johnson's electrocardiogram that the senator could carry on his person at all times. Johnson returned to SAM frequently, combining political check-ins on research with personal check-ups with Lamb. On one visit in February 1961, Johnson instructed Lamb to update his wallet-sized electrocardiogram, adding, "I want the new one to say Vice President on the back."[160] In 1963, a new batch of buildings was nearing completion at Brooks. Lamb wrote to Johnson suggesting that he invite President Kennedy to make the dedication. Johnson wrote back, assuring him that plans were already in the works.[161]

On November 21, 1963, President Kennedy's motorcade arrived at Brooks Air Force Base in San Antonio, Texas. In front of a row of television cameras and flanked by large mockups of the X-15 and X-20 space-planes, Kennedy took his place on a platform along with First Lady Jacqueline Kennedy, Johnson, Strughold, and Texas Governor John Connally.[162] "I have come to Texas today to salute an outstanding group of pioneers," the President began. "The men who man

[158] McDougall, 173.
[159] In his autobiography, "Inside The Space Race: A Space Surgeon's Diary" Lamb points out that he disqualified Slayton, not for fear he might die during the mission, but because a key part of the Project Mercury Astronaut's job was to generate physiological data about the human body under weightlessness conditions. Lamb argued that one of Slayton's occasional fibrillations might taint the data, and therefore compromise a key medical goal of the mission. After being scrubbed, Slayton served as the powerful head of the Astronaut office, which put him in charge of deciding the coveted Apollo crew assignments. Slayton ended up making his first and only spaceflight in 1975 as part of the Apollo/Soyuz Test Project.
[160] Lamb, 137.
[161] ibid, 320-321.
[162] A photograph of the stage can be found in Campbell and Harsch, pp. 80.

the Brooks Air Force Base School of Aerospace Medicine."[163]. After his speech, the president visited one of the SAM research buildings, where he happened upon a sealed cabin experiment in progress (Figure 8). For this experiment, four young Airmen were inside a chamber breathing pure oxygen. Kennedy entered the laboratory and made his way up to the glass viewing window, but none of the four subjects looked up from their simulated astronaut work to notice. With a mischievous smile, the President reached for a nearby headset that would allow him to hail the subjects inside. "Hello." He ventured. The airmen looked up, mouths agape. "Hello, sir," was all they could muster. "How are you feeling?" asked the President. "Fine, sir". "How long have you been in there?" "Ten days." "How much longer do you have to go?" "Twenty more days, sir." "Good luck." "Good luck to you, sir."[164] Less than twenty-four hours later, the airmen were stunned again—Kennedy was dead, and Johnson, the school's most famous patron and patient, was President.[165] In attendance for Farrell's exit from the simulator in January 1958, Johnson also welcomed home of the crew of Apollo 8, the first real week-long trip to the Moon and back, in December 1968. It was one of his final acts before leaving office.

[163] Lamb, 326. Later, the speech became known as Kennedy's "cap over the wall speech", for his reference to Irish poet Frank O'Connor: "This Nation has tossed its cap over the wall of space, and we have no choice but to follow it." But he also referenced the space cabin simulator, tying its work to the problems of urban pollution. "When you study the effects on our astronauts of exhaust gases which can contaminate their environment, and you seek ways to alter these gases so as to reduce their toxicity, you are working on problems similar to those in our great urban centers which themselves are being corrupted by gases and which must be clear." Online: https://www.youtube.com/watch?v=6DTX9OiKi9U

[164] The entire exchange is transcribed in Peyton, 237.

[165] In 2013, Philip Jameson, one of the airmen in the sealed cabin, recalled his interaction with the President: "He was just right there, Boston accent, the hairstyle. He wasn't the president when he talked to us, he was just a person that was into space." The next day, like the rest of the country, work in the simulator came to halt. Jameson remembers the researchers moving a television set in front of the glass viewing port so they could all watch the news. "We all just broke down and cried". See: Ryan Loyd. "JFK's Day In San Antonio 24 Hours Before His Assassination" in *Texas Public Radio* (July 10, 2013) Online: http://tpr.org/post/jfks-day-san-antonio-24-hours-his-assassination

Figure 8: President John F. Kennedy communicates with subjects of a sealed cabin test at SAM at Brooks Air Force Base. This visit occurred on November 21, 1963, the day before his assassination. (Source: Brooks City-Base).

In July 1969, Strughold, the former head of Luftwaffe medical research, watched Neil Armstrong walk on the moon from inside NASA mission control in Houston, Texas, where he was a guest of his former SAM colleague, Apollo flight surgeon Charles Berry. Afterward, Strughold wrote to Johnson, then out of office for six months:

> *"My dear President. At the occasion of the very successful Apollo 11 flight, I like to take the liberty to express to you my congratulations. Without the support by you during your pre-White House time and White House time, this fantastic*

achievement in human history would not have been made. I remember your presence at the end of the first 8-day long Airman Farrell experiment in the space cabin simulator at Randolph field, which gave us a tremendous morale boost at a time when space flight and space medicine was generally considered an illusion. I had the privilege to be present in the Mission Control Center at Houston during the Moon flight and to observe the recorded heart beat and respiration of the astronauts every day. This was the climax of my professional life. Again, best congratulations and many thanks for your early support of our space medical studies."[166]

FARRELL & FAILURE

Back in February 1958, Farrell stepped out of the simulator and into a hero's welcome. A *News of the Day* piece titled "Space Pioneer Gets Back To Earth" captured the moment Farrell shakily stepped out of the cabin and shook hands with Johnson, Strughold, and the assembled Air Force brass.[167] Following the simulator-side photo-opportunity, Farrell was hustled past reporters and armed Air Police guards into a waiting car that whisked him over to the School's Performance Physiology laboratory for a quick evaluation. Next, Farrell donned his crisp blue USAF uniform for a formal press conference held in the School's auditorium featuring Johnson, Strughold, and Benson, who pinned a commendation medal on him.[168] Seated dead center at the table of microphones, with Farrell, Benson, Strughold and Ward off to his right, Johnson delivered what one reporter called an "impromptu speech", explicitly casting Farrell's ordeal within the politics of the Cold War: "if we fail to master the Space Race first, then we will be in all respects only a second-best country."[169] Afterward, Farrell headed to the hospital for 72 hours of rest and observation. He showered, underwent a full medical check-up, and was photographed being served

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[166] New Mexico Museum of Space History Archives, folder "Hubertus Strughold". Also reprinted in Campbell and Harsch (but somewhat garbled from being translated into German and then back into English), 84-85. Strughold also wrote to Neil Armstrong: "My dear astronaut Neil Armstrong: A famous space-prophet [Konstantin Tsiolkovsky] once said: 'The Earth is the cradle of the mind, but you cannot stay in the cradle forever.' Today, the human mind is on the moon: Thanks for your first steps on its surface. I bring my congratulations in deep admiration."
[167] https://www.youtube.com/watch?v=8TndKZgrrNQ
[168] This is the same award given to Dalton F. Smith, the first 24-hour occupant of the simulator.
[169] Campbell; Harsch, 73.

a hearty steak dinner.[170] Johnson, who knew a good opportunity to hammer Eisenhower when he saw one, scooped up Farrell, Strughold, and Benson and headed for the airport. First, they flew to New York City, where in the wake of the Explorer I excitement Farrell appeared on radio and TV talk shows and was briefly reunited with his parents and girlfriend. The next stop was Washington D.C., where Johnson arranged for Strughold to speak at a luncheon on Capitol Hill attended by over 70 members of congress.[171] As Maura Phillips Mackowski aptly put it, "space medicine had arrived."[172]

But while Johnson toured Strughold and Farrell around, the rest of the SAM ground crew began the unpleasant task of sifting through the simulator. "The cabin contents are carefully analyzed… Determinations are made of the amount and type of food and juices consumed. Fecal material is weighed. All material written by the subject is collected."[173] This included Farrell's journal, complete with his choice words for Gerathewohl and others.

From Washington, Johnson made Farrell's test out to be a great success; evidence of yet another American space competency. In the press, Farrell gushed confidence and enthusiasm. He spoke of performing future tests in the simulator, adding "I would love to make a real trip to the Moon."[174] *The New York Times* described Farrell as "in one sense, the first 'space traveler.'"[175] Other journalists sketched him as heroic, calm, and collected. According to one article, Farrell's biggest problem in the simulator was his inability to whistle caused by the low-pressure.[176]

But back at SAM, with Farrell's journal in hand, the flight surgeons and psychologists had serious misgivings. Yes, Farrell had survived, and had not suffered any major physiological ill effects, but his performance on the instrument panel, and his state of mind, had tanked halfway through. The latter "was not always obvious to the Flight Surgeon on the outside but was definitely reflected in the man's log which he was required to maintain," wrote Hawkins and Hauty in their report. Farrell's dairy revealed what the psychologists described as a "gradual increase in irritability, and the seemingly abrupt onset of frank hostility" directed at the ground crew.[177] Even though they did not know the full extent of this until reading his logs, during the test the

[170] Steinkamp, 17.
[171] Peyton, 195.
[172] Mackowski, 177. As Mackowski aptly puts it, "space medicine had arrived."
[173] Steinkamp, 17.
[174] "Scientists Study Space Test Data" in *The Daily Banner* (February, 17, 1958) pp. 6.
[175] "Space Traveler" in *The New York Times* (February, 18, 1958) pp. 26.
[176] "Spaceman's Problem—He Couldn't Whistle" in *The Geneva Times* (Vol. 63, No. 222; February 17, 1958) pp.1
[177] Hauty, 2.

psychologists still considered Farrell's discernable funk to be "the single conceivable reason for a premature termination of the flight."[178] They blamed this on Farrell's inability to adjust to the tight space, bright lights, and odd hours. "The inability of the subject to adjust to the imposed schedule of work and rest might have been due to his complete lack of experience with the stresses encountered in the simulated flight."[179] Farrell, the accountant who had been cut from pilot training, was also quietly dropped from Operation Terrella.[180] As Steinkamp noted, "the decision was made to conduct all subsequent flights with pilots of appropriate background experience."[181] This switch presages Eisenhower's directive to limit the scope of Project Mercury's astronaut search to the ranks of college-educated military test-pilots. After Farrell, four more week-long simulations were made with older, more experienced pilots serving as subjects, to far less publicity. While Farrell was only 23 years old, the ages of the next four pilot subjects were 29, 34, 39, and 36, with the average age of the pilot group being 34.[182] The average age of the seven Mercury astronauts at their selection one year later in April 1959, was also 34 years.[183]

Farrell's performance was considered substandard, but the device itself and this type of experiment were both judged useful. Following the subsequent tests in the one-person simulator, the School received Honeywell's two-person space cabin simulator in the fall of 1959. Here teams of pilots spent as long as 30 days simulating living and working in space.

CONCLUSION

In June 1968—a century after Jules Verne imagined the sealed-cabin test in *From the Earth to the Moon*, and a decade after Strughold sent Farrell on his "flight to the moon and back"—three NASA astronauts climbed inside an Apollo Command Module for a high-stakes ground-based mission in

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[178] ibid, 4.
[179] Steinkamp, 22.
[180] Brian O'Leary. *The Making of an Ex-Astronaut* (Boston: Houghton Mifflin. 1970). O'Leary recounts his selection in 1967 and subsequent exit from the astronaut corps the following year following friction with the administration.
[181] Steinkamp, 22.
[182] Hauty, 18.
[183] The average age of the twelve Apollo astronauts who landed on the moon was 40 years, three months. Taking into scope all NASA astronauts to present, the average age at selection is 34 years old (the youngest was 26 and the oldest 46).

simulated space.[184] For eight days, the astronauts lived and worked sealed inside the module, while the spacecraft rotated slowly inside Chamber A of NASA's massive Space Environment Simulation Laboratory (SESL), at what was is now the Johnson Space Center (JSC) in Houston, Texas. The largest thermal vacuum chamber then in existence, the building can subject entire spacecraft to an airless void and to temperature extremes similar to space. In June 1968, the stakes couldn't have been higher. With the Space Race in full swing, American progress had stalled since January 1967 when the last crew to simulate mission conditions inside a sealed Apollo Command Module had burned to death in a horrific fire. The impending launch of Apollo 7, the first crewed mission in NASA's urgent attempt to send humans to the moon by 1970, depended on both humans and machines functioning as expected in this test.[185] This simulated Apollo mission was taken very seriously by the crew and ground controllers. It was designated 2TV-1 "Pacesetter", and the crew even had their own mission patch design.

Donald "Deke" Slayton, the benched Project Mercury astronaut then in charge of crew assignments, decided in 1966 that all simulated missions should include an astronaut who was also a medical doctor. In 1968, Slayton had three MD candidates to choose from, and went with Joe Kerwin, who had been with the Agency the longest.[186] A Navy flight surgeon with an MD from Northwestern University, Kerwin was selected in 1965, in NASA's first group to include non-pilot "scientist-astronauts". Joe Engle (Lunar Module Pilot), who had already piloted the experimental rocket-powered X-15 to the edge-of-space, and Vance Brand (Command Module Pilot) rounded out the crew.[187] This created the first instance of a seldom-seen crew dynamic of a scientist-astronaut ("second class citizens" to their test-pilot peers) commanding two seasoned pilots. Clad in bulky spacesuits they would wear for the simulated "launch" and "reentry", the crew was helped into the capsule by workers, the hatch sealed, and the surrounding atmosphere slowly evacuated.

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[184] Matthew Hersch. "Lunar Mission in a Bottle" in *Air & Space* (ed. Tony Reichhardt) (Smithsonian, July 10, 2009). Online: https://www.airspacemag.com/daily-planet/lunar-mission-in-a-bottle-110001066/; Ed Hengeveld. "Apollo Vacuum Chamber Tests: All dressed up and no place to go". Online: https://www.si.edu/object/nasm_A19790408000

[185] "Crew Enters Apollo 2TV-1 For Seven-Day Test" in *Roundup* (Houston: NASA Manned Spacecraft Center, June 21, 1968).

[186] Kerwin and flight surgeon Duane Graveline were selected in 1965, but Graveline resigned shortly afterward due to an impending divorce. In 1967, NASA selected two more astronauts with medical degrees: William Thornton, and Donald Holmquest. Holmquest retired from NASA in 1973 without ever flying in space, while Thornton flew two early Shuttle missions in the early 1980s.

[187] Kerwin received his MD in 1957 and trained as a flight surgeon at the Naval School of Aviation Medicine at Pensacola in 1958. His only spaceflight was "science pilot" of the Skylab 2 mission in 1973.

The crew remained in constant radio contact with a special mission control. This “ground crew” also kept constant watch over the astronauts via CCTV. Kerwin remembers having a full slate of tasks to complete that simulated many aspects of the upcoming moon missions, including launch and reentry duties. During rest periods the trio read books, played cards, and taste-tested food their colleagues would soon eat in space. Like Farrell, Kerwin also kept a diary of his time in the module. He recalled the biggest issue with the craft being specific to this ground-based test: special plumbing designed to carry the astronauts’ urine from inside the craft to doctors on the outside froze due to the extreme cold of simulated “space”. The crew had to mop up overflow as best they could (there was no leaving the capsule) and then repurpose empty water jugs for liquid waste storage. A project manager who examined the module after the crew exited recalled, “one of the most terrible stenches I have ever encountered.”[188] But despite this olfactory obstacle both vehicle and crew performed to NASA’s satisfaction producing the needed confidence to proceed with Apollo 7.

NASA’s 2TV-1 “Pacesetter” sealed cabin test in 1968 is a crucial but obscure episode in the Apollo development process. But it showcases the significance of Strughold’s simulated flights with the USAF space cabin simulator a decade prior. Kerwin being selected as commander shows how space medicine remained a central concern in sealed cabin simulations of spaceflight, even after the shift to NASA. It is easy to spot differences between the USAF and NASA tests: the use of a thermal vacuum chamber to replicate the space environment being the most obvious. More interesting and revealing are the many similarities and parallels, including the testing of humans and machines together, the pretend destination of the moon, the length of the mission, simulated work, and constant surveillance (including Kerwin’s diary keeping). These similarities also extend to actual space missions where isolation, automation, and surveillance from the ground became keys issues shaping astronauts’ time in space. Two examples from actual NASA missions, one from Apollo 13 in 1970, and the other from Skylab 4 in 1973 also echo Farrell’s ordeal.

On April 16, 1970, five days into the harrowing failure of Apollo 13, commander James Lovell decided to break protocol and remove the biomedical sensors attached to his chest. The rest of the crew—astronauts Fred Haise and Jack Swigert—soon followed suit. Facing an uncertain future in the cramped, freezing Lunar Module, and threatened with the prospect of carbon

[188] Duane Seaman. “The Apollo Moonshot—Hobnobbing with Scientists and Astronauts” in *Essays in Idleness* (Bloomington: AuthorHouse, 2011).

monoxide poisoning, they removed the electrodes that had been attached to their bodies since launch, denying the flight surgeon in mission control in Houston, Texas, their pulmonary and respiratory data.

Vance Brand (Houston): "Jim, could you switch your BIOMED switch to the position opposite to where it is now? We are getting a subcarrier, but no data. Over."

James Lovell (CDR, Apollo 13): "Now you know, Houston, I don't have BIOMED on."[189]

On November 16, 1973, the crew of Skylab 4, the third and final mission to NASA's first orbiting laboratory, docked their Apollo command module to the station. Before the trio could disembark, pilot William R. Pogue became nauseous and vomited. Upon entering the station, the three astronauts, Gerald P. Carr, Edward G. Gibson, and Pogue hatched a plan to hide the incident from ground controllers:

Carr: "We won't mention the barf, we'll just throw that down the airlock."

Gibson: "They're not going to be able to keep track of that."

Pogue: "Yeah, it's just between you, me and the couch."[190]

To their embarrassment, the three astronauts had forgotten that Skylab, like the space cabin simulator, was "bugged as thoroughly as the Nixon White House."[191] Their attempt at a medical cover-up was indeed caught, and the following day the crew was admonished by mission control. Six weeks later, growing friction between the crew and ground controllers over their work/rest schedule came to a head. On December 27, the Skylab astronauts switched off all communications, and enjoyed an unapproved day off, which a Harvard Business School study famously dubbed the "strike in space".

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[189] Conversation between capsule communicator Vance Brand at NASA Mission Control, Houston, and Apollo 13 commander James Lovell, April 16, 1970.
[190] Nicholas De Monchaux. *Spacesuit: Fashioning Apollo* (The MIT Press, 2011) pp. 291.
[191] Henry S. F. Cooper. *A House In Space* (Sydney: Angus and Robertson, 1977) pp. 44.

Apollo 13's "medical mutiny", and the tensions that led to Skylab 4's so-called "strike in space" were relatively minor episodes in otherwise eventful missions, but they bear a striking resemblance to events over ten years earlier in the space cabin simulator. More than just paralleling the sequence of events for later space missions—selection, training, mission, press conference, congratulations from powerful politicians, post-flight medical evaluation, extensive media coverage—work with the space cabin simulator established a number of practices and relationships that are now central facets of life in space. Foremost in these two examples is surveillance from the ground. Today astronauts are still closely monitored by mission control and have a relatively low level of autonomy when it comes to how they spend their time in space. Their actions are governed in part by the knowledge that someone back on Earth might be watching. Another related element is the power dynamic between ground controllers and astronauts, which has resulted in many testy exchanges similar to those expressed by Farrell in his journal. Psychological self-reporting is also still practiced and remains problematic. So is the military and masculine character of astronaut culture, which was under construction along with the simulator. Politicians, the media, and the public remain fascinated by astronauts both as exceptional people and as paragons of national achievement.

The mutual shaping between astronauts and the technological environment of the spacecraft (environmental and communication systems) is another aspect encountered in the simulator. Within the wider scope of Cold War technologies, the sealed cabin occupant resembles a number of other military positions created for the prosecution and survival of nuclear war. Launch control officers "sealed inside a secret silo", and submarine crews living underwater were trained to launch attacks, while political leaders and resourceful citizens hoped to ride out the atomic aftermath living inside massive underground survival bunkers, or backyard fallout shelters.

The SAM space cabin simulator, its human subjects and regimented practices, shows the Air Force's role in bringing astronauts into being. NASA's wide-reaching "Project Astronaut" call, and Glennan and Eisenhower's sudden about-face, should be understood in the context of these earlier simulated experiences. Here, months earlier, the astronaut and mission control had been fleshed out—literally. After a rocky start with Farrell the accountant, the job was quickly passed to experienced pilots. Meanwhile, attending doctors, psychologists, engineers, politicians and the media rehearsed their ground-based roles as well. Together, they produced a prototype vision of a passive push-button military astronaut, and a social model for life in space.

CHAPTER THREE: WORKING OUT ASTRONAUTS: RACE AND THE MOUNT EVANS ACCLIMATIZATION EXPERIMENT

"Many years ago the great British explorer George Mallory, who was to die on Mount Everest, was asked why did he want to climb it. He said, 'Because it is there.' Well, space is there, and we're going to climb it, and the moon and the planets are there, and new hopes for knowledge and peace are there." –John F. Kennedy, Rice University, 1962.

In July 1958, a team of seven men from the School of Aviation Medicine's Department of Space Medicine made their way to the summit of Mount Evans in Colorado, and into "make-believe space".[1] The group was led by physiologist Bruno Balke, an avid mountaineer and one of the German life scientists who had emigrated to America as part of Operation Paperclip. The goal of their six-week expedition was to utilize the low-pressure environment high on Mount Evans (a 14,000-foot peak in the Rocky Mountains 100 kilometers west of Denver) to establish practices for synchronizing humans with the artificial environments expected in future spacecraft.[2]

This chapter follows Balke's work on altitude acclimatization from 1938 to 1958 to show that field-based practices from mountaineering and high-altitude physiology were integrated into early space medicine and built up norms for the astronaut body. This biographical approach situates Balke's Mount Evans experiment in the context of his previous studies in the Himalayas in 1938, and the Peruvian Andes starting in 1954. Tracking Balke's experimental practices over two decades, and between several different national and technoscientific contexts, shows how altitude physiology—a colonial, military science structured around categories of race—established aspects of the astronaut.

When humans move significantly higher into the atmosphere, the drop in pressure gradually reduces the amount of oxygen reaching the brain. Above 10,000 feet, symptoms can become noticeable, including some combination of hyperventilation, light-headedness, headache, confusion, sore joints, nausea, loss of appetite, and weakness. In the 1950s, climbers on Mount Everest began calling the area above 26,000 feet "the death zone".[3] Beyond this altitude, the body

[1] "A Scientist's Ordeal in Make-Believe Space" in *LIFE* (Vol. 45, No. 15; Oct. 13, 1958) pp. 49.

[2] Bruno Balke. "Experimental Studies on the Conditioning of Man for Space Crews" in *Man in Space: The United States Air Force Program For Developing The Spacecraft Crew* ed. Lt. Col. Kenneth F. Gantz (Duell, Sloan, and Pearce, 1959) pp. 177.

[3] The concept of a "death zone" above 26,000 feet originated as "the lethal zone" in a 1953 paper by Swiss physiologist Edouard Wyss-Dunant. As Heggie (2012) points out, this is a flexible barrier, shifting somewhat based on physiological and environmental particularities. See: Vanessa Heggie. "Experimental Physiology, Everest and Oxygen: From the ghastly kitchens to the gasping lung" in *British Society for the History of Science*, 46 (No. 1, March 2013) pp. 123-147; Edouard Wyss-Dunant, "Acclimatisation" in *The Mountain World* ed. Marcel Kurz (London:

is slowly dying, and humans risk losing consciousness and succumbing to anoxia. To make their historic ascent in 1953, Tenzing Norgay and Edmund Hillary relied on supplemental oxygen to travel through "the death zone" to the summit at 29,029 feet. It was not until 1978 that acclimatized climbers proved a so-called "pure" ascent without oxygen was actually possible.[4]

Figure 9: Bruno Balke leads a team of seven USAF airmen on Mount Evans, Colorado in the summer of 1958. (Source: National Archives and Records Administration, moving image ID: 342-USAF-26260).

George Allen & Unwin, 1953) pp. 100. Similar constructs were crafted in aviation and space medicine. Harry G. Armstrong introduced "the Armstrong limit", the altitude at which liquids in the human body including blood boil off. In 1951, Strughold argued that from a physiological perspective space begins much lower than the 100 kilometer line drawn by astronomers and astrophysicists. He coined the term "aeropause" for the atmospheric region of "functional space equivalence" above 50,000 feet. See: Hubertus Strughold, Heinz Haber, Konrad Buettner, Fritz Haber. "Where does space begin? Functional concept of the boundaries between the atmosphere and space". *Journal of Aviation Medicine*, 22 (1951) pp. 342–57.

[4] Heggie.

For experts at the School of Aviation Medicine (SAM), the need for a spacecraft to carry an artificial atmosphere was a given. The big question, as director of research Paul Campbell explained, was what kind? "As Earthman becomes Spaceman he is required to consider the question of an ideal atmosphere for his environmental surroundings. Should it be exactly that which Nature gave him on Earth? If so, what altitude should it simulate? Sea level? Or should it simulate the Air Force Academy's approximate mile and one-quarter altitude?"[5] In the early 1950s, the consensus became that spacecraft interiors should be pressurized to the equivalent of 18,000 feet in altitude, to aid structural engineers attempting to save weight. For the humans inside, Campbell described the thin air as a compromise between "what is ideal, and what is tolerable."[6]

Crucially, this search for the optimal space environment was also the search for the optimal space body. In addition to adjusting environments, space medicine experts also considered ways to alter humans. In their influential 1960 paper that coined the term "cyborg", Manfred E. Clynes and Nathan S. Kline suggested drugs as a possible solution.[7] Balke's work on altitude acclimatization was an earlier effort to better align humans with artificial environments, but notably one that worked through interactions with "hostile" natural environments, and avoided drugs or implanted technologies. A summary of SAM research projects from 1957 explains that, "If the normal tolerance of Air Force flying personnel to oxygen deficiency and reduced atmospheric pressure could be raised by an altitude equivalent of even 10,000 feet, the weight and bulk of pressurization equipment required in aircraft operating at 30,000 to 45,000 feet could be sharply reduced, thus increasing their speed and payload."[8]

A consistent element in Balke's research was a fascination with race. His acclimatization studies often took the form of comparisons between white, male, military subjects, and Indigenous

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[5] Paul Campbell. *Earthman, Spaceman, Universal Man?* (New York: Pageant Press, 1965) pp. 165.

[6] Campbell, 165. This is roughly halfway between 10,000 feet and the "death zone".

[7] The original title of their paper was "Drugs, Space and Cybernetics". "If man attempts partial adaptation to space conditions, instead of insisting on carrying his whole environment along with him, a number of new possibilities appear." See: Manfred E. Clynes; Nathan S. Kline. "Cyborgs and Space" in *Astronautics* (September 1960) pp. 27. Cyborgs soon became emblematic of technological rather than pharmacological enhancement of human bodies, and more recently, the cyborg emerged as an important figure framing work on gender and identity in technology studies.

[8] "Selected Research Projects", 15. This line of reasoning was later criticized by Hans G. Clamann, who argued that "No weight of equipment is saved, since the oxygen uptake and carbon dioxide production by the body remain undiminished. The oxygen consumption falls only when the situation approaches irreversibility," and that "since the state of altitude acclimatization requires for its preservation constant hypoxia, the gain in altitude tolerance may be more than counterbalanced by the adverse effects upon physical and mental performance." See Clamann, Hans G. "Problems of Metabolism in Sealed Cabins" in *Lectures in Aerospace Medicine, 1961* (San Antonio: School of Aviation Medicine, Brooks AFB, 1961) pp. 14.

peoples who lived and laboured at high-altitudes in Peru.[9] Balke's challenge was how to make "sea level" astronauts in spacecraft as physically productive as "Indians with barrel-like chests and stocky legs" in the Andes.[10] Could he achieve via a relatively quick period of acclimatization what Indigenous bodies appeared to have gradually built-up over generations of adaptation? For Balke, who grew up climbing in the Alps, the question cut right to the Darwinian core of European mountaineering culture, which embraced hostile environments as masculine proving-grounds for ideas about race, nation, and the body.[11] But Balke's interest in race-framed science and comparative studies differed from nineteenth-century anthropologists who explicitly obsessed over human origins, hierarchies, and boundaries.[12] Animated by the German military's need to operate high in the atmosphere, and then America's need to operate in space, Balke was fascinated by populations that survived and thrived in extreme environments. He described his work in space medicine as a search for "the qualities of the superman".[13] However, his favoured method was to search for these qualities in racialized populations, understand their physiology efficiencies through comparative studies, and then figure out how white, male airmen could be made to replicate them.

Medical concepts of 'normal' and 'pathological' are complicated by extreme environments, including mountains, and the pressurized, microgravity interiors of spacecraft. A "normal" person from sea level becomes "sick" when taken to 18,000 feet. Similarly, when astronauts arrive in space, they are immediately impaired relative to Earth standards, and about half experience the disorienting symptoms of what is now called "space adaptation syndrome". Should these changes be considered pathological? Or a new "normal"? Space medicine experts

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[9] These types of studies became common in early space medicine. "Examples of this kind of racialized experimental design can be found among the 424 studies catalogued in *Space Travel and Human Thermal Limits: A Selected Bibliography*: 'Nine Indian men of an arctic village and eight urban white men have been compared in their responses to hand immersion in cold water. [...] The Indians withstood the hand immersion in ice water with quicker rewarming and less pain than the whites'". Quoted in Jordan Bimm; Patrick Kilian. "The Well-Tempered Astronaut" in *Nach Feierabend: Der* Kalte *Krieg* (Zurich: Diaphanes, 2017) pp. 85-107.

[10] See, Richard Dempewolff. "Science Climbs the Mountain Peaks" in *Popular Mechanics* (February 1962) pp. 220: "These mountain Indians with barrel-like chests and stocky legs set far apart, are peculiarly adapted to life a high altitude. They are the primary reason for these Andean labs."

[11] Michael S. Reidy. "Mountaineering, Masculinity, and the Male Body in Mid- Victorian Britain" in *Osiris* 30 (2015) pp. 160. "The mountains provided the perfect physical geography to discuss issues of race, [gender], class, nationalism, civilization, modernity, and physical ability."

[12] George W. Stocking. *Race, Culture, and Evolution.* (Chicago: University of Chicago Press, 1968); Nancy Stepan. *The Idea of Race in Science: Great Britain, 1800-1960* (London: Macmillan, 1982); Stephen J. Gould. *The Mismeasure of Man* (Second Edition) (New York: W.W. Norton and Company, 1996); Jenny Reardon. *Race to the Finish: Identity and Governance in an Age of Genomics*. Princeton University Press, 2004).

[13] Balke, 178.

have struggled to reconfigure the normal/pathological divide around a new concept of "space normal" which requires the simultaneous "renormalizing [of] astronaut bodies and the outer-space milieus they inhabit."[14] Anthropologist Valerie A. Olson argues that astronauts are unique "environmental subjects" that defy Michel Foucault's concept of biopolitics and its focus on "life itself". Instead, Olson turns to Foucault's mentor Georges Canguilhem and the term "eco-biopolitics" to describe how space medicine intervenes at the interface between organism and environment.

Balke's work on acclimatization built-up two different aspects of "space normal", one for everyday life, and another for emergency situations. "Work capacity"—measured by endurance tests on a cycle ergometer or treadmill—simulated exertion under new "normal" low-pressure conditions. "Time of useful consciousness" (TUC) tests conducted in altitude chambers simulated an emergency—the sudden loss of cabin pressure. Balke timed how long subjects could function effectively before the stupor of hypoxia set in. "Work capacity" established a "space normal" body, and TUC tests explored the failure of the "at-risk" human component. Following these practices from Balke's work in the 1930s to the 1950s shows how "environmental subjects" emerged from colonial and military projects, and how the astronaut became structured around categories of race.

THE MOUNTAINEER AND THE ASTRONAUT

To understand early astronauts, space historians have traditionally turned to pilots and the field of aviation medicine.[15] Without denying these obvious influences, this chapter uses the Mount Evans episode to chart an alternate contributing genealogy, one that focuses instead on the figure of the mountaineer, and high-altitude physiology. Like mountaineers, astronauts spend long periods of

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[14] Valerie A. Olson. "The Ecobiopolitics of Space Biomedicine" in *Medical Anthropology*, 29 (No. 2, 2010) pp. 171-172. Olson argues that the astronaut is a hyper-medicalized "environmental subject", rather than the typical biological medical subject captured by Foucault's term "biopolitics". She coins the term "ecobiopolitics" to capture this unique medical subjectivity that rests on the relationship between the subject and the surrounding environment (or milieu). "What defines astronaut medical subjecthood is how astronauts are hyper-medicalized during extreme environmental transitions, exposures, integrations, and adaptations." (pp. 173)

[15] Maura Phillips Mackowski. *Testing The Limits: Aviation Medicine and the Origins of Manned Spaceflight* (College Station, TX: Texas A&M University Press, 2006); Roger Launius. "Heroes In A Vacuum: The Apollo Astronaut as Cultural Icon" in *The Florida Historical Quarterly* (Vol. 87, No. 2, Fall 2008) pp. 174-209.

time living and working in low-pressure environments.[16] When astronauts leave their craft and step onto the surface of another astronomical body, they again shed some of their identity as pilots, and take on aspects of the extreme explorer.[17] Arguably the most iconic images of any astronaut, Buzz Aldrin photographed standing next to the American flag on the surface of the moon in July, 1969, depicts this type of exploration—rife with the symbolism of conquest—rather than aviation. Decentering the pilot both underscores and parses the hybridity of the astronaut, and adds a critical new vantage point from which to study the history and politics of space medicine and its approach to the body. Balke's merging of mountain and space medicine is also significant as the first use of a field-based "environmental analog" for spaceflight, which has become a routine research and training practice.[18]

In the summer of 1958, when Balke and his recruits were living high on Mount Evans, NASA was still an idea being debated in congress. It would be almost a year before their first team of astronauts, the Mercury Seven, was presented to the public. But even at this early moment Balke saw himself and his team of Air Force soldier-subjects as model astronauts.[19] Following six weeks on the mountain, Balke selected one of the men, Major Sam Karst, to accompany him for a 10-day stay sealed inside a two-person space cabin simulator. This was not just basic altitude research, these practices were expected to help choose and indoctrinate real astronauts in the near future. Occurring less than a year after the scare of Sputnik, these experiments were popularized in *LIFE*, *Popular Science*, and science fiction pioneer Donald G. Wollheim's young-adult adventure series,

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[16] Heggie has argued for a "strong disanalogy" between the mountaineer and the pilot. The critical difference is rate of ascent and time spent at altitude (quick ascent and hours at altitude for pilots, and slow ascent and weeks at altitude for mountaineers). Right from the start of space medicine, long duration missions, more akin to long expeditions, were considered a near-term possibility.

[17] In a 1962 report titled "Human Tolerances", Balke offers a moralistic parable about three mountaineers (one in "top physical condition" and two "out of shape") to argue for the physical conditioning of future astronauts. Bruno Balke. "Human Tolerances" (Oklahoma City: Federal Aviation Agency, 1962).

[18] Olson, 174. "To train for their risky missions, astronaut candidates practice living and working in 'analogous' space environments in the arctic and underwater, locations in an archipelago of technoscientifically accessible places now defined together as 'extreme environments' (pp. 174). In Project Mercury, astronauts began receiving survival training in remote desert and tropical locations, and during the Apollo program they began visiting sites in Arizona thought to mimic aspects of the Moon for geological training. See: G.E. Lofgren, F. Horz, and D. Eppler. "Geologic Field Training of the Apollo Astronauts and Implications for Future manned Exploration" in *Analogs for Planetary Exploration* (Boulder: The Geological Society of America, 2011) and Albert A. Harrison. *From Antarctica to Outer Space: Life in Isolation and Confinement.* (New York: Springer-Verlag, 1991).

[19] Balke's report on the expedition was titled, "Man in Space: Experimental Studies on Physiological Aspects of Training and Selection For Manned Extraterrestrial Flights". This formed the basis for his chapter "Conditioning of Man for Space Crews" in *Man In Space: The United States Air Force Program for Developing the Spacecraft Crew* (1959).

Mike Mars: Astronaut.[20] In late 1958, before NASA decided to limit its search to college-educated military test-pilots, their initial astronaut recruitment call listed "mountain climbing" as one of a handful of dangerous occupations where good candidates might be found.[21] So while space medicine was oriented around the pilot, the mountaineer was also in the mix.

SITE 1: NANGA PARBAT, PAKISTAN, 1938

In April, 1938, Balke boarded a freighter in Amsterdam bound for Mumbai. He was part of a large, high-profile German expedition competing to be the first to set foot on a desolate, hostile environment of purely symbolic value. Not the moon, but the summit of Nanga Parbat, a 26,000 foot peak in the Himalayas then considered on par with Everest. Led by Paul Bauer, the leading figure in German mountaineering, the team's goal was to make an historic first summit of the infamously perilous "Mountain of Destiny", which had killed seven of their colleagues the previous summer.[22] Balke's role as team physician extended beyond simply caring for sick or injured climbers, he was also conducting secret altitude research for the Luftwaffe—the German Air Force. Could a few weeks of rigorous activity high in the mountains boost the altitude tolerance of fighter pilots, giving them a tactical advantage in aerial combat? Balke's task was to study changes in the bodies of his teammates over the weeks and months living and working at altitude (Figure 10). This section situates his work on the 1938 German expedition to Nanga Parbat within the longer histories of European mountaineering and high-altitude physiology. This reveals the

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[20] Wollheim's series imagined the exploits of Project Quicksilver, a secret USAF manned space program running in parallel to NASA's Project Mercury and advertising the same set of existing technologies. The series, which circulated widely in paperback, was based on Wollheim's close consultation with Air Force personnel and literature. In *Mike Mars: Astronaut*, the character of Hugo Holderlin, the esteemed German head of USAF Space Medicine research, is clearly modeled after Strughold. Holderlin takes Mike Mars and the rest of the Quicksilver astronaut candidates on an expedition to Mount Evans where the topic of acclimatization and the principles of high-altitude physiology are introduced. Wollheim works in the names of the actual researchers, noting that, "Along with such men as Hubertus Strughold, and Bruno Balke, [Holderlin], had conducted many researches designed to enable men to survive in the conditions of intense cold, airlessness, and weightlessness." Donald Wollheim. *Mike Mars Astronaut* (New York: Doubleday & Company, 1961) pp. 44.

[21] "NASA Project A, Announcement No. 1", 4. "These three characteristics may have been demonstrated in connection with certain professional occupations such as test pilot, crew member of experimental submarine, or arctic or antarctic explorer. Or they may have been demonstrated during wartime combat or military training. Parachute jumping or mountain climbing or deep sea diving (including with SCUBA), Whether as occupation or sport, may have provided opportunities for demonstrating these characteristics, depending upon heights or depths attained, frequency and duration, temperature and other environmental conditions, and emergency episodes encountered."

[22] Another nickname for Nanga Parbat is simply "killer mountain".

military origin of measures of work capacity and TUC, as well as the colonial history of the field-based experimental practice he later used in space medicine. This episode also shows how existing discussions about race, nation, and the body prevalent in mountaineering and high-altitude physiology took on a heightened new significance in Germany during the 1930s, and shaped Balke's belief that producing physically fit soldiers was an indispensable component of geopolitical might.

Figure 10: The German members of the 1938 Expedition to Nanga Parbat. Luft at top, Balke at far right. (Source: Balke, Bruno; Fritz Bechtold; Rolf von Chlingensperg. *Nanga Parbat, Berg der Kameraden: Bericht der deutschen Himalaya-Expedition 1938*. Berlin: Deutsche Union, 1939. pp. 113.)

MOUNTAINEERING

Despite what British climber George Mallory famously proclaimed, nobody climbs a mountain simply "because it is there."[23] According to historian John Neale, there is nothing natural or timeless about mountaineering: "the people who lived in the Alps, the Andes and the Himalayas never used to do it." Historian Robert Macfarlane notes that it was only in the eighteenth century that a shift in European perception made menacing mountains suddenly seem attractive: "the qualities for which [mountains] were once reviled—steepness, desolation, perilousness—came to be numbered among their most prized aspects."[24] For members of Europe's rising middle class, physically positioning themselves "above" nature allowed them to reassert a sense of masculinity and mastery that seemed absent from their new bourgeoisie professions, which depended more on mental than physical prowess.[25]

The publication of *Origin of Species* in 1859 had a huge impact on mountaineers, focusing existing preoccupations with the body toward the budding study of physical performance and limits—physiology.[26] Darwin's emphasis on function, milieu, and competition inspired climbers to ponder and then test the limits of their own bodies in increasingly extreme environments. For them, the mountain worked as a kind of filter, sorting climbers into apparently "naturally selected" winners and losers.[27] In climbing culture, the continued resistance by some to the use of supplemental oxygen comes from this view of mountaineering as a high-stakes Darwinian fitness test.[28]

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[23] As historian of mountaineering John Neale wryly points out, the Empire State Building was "there" too. See: Jonathan Neale. *Tigers of the Snow: How One Fateful Climb Made the Sherpas Mountaineering Legends* (Thomas Dunne Books, 2002) pp. 19.
[24] Robert Macfarlane. *Mountains of the Mind: A History of Fascination* (London: Granta, 2003) pp. 18.
[25] Reidy, 179. "The new class of men was proud to break new ground in order to view the world from a unique vantage point."
[26] Reidy, 160. In the nineteenth-century, Some of Darwin's most prominent supporters, including John Tyndall and Joseph Dalton Hooker, made expeditions to the Alps and Himalayas. Tyndall in particular is credited with "infusing the sport with science" leading to a burst of "scientific mountaineering" in the second half of the nineteenth century. Scientific instruments were carried to high altitudes to measure aspects of the environment like temperature and barometric pressure. John B. West. *High Life: A History of High-Altitude Physiology and Medicine* (New York: Springer, 1998) pp. 251.
[27] Neale, 86.
[28] In his autobiography *Matters of the Heart*, Balke refers to "an unwritten climber's code, the use of artificial safeguarding equipment was strictly taboo." (pp. 22). Heggie writes about the "continued resistance of climbers to 'technological assistance'", within the context of the wider "oxygen dispute" surrounding Everest. (pp. 135).

This Darwinian frame encouraged an agonistic approach to nature that was articulated through military metaphors. Mountains were said to harbour threatening environmental 'weapons', while climbers laid 'siege', 'assaulted' summits, and 'avenged' fallen comrades.[29] These quasi-military adventures captured the European imagination and were framed explicitly in nationalistic terms as teams representing different countries competed for coveted "first ascents". Once the Alps had been 'conquered', attention shifted to greater challenges posed by the Himalayas. Nearly twice as tall, and thousands of miles from western Europe, these required teams to exploit colonial networks and relationships to enter sites in India, Tibet, Nepal, and Pakistan. Since the British then had exclusive access to Everest in Tibet, German climbers "adopted" Nanga Parbat as "their" challenge in 1932.[30] This was the colonization of specific mountains for nationalistic purposes.

A key feature too often relegated to the margins of European Himalayan climbing culture, is the racialized colonial regard for local porters, sometimes called Sherpas. European expeditions relied heavily on teams of hundreds of Indigenous people to maintain long and arduous supply lines to base camps. Once set-up on the mountain, European climbers also required a smaller team of "guides" to carry their supplies. Historian John Neale has characterized this problematic partnership between European and Indigenous climbers as typically colonial, ranging from well-meaning paternalism to blatant racism. These lopsided relationships gloss over many contradictions. As Neale notes, Europeans assumed they were inherently mentally and physically superior, and that accomplishments on the mountain were theirs alone. Yet they required porters to make the exact same journey weighed down with heavier packs and inferior equipment. Like other aspects of colonialism, nationalistic climbing expeditions relied on maintaining this sense of inequality and erasure to achieve their goals.[31]

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[29] Harald Hoebusch. "Ascent into Darkness: German Himalaya Expeditions and the National Socialist Quest for High-Altitude Flight" in *The International Journal of the History of Sport*, 24 (No. 4, April, 2007) pp. 525.
[30] West, 251.
[31] Neale, 14. A very disturbing example of this rift in regard is given by Neale: "Helicopters evacuate sick trekkers, whose insurance companies pay $4000 each time. There is no evacuation for porters with pneumonia or altitude sickness. In the great storm of November 1977, the snow trapped trekking parties all over Nepal. Many foreigners were taken out by helicopters. They left the porters behind because nobody would pay for their rescue." (pp. 14)

HIGH-ALTITUDE PHYSIOLOGY

The question of how altitude affects humans predates the sport of mountain climbing. John B. West's authoritative history of high-altitude physiology, *High Life* (1998) begins with ancient anecdotal reports from China and Greece of mountains having deleterious mental and physical effects.[32] However, the standard starting point for many histories of "mountain sickness" is an account from the sixteenth-century Jesuit missionary Father Joseph de Acosta, who in 1570 travelled across South America during the Spanish Conquest.[33] He described feeling pain and nausea while navigating a pass on Mount Pariacaca in the Andes while on his way to meet Viceroy Francisco de Toledo.[34] Acosta attributed his symptoms to the air being "so subtle and delicate, as it is not proportional with the breathing of man, which requires a more grosse and temperate air".[35]

Antoine Lavoisier's discovery of oxygen in 1778 led to a scientific reframing of mountain sickness in terms of a lack of this vital gas. But it was late nineteenth-century French physiologist Paul Bert who in 1878 transformed the study of altitude sickness from a collection of diverse anecdotal accounts into a modern, laboratory-based, experimental science. Funded by wealthy patron and fellow researcher Denis Jourdanet, Bert constructed a set of human-sized hypo and hyper-baric chambers in his Paris laboratory.[36] The tragic deaths of early balloon aeronauts venturing high into the atmosphere inspired his search for the physical cause of altitude sickness and death.[37] His experiments with both animal and human subjects in these chambers resulted in his important book *La Pression Barométrique* (1878). Bert's most pivotal finding was that illness or death from altitude was determined by the partial pressure of oxygen, and not by a lower concentration of oxygen in the air.[38] Bert famously used one of his chambers to simulate an ascent of Mount Everest, but this was as close to the field as he ever got.[39]

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[32] West, 1-7.
[33] West, 11. West notes that in the 1960s a portrait of Acosta was hung at the School of Aviation Medicine.
[34] ibid, 11-14.
[35] ibid, 15. West notes that this understanding predates both Torricelli's first mercury-based thermometer in 1643, and Pascal's discovery that barometric pressure falls with altitude in 1647.
[36] These were based on the work of Robert Boyle's assistant Robert Hooke, who first built a human-sized chamber connected to an air pump and performed experiments on himself inside.
[37] Marcos Cueto. "Andean Biology in Peru: Scientific Styles on the Periphery" in *The History of Science Society*, 80 (No. 4, December, 1989) pp. 641.
[38] The partial pressure of a gas in a mixture is the pressure it would exert alone in a container of the same volume. The total pressure for the mixture is the sum of the partial pressures of each individual gas (Dalton's Law).
[39] West, 70.

Despite Bert's foundational lab work, the discipline quickly shifted to a field-based expeditionary science. Physiologists interested in altitude prioritized knowledge produced in the field over contrived laboratory simulations and began venturing to high places in colonial circuits. Heggie notes that the location of high-altitude physiology's "truth-spot" in the field rather than the laboratory resulted from instances of lab-predicted limits being surpassed during expeditions.[40] In 1889, Angelo Mosso established the first experimental high-altitude station—a lab situated in the field—in the Italian Alps. This new type of laboratory made use of the surrounding environmental conditions, and later became central to Balke's work. These early expeditions were conducted with explicit military and colonial goals in mind; the figures conjured time and again were the soldier and the worker, resulting in a kind of hybrid precursor to the astronaut.[41]

COMPATIBILITY WITH NATIONAL SOCIALISM

The handful of historians who have written about German mountaineering and high-altitude physiology agree that, unlike theoretical physics, these fields proved very compatible with National Socialism in the 1930s.[42] Their preexisting nationalistic and militaristic character, and obsession with the body as a holistic "tool", aligned with Nazi ideology.[43] Macfarlane notes that, "Hitler believed strongly in the mystical power of mountains, and the image of the striving, suffering, physically remarkable mountain-climber lent itself well to fascism."[44] Nazi leaders saw the nationalistic competition brewing in the Himalayas as an opportunity to reassert the nation following their humiliating defeat in World War One, and the military restrictions of the Treaty of

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[40] Heggie, 124.

[41] Cueto, 642. For example, "Bert's physiological studies were expressly directed to resolving the acclimatization problem of the French troops attempting to maintain the Habsburg regime of Maximilian I in Mexico. Barcroft's research was done in Cerro de Pasco, the country's most important mining district, which was exploited by the U.S. Cerro de Pasco Copper Corporation, a company that controlled the extraction of Peruvian copper. His conclusions on physical exertion at high altitudes could be useful for the mining industry; in fact, Cerro de Pasco provided assistance and facilities to the expedition." (pp. 642).

[42] See: David Cassidy. *Uncertainty: The Life and Science of Werner Heisenberg* (New York: Henry Holt and Company, 1993).

[43] Macfarlane, 2003; Neale, 2005; Hoebusch, 2007; Rodway, 2009. Neale has highlighted how Nazi racial ideology focused on the body, rather than the mind, forging a strong connection between a fit population and the restoration of the nation's collective might. Harald Hoebusch and Macfarlane have both written about the remarkable compatibility between conservative, Darwinian ideas in mountaineering and the racial ideology of National Socialism.

[44] Macfarlane, 91n.

Versailles.[45] As Paul Bauer, the leader of Balke's 1938 expedition to Nanga Parbat put it, "when we had to lay down our weapons, the empty hand felt around for the ice axe."[46] Under this new régime, all sports—but mountain climbing in particular—took on deep political resonances.[47] Many well-known mountaineers were also enthusiastic party members, and served as prominent functionaries in revitalized German sports organizations. Recognizing the immense potential mountaineering achievements had for their propaganda effort, the Nazi government began funding mountaineering expeditions. For example, Willy Merkl's 1931 expedition to the Himalayas was conducted on a shoe-string budget. However, when he expressed interest in returning in 1934 he suddenly received lavish funding from the newly-appointed Reichssportfuhrer, which came with publicity, and intense expectations of success. German mountaineers were not attempting to climb Nanga Parbat because it was there, but as part of a wider project to rebuild German national identity and advertise physical and technological capabilities as a proxy for military might. But as Balke's dual role as physician and military researcher shows, these were not only symbolic missions to produce propaganda. Tangible applications to aid the Air Force in projecting Nazi power globally was also a major goal of the mission.

BRUNO BALKE AND THE 1938 GERMAN EXPEDITION TO NANGA PARBAT

Balke was born in 1907 in Braunscheig, Germany to a sporting family of skiiers and mountain climbers. He excelled at both and enrolled in Berlin's new Academy of Physical Education in Berlin with the goal of becoming a teacher or trainer. In 1928, he was admitted into medical school at Berlin. To be able to afford the expensive tuition, he worked nights as a fencing coach, and spent semester breaks as a mountain guide and ski instructor in the Alps.[48] At medical school in Berlin, Balke met another student named Ulrich C. Luft, who later played a recurring role in shaping his

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[45] Writing as an American citizen in his autobiography in the 1990s, Balke still appears upset over the "much harsher peace treaty", noting the "horrendous reparations payments", and lamenting that Germany "lost all of its overseas colonies." Balke, *Matters of the Heart*, pp. 17.
[46] Neale, 92.
[47] Hitler's obsession with hosting and dominating the 1936 Olympics is another good example of this.
[48] Balke, *Matters of the Heart*, 25-26.

career, both in Germany and later in the United States. Balke received his medical degree in 1936, and in 1937 was hired as a sports physician at the University of Berlin.[49]

In early 1938, Luft came to Balke with an enticing but risky proposition: would he consider joining him as part of an expedition attempting to summit Nanga Parbat? It was a very dangerous offer to be sure. Willy Merkl, who had failed to summit Nanga Parbat on a tight budget in 1931, froze to death along with nine other climbers during his well-equipped Nazi-funded attempt in 1934. In 1937, just months before visiting Balke, Luft had been the only survivor of another disastrous attempt. While camped at 20,000 feet, a massive avalanche had crushed the German team's tents, suffocating 16 climbers in their sleep. Luft alone was spared because he had temporarily returned to a lower camp. Back in Germany, these two disasters were a major blow to the nationalistic climbing community's narrative of German superiority, and Paul Bauer, head of Nazi mountaineering, became determined to personally deliver the propaganda victory that had so far eluded them. For Bauer, a proud veteran of the Great War, refocusing on an easier mountain was out of the question; "it would have been intolerable to attack another Himalayan mountain as long as Nanga Parbat held our comrades unavenged," he seethed, framing the expedition as a military operation and moral obligation.[50] Luft's job on the doomed 1937 expedition had been to assist Hans Hartmann, a physiologist with the Luftwaffe's new aviation medicine research institute (LMFI) in Berlin.[51] Their role was to study how the team acclimatized to altitude, but Hartmann was among the 16 climbers killed in the avalanche. All was not lost, however, as Luft and a rescue team were able to excavate Hartmann's frozen corpse and locate his notebook filled with data. It was this Luftwaffe-sponsored study that Luft now asked Balke to join him in completing. Balke jumped at the chance for adventure.

In 1943, Balke, Luft and five other team members published an account of the expedition, titled *Nanga Parbat: Berg Der Kameraden* ("Mountain of Comrades"). The travel narrative is illustrated with one hundred striking black and white photographs. It begins by depicting the team's arrival in India, and their long trek into the Himalayas to base camp.[52] The team is shown climbing amid majestic snow-capped peaks as the expedition's main events unfold: the setting up

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[49] ibid, 30.
[50] Neale, 209.
[51] Hubertus Strughold was the director of the institute from 1935 until the fall of Berlin in 1945.
[52] Bruno Balke, Fritz Bechtold, Rolf von Chlingensperg. *Nanga Parbat, Berg der Kameraden: Bericht der deutschen Himalaya-Expedition 1938* (Berlin: Deutsche Union, 1939) pp. 42.

of a portable radio transmitter and receiver, communication with an in-bound Luftwaffe Ju-52 airplane, the test recovery of airdropped supplies on the mountain, the grisly discovery of Willy Merkl's frozen corpse from the failed 1934 expedition, and the men closing in on the summit. The image of the portable radio set, and the Ju-52 plane appearing over a ridge, later became emblematic of the expedition, underscoring their military work. Photographs also capture the team's colonial regard for the Nepalese porters their mission relied upon. A common trope in mountaineering accounts is that European climbers are presented as individuals, while Indigenous porters and guides are rendered invisible, infantile, anonymous, or treated as a group.[53] In *Berg Der Kameraden* this can be seen by comparing photographs of Germans and Nepalese participants. Captions identify each German climber by name: "Balke unter dem Gipfel des Buldar-Peak".[54] Photographs of Nepalese climbers weighed down with heavy packs do not: "Sherpa-Träger im Pendelverkehr zwischen Lager II und IV".[55]

After spending two months working their way up to 25,000 feet on Nanga Parbat, Bauer decided to conclude the expedition without reaching the summit. Exercising caution, he turned back rather than risk another embarrassing disaster. But Luft and Balke were successful in completing Hartmann's study.[56] Luft concluded that "The data we obtained on the mountain at altitudes up to 25,000 feet led to the conclusion that, given enough time at intermediate altitudes, the human body can adapt adequately up to 19,000 or 20,000 feet for a period of many weeks."[57] Luft and Balke suggested that acclimatized pilots could fly unpressurized fighter planes 3,000 feet higher than their adversaries, and published their encouraging data in two articles that appeared in the military aviation medicine journal *Luftfahrtmedizin*.[58]

Like many other German scientists who participated in Operation Paperclip, Balke later downplayed the military character of his research, casting himself as the typical apolitical scientist. In his 2007 autobiography, Balke wrote that "My own sportsmedical work and the work with Uli Luft on the physiological evaluation of the expedition members occupied all of my time and

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[53] Neale, 17.
[54] *Berg Der Kameraden*, 117.
[55] ibid, 122. Translation: "A Sherpa porter between camp II and IV".
[56] Hoebusch, 527. This included taking cardiovascular, respiratory and haemotological measurements on all team members during the expedition, and also determining how their tolerance to acute exposure to extreme-altitude—"TUC"—in low-pressure chambers had changed before and after they had been acclimatized.
[57] ibid, 527.
[58] ibid, 527. Their articles were titled "Physiologische Beobachtungen am Nanga Parbat 1937/38" ("Physiological observations on Nanga Parbat 1937/38") and "Zur Verwendung von Hohenatemgeraten auf Himalajaexpeditionen" ("On the use of oxygen apparatus on Himalayan expeditions").

interest; thus I paid no attention to the political upheaval of that time."[59] But his work *was* inherently and obviously political. Figuring out how to achieve high-altitude flight supported the Luftwaffe's goal of attaining air superiority—a crucial element of Hitler's expansionist plans.

BALKE'S WAR

In September, 1939, Hitler invaded Poland and the Second World War began in earnest. Shortly afterward, Balke joined the Wehrmacht—the German Army—where he served as a field doctor.[60] In the spring of 1940, Balke requested a transfer, and was reassigned to the Wehrmacht's elite First Mountain Division, famous for their ability to fight in difficult terrain (Figure 11). He participated in the invasion of France, where he was briefly reunited with Paul Bauer and other members of the Nanga Parbat expedition. This time he wished them luck on another assault: the Aisne Canal en route to Paris.[61] In 1941, Balke's unit was part of Operation Barbarossa, the Nazi invasion of Russia. As a doctor near the front, he saw many horrors of war firsthand, treating both gunshot and shrapnel wounds as well as infectious diseases. Balke eventually contracted Hepatitis himself and was ordered back to Berlin to recuperate—an unlucky turn that probably saved his life. While in Berlin, he was contacted by his old friend Luft who again made him another life-altering offer. The Luftwaffe had read Luft and Balke's publications based on the Nanga Parbat studies, and wanted to condition pilots at a high-altitude station. Luft, who had replaced Hartmann at Strughold's research institute in Berlin, thought Balke perfect for the alpine post. Given that the alternative was to return to the fighting on the Russian front, the choice for Balke was obvious.

[59] Balke, *Matters of the Heart*, 42.
[60] ibid, 42. Balke recalls becoming "a kind of drill sergeant" to the Wehrmacht soldiers.
[61] ibid, 43.

Figure 11: Balke in his Wehrmacht uniform in 1942. (Source: Bruno Balke. *Matters of the Heart: Adventures in Sports Medicine.* Monterey: Healthy Learning, 2007. pp. 69.)

Early in 1942, Balke reported to the Wehrmacht's Mountain Medical School in St. Johann, a small town on the Austrian side of the Tyrolean Alps. The school had been established to train physicians and officers in the medical problems of fighting in extreme environments.[62] The school had two existing laboratories, including one that focused on Balke's forte: "experimental investigations of human capacity and on adaptability to special conditions encountered in mountain regions."[63] His first job was to establish a third off-site high-altitude laboratory for training and conditioning Luftwaffe pilots. A scouting excursion to the central Alps near Grossglocker located a good fit: the Oberwalder Hut constructed by the Austrian Alpine Club at 9,900 feet was quickly converted to accommodate his work. Balke began using a cycle ergometer

[62] Paul Weindling. *Victims and Survivors of Nazi Human Experiments: Science and Suffering in the* Holocaust (London: Bloomsbury, 2015) pp 85. Lethal human experiments on concentration camp prisoners for the purpose of acclimatization to extreme dry cold were planned by S.S. officer Sigmund Rascher at St. Johann.
[63] ibid, 48.

to measure changes in work capacity with acclimatization to altitude. It is here that Balke began developing the practice of training at altitude to boost work capacity after a return to sea-level, which was the basis of the Mount Evans experiment in Colorado.[64] "We learned that a period of two to three weeks at an altitude above 3,000 meters (10,000 feet) resulted in maintaining consciousness at simulated altitudes of 10,000 meters (32,800 feet). For practical applications, fighter pilots were trained under my guidance at the high-altitude station. Upon returning to their bases, they were able to exceed the altitude tolerance of nonacclimatized pilots by about 3,000 feet, a great advantage in battle."[65]

In the aftermath of the war, Balke claims to have been cleared of explicit connections to Nazism by an unnamed French official during the occupation.[66] He spent the next few years bouncing around the ruins of Europe, working as a masseuse for the Austrian nation hockey team, and also as a cobbler. His luck changed in November 1949, when he received a personal visit from Hubertus Strughold, who had been the director of the Luftwaffe's research institute in Berlin that had employed Hartmann and Luft. Luft had again put Balke's name forward, this time to join Strughold at the United States Air Force's School of Aviation Medicine in San Antonio, Texas through a special program called Operation Paperclip. Strughold, who had just been made the head of the new forward-looking Department of Space Medicine, needed a specialist in human performance physiology. Balke agreed without hesitation. In February 1950, he boarded the transport ship *General McCullen* in Bremerhafen and made port in New York City. He headed south to Texas by train.

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Balke arrived at the School of Aviation Medicine later than most German scientists. Now forty-three years old, he was assigned to the newly-minted department of human performance and physiology for a six-month trial. By comparison, most of the other German scientists at the School

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64 "Tests of maximal functional capacity at the end of rigorous physical training at low elevation, followed by training at altitudes above 3,000 meters (10,000 feet) and testing again after returning to the former lower base level." Balke, *Matters of the Heart*, pp. 49.

65 Balke, *Matters of the Heart*, 50. Balke used his research at the high-altitude station as the basis for a PhD dissertation in physiology titled "Physical Performance Capabilities in High Mountains," which was granted by the University of Leipzig in March, 1945, just days before the fall of the Reich.

66 ibid, 56. "All accusations against me were dropped. I could go home as a free man."

already had secured long-term contracts, resettled their families, moved into houses, and even owned their own cars—astonishing to Balke who had just come from poverty-stricken post-war Germany. Determined to impress Strughold and his new American bosses, Balke immediately began working on new problems of physical performance at altitude faced by American nuclear bomber crews flying at 50,000 feet.[67] However, the school and surrounding Texan desert was missing a crucial element of Balke's previous work: mountains. Restricted to the laboratory, Balke lacked access to high-altitude physiology's ultimate "truth-spot", and the only practical place to study long-term acclimatization to altitude.[68]

SITE 2: MOROCOCHA, PERU, 1954

In 1954, Balke flew to Lima, Peru and then drove inland from the coast up to Morococha, a small mining town situated at 14,900 feet in the Andes Mountains. He was sent by the School of Aviation Medicine to perform work capacity and TUC tests on himself and the local Indigenous population, who had long been considered uniquely adapted to the high-altitude environment.[69] This section explores the United States Air Force's little-known outpost in the Peruvian Andes, where race and nationalism framed high-altitude physiology in a very different way. The USAF's contract with the Institute of Andean Biology in Lima allowed Balke to use their high-altitude laboratory in Morococha to experiment on Indigenous copper miners with the bodies of future astronauts in mind. Here we see how race and colonialism extended beyond the expedition to the experiment.

Like the Air Force's cold acclimatization and radiation experiments performed on Indigenous peoples in Alaska, Balke's goal was biological appropriation.[70] He attempted to mobilize aspects of Indigenous bodies that seemed militarily advantageous, and then recreate their functional effects in white soldiers. It was the reverse engineering of human difference. In the

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[67] ibid, 64. In 1953 Balke was able to bring the rest of his family over from Germany, and in 1954 his status as a permanent resident was approved by the U.S. Civil Service Commission

[68] Both because it was impractical to live and exercise for weeks inside a pressure chamber, and because Balke and other high-altitude physiologists who were experienced mountaineers trusted the field more than the lab. See: Heggie.

[69] A 1921 newspaper article describing Barcroft's expedition to Morococha, titled "Peru Natives Are High Air Birds", noted that "Many of the natives of Peru, it is stated, are much less affected by the rarified air of high-altitudes than are ordinary men of other races who are accustomed to hard labour". (pp. 4).

[70] Matthew Farish. "The Lab and the Land: Overcoming the Arctic in Cold War Alaska" in *Isis* 104, (No. 1, 2013), pp. 1-29.

1950s, Indigenous people in Peru were also studied by American social scientists, and were the subject of a special World Health Organization session in 1966.[71] In *Race to the Finish: Identity and Governance in an Age of Genomics*, Jenny Reardon explains how after the Holocaust scientists attempted to discredit and jettison the now-toxic concept of "race". An important episode in this post-war "retreat from race" was the 1946-1947 Nuremberg Doctor's Trial, where 23 German medical doctors—including some of Balke's Luftwaffe associates—were tried for crimes that included lethal altitude experiments on vulnerable subjects considered to be racially inferior and therefor disposable for scientific ends. Adding to Reardon's point that this "retreat" was largely superficial, Balke provides an interesting case: a former Nazi doctor resuming human experimentation on vulnerable racialized populations seven years after the Doctor's Trial, and in the wake of the UNESCO statements on race, for the United States military.[72] Balke's racialized comparative studies show how older relationships between Indigenous people and colonizers were reconfigured around Cold War military problems; his close study of high-altitude people was to enable American soldiers operate in extreme environments, and to settle the new frontier of space.

Balke's work at Morococha shows how high-altitude physiology's colonial character constructed two separate models for the relationship between humans and low-pressure milieus—long-term adaptation and short-term acclimatization. Critically, these two models also distinguished between two different racialized subjects: Indigenous inhabitants who had 'adapted', and 'normal' white colonial visitors who wanted to 'acclimatize' relatively quickly. This dichotomy facilitated the colonization of the Andes, but also became part of a wider move to colonize an entire *type* of space: low-pressure artificial environments in outer-space. Balke wanted to acclimatize "visitors"—white Air Force pilots—to display the same work capacity and TUC as Indigenous "inhabitants".

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[71] See: "Life at high altitudes. Proceedings of the Special Session held during the Fifth Meeting of the PAHO Advisory Committee on Medical Research 15 June 1966". (Pan American Health Organization: Scientific Publication 140, 1966) pp. 140; "Biomedical Challenges Presented by the American Indian". (Pan American Health Organization: Scientific Publication 165, 1968), pp. 1. In his article "Developing Selves: Photography, Cold War Science and 'Backward' People in the Peruvian Andes, 1951-1966", Jason Pribilsky describes how behavioural scientists from Cornell attempted to read and encourage proto-capitalistic values in Vicosian culture. "As one evaluator enthused, 'To actually 'rent' a population in which the experimental introductions could be carried on would come excitingly close to the long-sought laboratory of human society which sociologists and anthropologists have often dreamed.'" See: Pribilsky, Jason "Developing Selves: Photography, Cold War Science and 'Backward' People in the Peruvian Andes, 1951-1966." In *Visual Studies*, 30 (No. 2, 2015) pp. 132.

[72] Jenny Reardon. *Race to the Finish: Identity and Governance in an Age of Genomics* Princeton University Press, 2004) pp. 25-28.

In the context of space medicine, this practice implicitly built-up the astronaut in opposition to the high-altitude Indigenous person. This was a subtle, yet crucial act of exclusion that had an insidious self-reinforcing effect: information generated in these studies became "guidelines" for making future astronauts.[73] The following section provides a brief history of high-altitude physiology's interest in Andean people, with a focus on research at Morococha.[74] I suggest that "Andean Biology", the unique style of nationalistic medicine developed by Peruvian physiologists in the 1920s, was a precursor to the modern concept of "space normal". Presenting "Andean Man" as a foil for the astronaut was an act of exclusion that cast the astronaut as implicitly white.

Figure 12: The IAB laboratory at Morococha visible above a row of worker homes. (Source: Hermann Rahn. "Soccer or Soroche" in *Rochester Review* 17 (No. 4, 1956) pp. 14-15.)

[73] Alberto Hurtado; Robert T. Clark "Parameters of Human Adaptation to Altitude" in *Physics and Medicine of the Atmosphere and Space* (Wiley, 1960). "Studies on the altitude natives will continue to furnish guide lines for further research toward physical selection and training of crewmen for high performance vehicles in the future".

[74] On the topic of high-altitude physiology in Peru, Marcos Cueto (1989) has written extensively about the main personalities, Carlos Monge Medrano, and Alberto Hurtado, as well as the founding of the Institute of Andean Biology in Lima. More recently, Jorge Lossio (2008) has written about the Institute's partnership with the Cerro De Pasco Mining Corporation by focusing work at the Chulec Hospital. Marcos Cueto. "Andean Biology in Peru: Scientific Styles on the Periphery" in *The History of Science Society*, 80 (No. 4, December, 1989) pp. 640-658; Jorge Lossio. "Nation Disease and Health: Medical Research in the Peruvian Andes and the Emergence of 'High-Altitude Diseases" in *Beyond Borders: Fresh Perspectives in History of Science* eds. Josep Simon and Néstor Herran (Newcastle: Cambridge Scholars Publishing, 2008) pp. 269-290.

ANDEAN BIOLOGY AND ANDEAN MAN

In the late nineteenth-century, following the quick turn from lab to field, European and then Peruvian researchers took an interest in Indigenous people who lived permanently at high-altitude. In 1863, Bert's benefactor Jourdanet journeyed from France to the high plains of Mexico where he performed the first physiological studies on Indigenous people living at altitude. He concluded that they were "a race characterized by signs of marked debility."[75] In 1889, Bert persuaded another French physiologist, Francois-Gilbert Viault, to travel to the Peruvian Andes to conduct tests on Indigenous people who laboured in high-altitude copper and silver mines. Viault travelled to Morococha—the future site of Balke's Cold War visits—where he noted an increase in red blood cells in samples drawn from himself and the locals, which he argued was an adaptation to the low atmospheric pressure. This was the first suggestion that then-unknown physiological processes could counteract the effects of altitude.[76]

In 1921, Cambridge physiologist Joseph A. Barcroft led an expedition to the Cerro de Pasco mining district located at 14,200 feet in the central Peruvian Andes.[77] After converting an empty railcar into a makeshift laboratory, the group began three months of tests on themselves, and the local Indigenous population. At the time, Barcroft was engaged in a debate with J.B.S. Haldane over the exact mechanism of acclimatization. In 1914, Haldane had conducting an expedition to Pike's Peak in Colorado, where he concluded that people who live at high-altitudes undergo physiological changes that effectively counteract the low-pressure and eventually produce functionality equivalent to that at sea-level. Barcroft's work in Peru, published in 1923, found the opposite: "All dwellers at high-altitude are persons of impaired physical and mental powers."[78]

These findings, and the above passage in particular, caught the ire of Carlos Monge Medrano, a mostly self-taught Peruvian physiologist who also had trained in Paris and London in tropical medicine. Insulted by Barcroft's low estimation of Andean people, Monge attacked the findings, cleverly suggesting that altitude may have clouded Barcroft's judgment. In April, 1927,

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[75] West, 205. According to historian Marcos Cueto, Jourdanet "concluded that Mexicans were an anemic race because anoxia… kept them in a permanently weakened state." (Cueto, 641)
[76] Cueto, 641.
[77] His team also included researchers from Harvard and the University of Toronto. See Barcroft (1923).
[78] Cueto, 642. West, 205. Barcroft wrote: "The acclimatized man is not the man who has attained bodily and mental powers as great in Cerro de Pasco as he would have in Cambridge (whether that town be in situated in Massachusetts or England). Such a man does not exist."

he led his own team from San Marco University in Lima up to Morococha.[79] Between 1927 and 1932, Monge and groups of researchers made eight trips to different settlements in the highlands. Monge's resulting publications trumpeted "the exceptional performance—especially physical performance—of native Indians", and significantly raised his profile among his better-funded North American and European peers. Sustained interest from abroad resulted in the founding of The Institute of Andean Biology at the Faculty of Medicine at San Marcos University in Lima in 1931.[80] In 1934, Monge became the director of the Institute.

In contrast to Balke's work in the Himalayas that focused on Germans and sidelined Sherpas, Monge promoted what he saw as the unique strengths of Indigenous bodies. Monge's strong response to Barcroft, and the subsequent founding of the institute, were part of a wider nationalist intellectual movement in Peruvian society called *indigenismo*.[81] Started in the 1920s, *indigenismo* sought to recover "Andean life" and rethink the place of Indigenous people in modern Peruvian society.[82] Taking Barcroft's assessment as an affront to national pride, Monge set out to rehabilitate the standing of the Indigenous Peruvians in biology. This was *indigenismo* "extended to medical and scientific circles".[83] Monge's view of biology incorporated this surging nationalistic sentiment. He believed that the high-altitude Andean environment was unique, and that existing medical ideas and practices that took sea-level conditions as "normal" needed to be adapted. Historian Jorge Lossio notes that Monge stressed the locality of medical knowledge, which ran counter to the dominant trend toward universalistic conceptions of health and pathology. To underscore this, Monge called his new sub-discipline "Andean Biology".

For Monge, the reconfiguration of 'normal' and 'pathological' in Andean Biology demanded a physiological reappraisal of its unique human subject, the Indigenous person, as "Andean Man". Crucially, while Barcroft had only studied resting bodies, Monge shifted the focus to exercise physiology and "work capacity"—the time spent exerting before exhaustion. According to Monge, the low-pressure environment had produced special adaptations in the bodies of Andean people that allowed them to physically outperform visitors from the lowlands. He considered "Andean Man" to belong to a "climatic variety of the human race", and to be "the race

[79] Cueto notes Monge made eight trips to ten different destinations between 1927 and 1932.
[80] Cueto, 644.
[81] Pribilsky, 134. "Beginning in the 1920s, intellectuals and artists began promoting the country's native inhabitants towards a Peruvian national identity based on the Inca past."
[82] Cueto, 647.
[83] ibid, 647.

with the greatest physical performance in the world."[84] Far from Barcroft's image of permanent impairment at altitude, Monge held up "Andean Man" as a kind of superman.[85]

But Monge's defense of Andean people still stemmed from a particular paternalistic colonial gaze, which has been termed "Andeanism".[86] Looking at Europe and the Alps, Michael Reidy has detailed how male climbers crafted a gendered hierarchy of altitudinal "zones", with the highest levels comprising a masculine preserve.[87] A similar concept of altitudinal zoning, this time along racial lines, was constructed in Peru, with European-descended "mestizo" inhabiting the lower coastal areas, and Andean people "properly" residing in the mountains. This was the basis for the idea that Peru is really "two countries in one".[88] Andeanism, inspired by Said's Orientalism, divides humans into categories of "we" and "they" and essentializes the resultant 'other'. Andeanism dichotomizes between the urban, coastal, Western "mestizo", and the inland, Indigenous peoples who reside in the Andes. This view portrays Indigenous people as unitary, "pure", and "timeless". This division is spatial (horizontal *and* vertical) but also temporal. The coast is depicted as the future-oriented present, while life in the mountains harkens back to the pre-colonial Incan past.[89] Lossio points out that this idealized view of the "timeless Andean native" masked the reality that these people had undergone massive social and cultural upheavals since colonization, from Inca, to colonial peasants, to industrial miners.[90] Focusing on Andean Man's resilience against nature also allowed Monge to conveniently avoid addressing the hostile social and economic environment of these mining towns. While he promoted their physiology, Monge still viewed Andean miners as scientific objects in a natural laboratory. This colonial binary of lowland/highland at the root of Andeanism, was reproduced in comparative high-altitude physiology and incorporated into space medicine.

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[84] ibid, 646.
[85] ibid, 646. Cueto notes that Monge never used the term "superman", but argues that it is an apt descriptor of his view.
[86] This is a nod to Edward Said's related term Orientalism.
[87] Reidy, 163.
[88] Lossio, 282. When this characterization of geographic and cultural division is extended to include the Amazon region, Peru becomes "three lands". See: Hermann Rahn. "Soccer or Soroche" in *Rochester Review* 17 (No. 4, 1956) pp. 15.
[89] Rahn, 15. One example of this depiction is given by Hermann Rahn, an American physiologist who worked at Morococha in 1956 as part of a Rockefeller-funded fellowship: "The Spanish settled primarily along the Pacific Coast and Lima has become the cultural and business center, while on the east side of the mountains remain the vast and nearly untapped resources of the Amazon. In between lies the lofty Andean home of the ancient Inca empire. Even today their descendants prefer the high altitudes and provide one of nature's fascinating experiments—acclimatization of man to low oxygen pressure."
[90] Lossio, 272.

The story of Monge and “Andean Man” is incomplete without highlighting the essential and troubling role of the Cerro de Pasco Mining Corporation in creating Andean Biology. Cueto and Lossio both argue that by installing modern medical facilities in remote areas and employing large populations, industrialized mining was indispensible in the development of Peruvian high-altitude physiology. Without these elements already in place, Monge’s work would have been prohibitively difficult. In the early twentieth century, a group of American investors bought up most of the lands and mines in central Peru, launching a major effort to industrialize and scale-up extraction under the banner of the Cerro de Pasco Mining Corporation. By the end of World War Two, the U.S.-based company was the largest single employer in Peru.[91] Lossio notes how American managers sought to employ a large, exclusively Indigenous workforce. This involved instigating “the migration of thousands of native workers from moderate to high-altitudes, and the establishment of modern hospital facilities there.” These modern hospital facilities included laboratories and equipment, but most crucially patients, who researchers from Monge’s Institute could use as experimental subjects.[92]

[91] ibid, 272.

[92] Lossio points out that while Monge and his student Hurtado were at times critical of the corporation’s treatment of the Indigenous workers, they still accepted work and resources presented by the company. Lossio goes so far as to suggest that the company used the presence of the physicians and some token improvements to strategically soften its reputation for brutality.

Figure 13: Miners employed by the Cerro de Pasco Mining Corporation at Morococha. (Source: Pontifical Catholic University of Peru archives. Online: http://repositorio.pucp.edu.pe/index/handle/123456789/4704).

Lossio also outlines the company's long history of exploitative labour practices. They used questionable tactics to convince Indigenous people to relocate to mining towns—everything from predatory lending, to willfully destroying the farmlands around existing villages. At the mines, life and work was racially divided, with white American managers and engineers overseeing teams of Indigenous workers. Lossio notes that the company exclusively recruited Indigenous workers because of a "conviction of the unique capacity of the Andeans to resist the effects of high-altitude", but also because they were a population that could be exploited.[93] Work in the mines was often perilous, and the company's checkered safety record was first protested by activist Dora Mayer in her 1913 condemnation *The Conduct of the Cerro de Pasco Mining Company*, which highlighted the widespread use of child labour, institutionalized neglect for worker safety, high

[93] Lossio, 273.

number of worker deaths, and poor living conditions.[94] Lossio describes these Indigenous workers as a "captive population", and a "population out of place", lacking the resources to escape the coercive circuits of the company town. Lossio includes this chilling description of the tight hold the Pasco Corporation had on its all-Indigenous workforce: "the physician of the company delivers the children; afterward they attend the school of the company; are employed by the company; and are buried by the undertaker of the company."[95] In this sense, these high-altitude people were a vulnerable population for which voluntary participation in experimental medical research was by no means a straight-forward proposition.

IAB & SAM

Soon after the founding of the Institute of Andean Biology in 1931, outside funding began to arrive from American universities and foundations. In 1934, as part of their much wider interest in Latin America, the Rockefeller Foundation began a longstanding relationship with the Institute, donating equipment for laboratories, and paying for Peruvian medical students to study at universities in the United States. One student who had previously gone this route in the 1920s was Alberto Hurtado, who along with Monge is the other major figure in Peruvian high-altitude physiology. A generation younger than Monge, Hurtado was a Harvard-trained medical doctor who had done Rockefeller-funded research at the University of Rochester. Although the two disagreed on the essential uniqueness of Andean Biology, Hurtado worked alongside Monge at the Institute as research director and formed the most lucrative relationships with American funding bodies, including the United States Air Force.

In 1947, Monge and Hurtado used their connections with the Rockefeller Foundation, and the Cerro de Pasco Mining Corporation to establish a special high-altitude laboratory at Morococha, which had been a site of previous expeditions going back to Viault in 1889. The Pasco Corporation donated a plot of land, and a Rockefeller grant provided funds for equipment and staff

[94] Dora Mayer. *The Conduct of the Cerro de Pasco Mining Company*. (Lima: Association Pro-Indigena, 1913)
[95] Lossio, 274.

salaries. Hurtado saw these partnerships as essential for science to thrive on the "periphery": "We are the sons of Rockefeller. . . . They gave us the possibility of equipment, training—everything."[96]

The laboratory's selling point was the local Indigenous population; the stone and glass building even physically overlooked a row of worker housing (Figure 12).[97] Monge and Hurtado advertised the facilities as "the highest laboratory in the world" to American experts in a 1947 letter published in the *Journal of the American Medical Association*: "Morococha, where the laboratory is being built, is a mining town with a permanent population of about 4,000 inhabitants, most of whom are of the Indian race… [this] will allow investigations concerning the effects of a low pressure environment on human beings and animals born and raised under such a condition and on newcomers."[98]

A journalist for *Popular Mechanics* described the experience of a "lowland" visitor arriving at the Institute's high-altitude laboratory: "At Morococha, after 90 tortuous miles, even rugged men unaccustomed to the rarified air in the mining town, pant from the exertion of getting out of the car at the 14,900-foot altitude, flop weakly into a chair and complain of light-headedness. Often their demoralization is made complete by the sight, through the lab's big windows of Peruvian miners racing around outside in a vigorous game of soccer."[99] Paul A. Campbell, director of research at SAM, had a similar recollection: "Here I had stood gasping for breath, watching a new generation of children born at that altitude, play a most vigorous game of touch football."[100]

In 1953, the United States Air Force School of Aviation Medicine took Monge and Hurtado up on their offer, granting Hurtado an ongoing research contract, (AF-18[600]-174) to conduct high-altitude studies on Andean miners (Figure 13).[101] Part of this agreement involved the School

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[96] Cueto, 654.

[97] A photo in Rahn's article depicts this close proximity between researchers and workers—literally meters apart—showing the laboratory looming over a row of housing. The photograph's caption reads: "Institute of Andean Biology at 15.000 feet (highest building seen in photo). Indian miners and their families live in company quarters in the foreground sharing the facilities with their chickens and dogs." Rahn, 15.

[98] Monge and Hurtado make every effort to sell the unique facilities to American researchers: "Incidentally, it may be mentioned that Lima, and in consequence Morococha, are only twenty hours air travel distance from New York." They also reassuringly stress the town's colonial structure, mentioning that "there are also a considerable number of white persons." See: "Correspondence: Institute of Andean Biology for Study of High Altitude Physiology" in *Journal of the American Medical Association*, 135 (No. 6, 1947) pp. 375.

[99] Dempewolff, 151. Soccer is often referenced to soften the image of hard labour in these towns. See also: Rahn's article "Soccer or Soroche".

[100] Campbell, *Earthman, Space Man, Universal Man?* pp. 136.

[101] "Biographies and Abstracts: Physics and Medicine of the Upper Atmosphere II, 1958" See entry for "Alberto Hurtado": "Most of the work carried out is related to the study of the Indian native resident in the Andean region, at an altitude of 14,900 feet. Since 1953, has a contract with the School of Aviation Medicine, USAF, Randolph Field, Texas, for high altitude research." See: Velasquez, T. "Correlation Between Altitude and Consciousness Time in High

installing two state-of-the-art low-pressure chambers, one at the Institute in Lima and one at the laboratory at Morococha. Balke's trip in 1954 was to check-in on their progress, and to conduct his own comparative research on the local population. In his autobiography, Balke recalled that "According to Dr. Hurtado, the performance capacity of the Andean natives was supposedly much superior to that of any newcomer from the 'lowlands', and thus they were perhaps ideally suited for eventual extraterrestrial work."[102] Balke was no doubt familiar with Monge's nationalistic boast about Andean Man printed in *Time*: "Where North American aviators ask for oxygen, Peruvians play soccer."[103] Balke, who seems to have thrived on competition, wanted to prove that this "superiority" was overstated and not absolute: "From my experience in the Himalayan mountains I knew that ordinary men coming from sea level can adjust to the demands of very high altitude in a relatively short time. Therefore, I was interested in comparing my performance level after a few weeks of training at altitudes up to 6,000 meters (20,000 feet) with the functional capacity of the natives."[104]

Altitude Natives (Morococha). Report (unpublished) to the School of Aviation Medicine, USAF, Randolph Air Force Base, Texas, March, 1956; Merino, C. "The Plasma Erythropoietic Factor in the Polycythemia of High Altitudes" Report 56-103, School of Aviation Medicine, USAF, Randolph Air Force Base, Texas, November, 1956.
[102] Balke, *Matters of the Heart*, 65.
[103] *Time*, June 23, 1947. pp. 24.
[104] Balke, *Matters of the Heart*, 65.

Figure 14: *LIFE* magazine characterized Balke's space research in Peru as "copying high-altitude Indians". (Source: "A Scientist's Ordeal in Make-Believe Space" in *LIFE.* Vol. 45, No. 15; Oct. 13, 1958. pp. 53).

ANDEAN MAN AND THE ASTRONAUT

Balke made the first of three research trips to Morococha in the spring of 1954. According to his report "Experimental Studies on the Conditioning of Man for Space Crews", he spent six weeks there, each day hiking from the Institute's laboratory up to 17,000 feet in an effort to maximize the speed and extent of the acclimatization process. Balke's interest in high-altitude Indigenous people at Morococha took the same two experimental tracks as in the Alps: work capacity, and altitude tolerance (TUC). To test work capacity, subjects were instructed to run on a treadmill, or pedal a stationary bike, to the point of physical exhaustion. For TUC, subjects were placed in a pressure chamber and air pumped out until an even higher simulated altitude was attained. Researchers measured the time in which the subject could perform meaningful work before debilitating confusion set in. Here, Balke was interested in how long subjects could function between 25,000 and 40,000 feet. For each of these tests, Balke compared his performance with that of unnamed local miners.

Popular Mechanics described the work of Andean miners in the IAB pressure chamber: "In the stone and glass station at Morococha, these mountain men sit for long periods in a huge spherical altitude chamber, where atmospheric pressures are raised and reduced while scientists study a battery of instruments to observe reactions."[105] In his autobiography, Balke claims that his efforts to acclimatize himself at Morococha succeeded. Eventually he could match the work capacity of a group of miners. "It turned out that no difference existed in terms of maximal working capacity on the treadmill between myself and the most efficient miners."[106] He also claims to have matched their TUC: "a group of native residents reached an average critical altitude of 31,000 feet. The author… was still conscious at 33,000 feet."[107] Balke concluded that the miners' physiology showed unique and intriguing efficiencies, but in the end was no match for his meticulously trained and conditioned body. "Even the native Indians who live and work at altitudes between 13,000 and 16000 feet, and who work and play harder at those altitudes than most people in lower countrysides, do not attain the same maximal performance as do well-conditioned subjects at sea level."[108] However, further experiments on miners performed by Balke and T. Velasquez, a researcher from the IAB, set an even higher bar: "a TUC of one and one half minutes for natives exposed to a simulated altitude of 40,000 feet."[109]

Nowhere in the technical or secondary literature is the informed, ethical consent of Indigenous subjects discussed or even mentioned. The miners who participated are never described as individuals nor are their names or biographies recorded. The SAM report on Balke's third trip to Morococha includes the colonial trope of using photography to enroll Indigenous people. "The Polaroid camera proved to be a great asset in winning the confidence of the Indians. Pictures taken and presented seconds later often won the all-out cooperation of an entire village."[110] The report

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105 Dempewolff, 152.
106 Balke, *Matters of the Heart*, 65.
107 Balke, "Experimental Studies on the Conditioning of Man for Space Crews", 182.
108 ibid, 181.
109 ibid, 73.
110 *SAM History*, July-Dec 1956, 21.

did note that the Cerro de Pasco company played a role in contact between Balke's team and the locals. "Employees of the Cerro de Pasco Mining Company volunteered invaluable assistance. It was felt that the work at Morococha and La Oroya was made possible during the limited time available only through the help of the mining company. The mine officials helped in establishing excellent rapport between the Indigenous people and the photographers, and even lent their private automobiles when transportation was needed."[111]

Balke's work in Peru brought Andean Man into the orbit of the astronaut, but the two figures were always kept separate. As Hurtado noted in a 1958 report, "Most of the prerequisites [for astronauts] are met by high-altitude natives; therefore, it would seem feasible to attempt to train prospective crewmen as closely as possible to the physical standards of these natives."[112] In his 1959 book *New Dimensions of Flight*, American author Lewis Zarem noted that "For the past several years, the attention of the Air Force School of Aviation Medicine has been focused on the *Andean Man*, who lives in the tiny Peruvian mining village of Morococha, 14,900 feet high, in the Andes Mountains northeast of Lima, Peru."[113] Also in 1959, author Harry Edward Neal wrote that "A tribe of South American Indians, living closer to outer space than any other people, may help the first human space traveler to survive."[114] Hans Clamann, SAM's German expert on atmospheres told reporters in 1954 that, "The Incas of Peru work without difficulty in the mines of the Andes at that altitude… and maybe America's space men of tomorrow can too."[115] In 1958, an article in *LIFE* magazine summarized Balke's acclimatization research as "copying high-altitude Indians" (Figure 14).[116] That issue's editor lauded Balke's space research in grand, epochal terms: "scientists of the present are reaching out into our future by learning how to live like the men of tomorrow."[117] These convey a temporal dichotomy rooted in Andeanism: the astronaut represents the future of humanity, and Andean Man is cast as an interesting yet separate model from the past not included in "the men of tomorrow". Indigenous people were 'othered' by experts' instrumental use of their bodies as a benchmark: "Man, when temporarily acclimatized to more

[111] SAM History, July-Dec 1956, 21.
[112] Hurtado, 367.
[113] Lewis Zarem. *New Dimensions of Flight* (Boston: Dutton, 1959) pp. 184.
[114] Neal, 9. Note the parallels with the enduring American "Thanksgiving" stories about Indigenous Americans helping early European colonists survive their first winters, as well as European survival in the arctic.
[115] "Air Force Gets New 'Space Ship'" in *The Victoria Advocate* (Texas: Sunday, August 8, 1954) pp. 2A. "Without difficulty" ignores the social/economic conditions.
[116] "Make Believe Space", 53. The article notes that "the basis for Dr. Balke's beliefs was a study made in the Peruvian Andes which shows that the Indians there can do hard work even in the thin air of high altitudes."
[117] "A Scientist's Ordeal in Make-Believe Space", 2.

extreme altitudes, behaves more like a native Peruvian Indian."[118] Here "Man" is presented as distinct from "native Peruvian Indian".

SPACE, RACE, AND THE OLD FRONTIER

In 1960, John F. Kennedy famously described space as a "new frontier", a direct reference to the colonization of the American West that cast astronauts as European settlers. For many Indigenous people in America, "the frontier" also conjures up centuries of unjust treatment.[119] Scholarship about Indigenous Americans and space exploration is still only beginning to develop. But to situate Balke's regard for Indigenous Peruvians, it is worth briefly examining how German and American space experts regarded Indigenous Americans.[120]

Both Strughold and Balke reminisce about reading German author Karl May's Western novels while growing up. Beginning in the 1880s, May's stories about the American frontier initiated a German fascination with Indigenous American culture that still thrives today. Scholars have characterized May's vision of Indigenous Americans as "Indianthusiasm", which Susan Zantop describes as "the exoticized yet sympathetic, even idealizing depiction of the Other; the fixation on hair and skin color as essential marks of difference… the fantasy of balance, equality, tacit agreement."[121] Strughold recalled how May's stories fostered in him a lifelong interest in Indigenous American culture, but initially left him with unrealistic expectations. "I had the opinion that in the United States there are only Indians there. And when I came for the first time, over here

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[118] Balke, "Experimental Studies on the Conditioning of Man for Space Crews", 181.

[119] Jane Young. "'Pity the Indians of Outer Space': Native American Views of the Space Program" *Western Folklore* 46 (No. 4, October, 1987) pp. 269-279.

[120] Young's survey "'Pity the Indians of Outer Space': Native American Views of the Space Program" is a good starting point that catalogues a range of experiences focused around the disconnect between the Western instrumentalist view of space, and many Indigenous cosmologies that hold these places—especially the Sun, Sky, and Moon—to be sacred ancestors deserving of respectful treatment. Young quotes a story told to an anthropologist in Alaska after the landing of Apollo 11 in 1969: "We didn't know this was the first time you white people had been to the moon. Our shamans have been going for years. They go all the time… The issue is not whether we go to visit our relatives, but how we treat them and their homeland when we go." (pp. 272). See also: Barbara Tedlock. *The Beautiful and the Dangerous: Encounters with the Zuni Indians* (Albuquerque: University of New Mexico Press, 1992); Eric Gary Anderson. "Carter In Space" *Studies in American Indian Literatures*, Series 2, Vol. 15, No. 1, In Honor of Carter Revard (Spring 2003), pp. 26-31; Joy Porter. *Place and Native American Indian History and Culture* (Oxford: Oxford University Press, 2007) pp. 210; and Matthew D. Tribbe. "God Is Alive, Magic is Afoot" in *No Requiem for the Space Age: The Apollo Moon Landings and American Culture* (Oxford: Oxford University Press, 2014).

[121] Colin Gordon Calloway, Gerd Gemnden, Susanne Zantop (eds). *Germans and Indians: Fantasies, Encounters, Projections* (Lincoln: University of Nebraska Press, 2003).

[in 1928, on a one-year fellowship], I was surprised that there were not too many Indians. But I was very much interested in these people."[122] Once installed at SAM, Strughold remembers visiting a reservation in Texas and purchasing a headdress, which he says he wore on occasion ("I appeared at some places sometimes, as an Indian").[123] Mary Strughold, Strughold's wife, offered another awkward anecdote about the time Strughold showed up to teach dressed like a cowboy.[124] Balke, for his part, counted indigeouns American athlete and football legend Jim Thorpe as a childhood idol.[125]

In space fiction, the first representation of a Indigenous American astronaut is Johnny Bluehawk in Donald G. Wollheim's *Mike Mars* series, first published in 1961.[126] Blending aspects of Indianthusiasm and realistic space fiction, Bluehawk is a young Air Force jet pilot and member of an elite secret Air Force space program that closely mirrors NASA's Project Mercury. Wollheim's description of Bluehawk displays Indianthusiasm: "He was dark-eyed and dark-haired, and his sharp nose and high cheek bones indicated his ancestry as that of a true American—a full-blooded son of the famous fighting Indians of the prairie, the Cheyennes."[127] In the stories, Bluehawk—his name an obvious combination of Air Force and Indigenous American imagery—is the stalwart best friend of Mike Mars, the white protagonist and hero in this series of space adventures. Like May's idealized "equality" between European settlers and Indigenous Americans that was never quite equal when it came down to it, Mike Mars performs all the important space "firsts", while Johnny Bluehawk patiently waits his turn in the follow-on plane, or recovery ship.[128] The purpose of their friendship, like many similar ones found in May's novels, is to vouch for the high moral stature of the white hero.

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122 Strughold, Hubertus. "Institute of Texan Cultures Oral History Program: Hubertus Strughold." Conducted by Ingrid Kokinda, May 23, 1982. pp. 16.
123 Ibid, 16.
124 "He bought boots and he bought a hat, a western shirt, the whole bit. One day, out at Randolph [Air Force Base]... you understand that he was at that time, the very much dignified, formal, German professor. When he walked into the room, his students stood up and they treated him with awe. Anyway, he had all this cowboy regalia on and he went to class with it and as he was going down the hall some student says, 'Hi, Tex' and Struggie was just highly insulted. He said no student in Germany would call his Professor, 'Hi Tex.' I had to calm him down and tell him that was just a friendly expression and he had brought it upon himself rigged out like a cowboy." (Ibid, 17)
125 Balke, *Matters of the Heart*, 22.
126 This story also includes a fictionalization of Balke's Mount Evans experiment. See note 16. The most famous example of an Indigenous American character in science fiction is Chakotay from the TV series *Star Trek: Voyager*, although many have been critical of this characterization (See: Anderson, 26).
127 Donald Wollheim. *Mike Mars: South Pole Spaceman* (New York: Doubleday & Company, 1962) pp. 29-30.
128 Wollheim, *Mike Mars: South Pole Spaceman*, 30. "Though his role was more that of observer than active participant, he took as much pleasure in the task as Mike."

The question of race in space history has largely been taken up in the context of the 1960s Civil Rights Movement.[129] The emergence of the astronaut as white and male, and the exclusion of minorities and women, is often narrated as a "default", resulting from the existing structure of Cold War American society.[130] The culprits are social, cultural, and institutional barriers to prerequisites like a college degree in engineering and 1,500 hours flying military jets. These challenges, as well as racial intimidation and violence, feature in the stories of early Black astronaut candidates Edward Dwight, and Robert Henry Lawrence Jr. in the 1960s.[131] However, the case of Indigenous Peruvian miners in 1950s space medicine research shows how racial exclusion also operated through scientific knowledge about human bodies and human difference. Apologists for the colonial rhetoric so prevalent in space exploration often cite the appearance of space as "empty" as a rationale for the continued use of these problematic frontier metaphors and colonial goals.[132] But, as this episode shows, European racial categories, and politics from the old frontier, carried over to Kennedy's "new frontier" of space, both in culture, experimental practice, and scientific knowledge.

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[129] Lynn Spigel. "Outer Space and Inner Cities: African American Responses to NASA" in *Welcome to the Dreamhouse: Popular Media and Postwar Suburbs* (Durham: Duke University Press, 2001). 141-185.
[130] Weitekamp, 151. John Glenn explained the absence of women astronauts as "a fact of our social order."
[131] Sanders, Charles L. "The Troubles of 'Astronaut' Edward Dwight: Official Excuses Cloud Routine Assignment of Nation's Only Negro Trained for Role in Space" in *Ebony* (June, 1965) 29-32.
[132] See Frank White, *The Overview Effect: Space Exploration and Human Evolution*. "The role frontiers play in society's evolution not only allows civilization to expand outward into empty spaces, but they also allow consolidation at home." (pp. 109) See also, Robert Zubrin *The Case For Mars*.

Figure 15: Balke (left) and his USAF team near the summit of Mount Evans in summer 1958. (Source: National Archives and Records Administration, moving image ID: 342-USAF-26260).

SITE 3: MOUNT EVANS, COLORADO, 1958.

In July, 1958, Balke flew from San Antonio, to Denver Colorado, and then drove one hour west through the small mining town of Idaho Springs before turning up the winding Mount Evans scenic by-way to Echo Lake, 10,000 feet above sea level.[133] With six younger airmen and a mobile laboratory and pressure chamber in tow, Balke wanted to see if six weeks of vigorous exercise high in the Rockies could significantly boost their work capacity and TUC to the levels measured in Peruvian miners (Figure 15).[134]

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[133] Mount Evans was selected because it was the highest point in the United States accessible by highway. The Mount Evans scenic byway extends from the town of Idaho Springs up to a point just below the summit. Mount Evans also had a long history of hosting scientific research, mostly related to cosmic ray studies. By 1958 the summit was home to a set of modest structures called the Inter-University Laboratories.

[134] The study was initiated by the School of Aviation Medicine's Department of Space Medicine, and results were published in their annual *Bioastronautics* report. See: *Bioastronautics: Advances in Research*. Air University, School of Aviation Medicine, March 1959.

The first part of the program "Mt. Evans I" had already gotten underway five weeks earlier back at the School in San Antonio. Each day, Balke had the team run three to five miles in the desert around Randolph Air Force Base.[135] Now surrounded by mountains at Echo Lake, they resumed the daily fitness program, jogging through the alpine forest. Once acclimatized to this intermediate altitude, the group moved even higher, above the tree line, up to 14,200 feet near the summit of Mount Evans. They continued daily exercises, including climbing, hiking, running, and carrying heavy loads up and down the barren, boulder-strewn slopes. Air Force films shot on location during the experiment show Balke leading the men in these high-altitude workouts. In some, they appear to be having fun. Clad in t-shirts and gym shorts they piggy-back and wheelbarrow race each through alpine meadows. In others, they appear very serious; all geared up. In matching jackets with helmets and oxygen masks obscuring their faces, the airmen traversing the desolate mountainside could be mistaken for astronauts exploring another planet. Of the seven, only Balke is always instantly recognizable; he is the only one wearing German-style bundhosen and knee socks.

The outdoor activity was broken up with tests inside their "spaceship"—the mobile laboratory and pressure chamber (Figure 16, Figure 17). Together they looked like an tractor trailer hitched to a railroad tank car. Inside, Balke and his subjects used a cycle ergometer and exercises including squats to regularly check for changes in their work capacity. They tested TUC by lowering the pressure to critical levels while gauging neuromuscular coordination using a stick-and-lightboard complex coordinator program. In terms of TUC improvement, Balke noted that, "From the two subjects suddenly exposed to the level of 30,000 feet one stayed conscious for 5 minutes, the other subject for a total of 30 minutes. Normally, man will become unconscious within 2 to 3 minutes at this altitude."[136]

[135] Balke, "Experimental Studies on the Conditioning of Man for Space Flight", 71.
[136] Balke, "Experimental Studies on Physiological Aspects of Training and Selection for Manned Extraterrestrial Flight", 125.

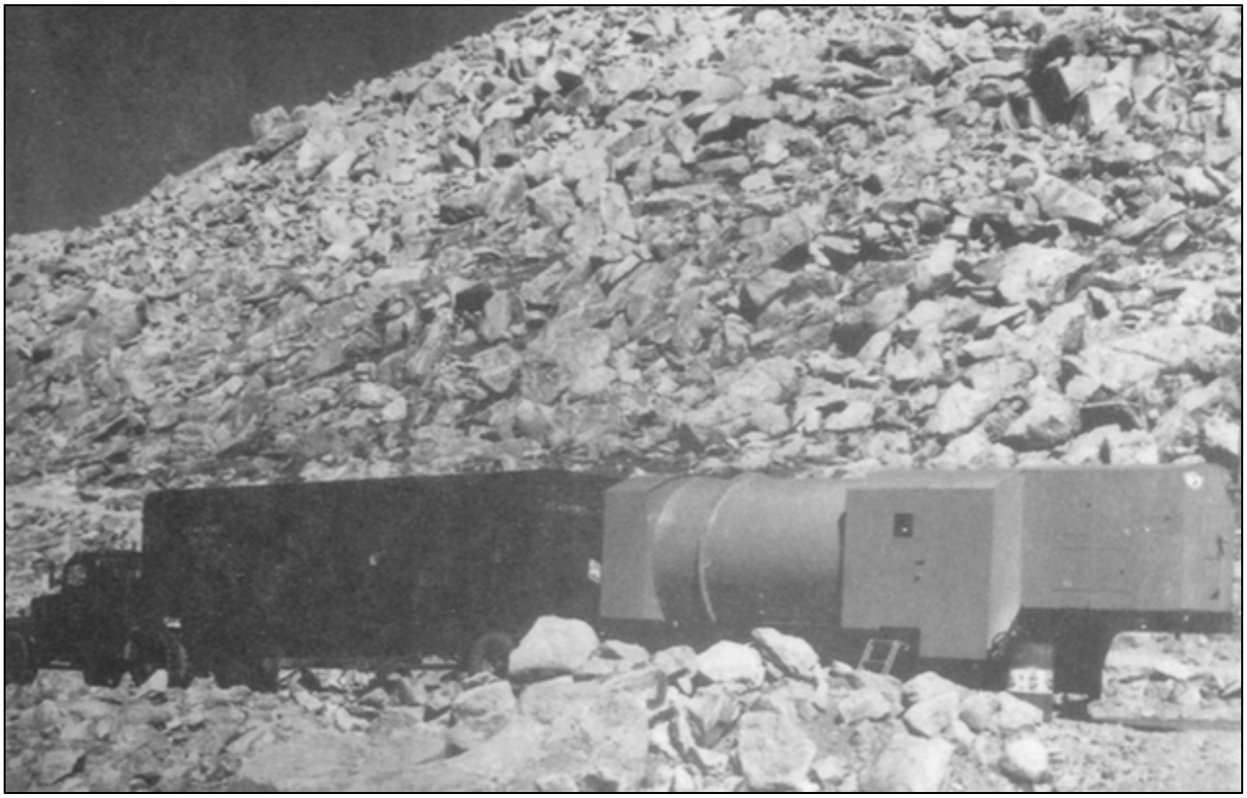

Figure 16: The SAM mobile laboratory (left) and pressure chamber (right) parked near the summit. (Source: Bruno Balke. "Man In Space: Experimental Studies of Physiological Aspects of Training and Selection for Manned Extraterrestrial Flights: Progress Report No. 1" in *Bioastronautics: Advances in Research*. Air University, School of Aviation Medicine, March 1959. pp. 143).

After six-weeks on the mountain the group returned to Texas for phase two ("Mt. Evans II"), where Balke, and one of the airmen—Major Sam Karst—who was considered to be the best acclimatized, spent 10 days living sealed inside their mobile chamber which had been converted into a space cabin simulator. Inside, the pair lived at a simulated altitude between 14,000 to 20,000 feet, but regularly ascended even higher to test their newly acquired tolerance. They exercised regularly and at intervals took the Kraepelin math test to gauge their mental acuity.[137]

At a symposium organized by the School later that year, and attended by then-Senate majority leader Lyndon Johnson and Wernher Von Braun, Hurtado explicitly connected Balke's recent Mount Evans work to on-going experimentation on Indigenous Peruvian miners. "During the past two years Balke has attempted to build the body reserves of previously untrained personnel

[137] See previous chapter. "Mt. Evans II" also had a psychological component: "We wished to learn, also how the subjects would get along with each other under the heavy strains encountered." Balke, "Experimental Studies on Physiological Aspects of Training and Selection for Manned Extraterrestrial Flight", 123.

to approach that of the high-altitude native".[138] Hurtado noted that Balke and another Peruvian researcher, T. Velasquez, were continuing to compare high-altitude Indigenous people and newcomers. "It would seem then," he concluded, "that studies on the altitude natives will continue to furnish guide lines for further research toward physical selection and training of crewmen for high performance vehicles in the future".[139]

In the context of space medicine, "work capacity", Balke's favourite measure of physical fitness, defined the limits of everyday activity under the new low-pressure "normal" expected for spacecraft interiors. The TUC tests simulated an emergency in space: the sudden loss of some or all cabin pressure. How long could humans maintain consciousness at pressures ranging from the edge of human tolerance, to the hard vacuum of space? From his work in the Himalayas and the Andes, Balke thought that both of these factors—work capacity and TUC—could be significantly improved by natural altitude acclimatization. This would help determine how thin spacecraft atmospheres could be made. It would also determine how long an astronaut had to initiate a backup system, or don protective equipment like an oxygen mask. How simple did back-up systems need to be? Answers to these questions normalized the space milieu and space body, while at the same time figuring the astronaut as an "at risk" system component.

These concerns reflected new anxieties about bodies in the early Cold War. The more powerful and automated technological systems became, the less individual human performance seemed to matter. But as the prospect of nuclear war challenged the traditional military concept of strength in human numbers, and at first glance minimized the importance of individual soldier physique, reliance on complex weapons systems actually heightened attention to the bodies of their human operators. Figured as "at risk" components in the system, engineers and physiologists debated the merits and role of humans "in the loop", but also ways in which their mental and physical performance could be maximized, and an overall sense of reliability maintained.

[138] Hurtado, "Parameters of Human Adaptation to Altitude", 367.
[139] ibid, 368.

Figure 17: On Mount Evans, Balke observes a USAF subject in the portable pressure chamber. (Source: National Archives and Records Administration, moving image ID: 342-USAF-26260).

FUTURE HUMANS IN SPACE: NATURAL MAN, OPTIMAN, AND THE CYBORG

In the 1950s, the question "Can Man Be Improved?" was not new, and has a long history extending back to The Enlightenment.[140] The eighteenth century debate about the perfectibility of humans centered around comparative studies of "natural man"—feral children and Indigenous peoples seen as being closer to nature—and self-described "civilized" Europeans.[141] The attempt to draw a line separating the range of humanity from animals was bound up in questions of colonialism, slavery,

[140] Julia Douthwaite. *The Wild Girl, Natural Man, and the Monster: Dangerous Experiments in the Age of Enlightenment*. (Chicago: University of Chicago Press, 2002); Freedman, Toby. "Can Man Be Modified?" Paper delivered before American Rocket Society meeting, Los Angeles, California, Nov 13-18, 1962.
[141] Francis Moran. "Between Primitives and Primates: Natural Man as the Missing Link in Rousseau's Second Discourse", in *Journal of the History of Ideas*, Vol. 54, No. 1 (January., 1993), pp. 37.

gender, citizenship and education.[142] This question took on a broad new urgency in several Western nations in the late nineteenth-century when Francis Galton extended Darwin's concept of natural selection toward the goal of improving humans, which he termed 'eugenics'. According to Darwin, who focused his study on plants and animals, an organism's relative "fitness" is defined by its surrounding niche. Change aspects of the niche, and "fitness" is also affected. For Galton and his disciples, rationally directing human evolution through artificial selection meant deciding on a goal—an idealized vision of humanity—that could be worked toward by either positive (encouraging reproduction) or negative (limiting reproduction) means. Eugenics flourished in Europe and North American in the early twentieth century but was discredited following its most infamous application in Nazi Germany's programs of sterilization, euthanasia, and genocide.

In the context of early aviation, some wondered if humans would evolve to live permanently in the atmosphere. In 1916, commercial aviation pioneer and utopian author Alfred Lawson argued that prolonged contact with low-pressure environments enabled by aircraft would over time produce a vastly superior new type of human he called "Alti-man" (short for "altitude man"). Alti-man would live in the atmosphere, and would no longer require oxygen, or even an airplane. Lawson also imagined a new totalitarian political configuration based on altitude tolerance: the "all knowing" Alti-man would rule over non-altitude adapted "ground-men" below.[143] This vision was based on Darwinian evolution, emerging slowly over thousands of years.

In the context of early space medicine, the urgency of the Cold War required much faster means of "improving" humans to fit hostile environments be considered. At the 1962 Ciba symposium "Man and His Future", J.B.S. Haldane, once a leading proponent of eugenics before World War Two, used the astronaut to complicate the supposedly fixed and obvious idea of human "perfection", and the idea of cavalierly altering human bodies. In space, he argued, "fitness" would be relative to a totally new environment, reconfiguring categories of 'ability' and 'disability'.[144] Underlining his point with some dark humour, Haldane imagined using a chemical like thalidomide to produce astronauts without legs, since he argued these would not be wanted in a

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[142] Anthony Pagden. *The Fall of Natural Man: The American Indian and the Origins of Comparative Ethnology*. (Cambridge: Cambridge University Press, 1982)
[143] Joseph Corn. *The Winged Gospel: America's Romance with Aviation*. (Oxford: Oxford University Press, 1983) pp. 41.
[144] Alexander Von Lünen. "'The Perfect Astronaut Would Be A Human Without Legs': JBS Haldane and Positive Eugenics" in *What is National Socialist About Eugenics?* (Regina Wecker, Sabine Braunschweig, Gabriela Imboden, Bernhard Küchenhoff, Hans Jakob Ritter, eds.) (Köln: Böhlau Verlag, 2009).

weightless environment.[145] Turning to the problem of low-pressure, Haldane noted that "an Andean or Tibetan might be able to live at an external pressure of a fifth of an atmosphere. If this is the approximate pressure on Mars, as some astrophysicists believe, it may be desirable to pick colonists with Andean or Tibetan ancestry."[146]

In his 1965 chapter "The Quest for Optiman", American space writer Tom Allen explores two different figures that represented competing approaches to how astronauts might be altered: the technologically enhanced cyborg (short for "cybernetic organism"), and the now-forgotten Optiman ("optimized man"). Despite Clynes and Kline's initial focus on drugs, Allen describes the cyborg as "a creature who accomplishes his space mission at the cost of trading most of his physiological systems for electronic ones."[147] General Electric engineer Dandridge M. Cole goes further, suggesting that all internal organs will be replaced with "superior artificial components", and that this trend will result in the ultimate cyborgs, "Closed-Cycle Men". These "will be things consisting of hardly more than brains with electrochemical substitutes for arms, legs, and trunks."[148] This concept centers around the radical augmentation and eventual replacement of the body with technologies. Philosopher Hannah Arendt worried that the cost of leaving Earth would be "the stature of man"—our sense of humanness, lost in space.[149]

To contrast this vision, Allen presents "Optiman", "an ideal man, but still a man".[150] Conjured by Air Force space medicine expert Toby Freedman, Optiman "would be a man whose outward appearance is quite normal, but who has been adapted to the oxygen requirements of a Himalaya Sherpa, the heat resistance of a walker-on-coals, who needs less food than a hermit, has the strength of Sonny Liston, and runs the mile in three minutes flat, while solving problems in

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[145] J.B.S. Haldane. "Biological Possibilities for the Human Species in the Next Ten Thousand Years" in *Man And His Future*. (Gordon Wolstenholme ed.) (Boston: Little, Brown and Company, 1963). pp. 354. This idea has endured, and NASA's anthropomorphic "Robonaut", built in 2011, is legless. See: http://robonaut.jsc.nasa.gov/default.asp

[146] Haldane, 355.

[147] Thomas B. Allen, "The Quest for Optiman" in *The Quest: A Report on Extraterrestrial Life* (Philadelphia: Chilton Company, 1965) pp. 230.

[148] Allen, 230.

[149] Hannah Arendt. "The Conquest of Space and the Stature of Man" in *The New Atlantis* (1963) pp. 52. Online: https://www.thenewatlantis.com/publications/the-conquest-of-space-and-the-stature-of-man

"The astronaut, shot into outer space and imprisoned in his instrument-ridden capsule where each actual physical encounter with his surroundings would spell immediate death, might well be taken as the symbolic incarnation of Heisenberg's man—the man who will be the less likely ever to meet anything but himself and man-made things the more ardently he wishes to eliminate all anthropocentric considerations from his encounter with the non-human world around him."

[150] Allen, 230.

tensor analysis in his head."[151] Balke's acclimatized airmen formed the basis for part of Freedman's vision of optiman as a human "improved" without violating the integrity of the body. Preserved in optiman (and reflected in its name) is humanity. Freedman points out that "Optiman would presumably not be a mosaic of spare parts and odd pieces of machinery, a Loop unto himself. Rather, he would be pure *man*."[152]

When USAF space experts began working out what type of person to pair with a spacecraft, they were thinking in grand, epochal terms about evolution and the future of humanity. In ways not present in aviation medicine, space medicine experts cast their work in cosmic, sometimes outright religious terms. A good example of this philosophizing can be found in Paul A. Campbell's career capstone tome *Earthman, Spaceman, Universal Man?* (1965). "Man had been placed on a pedestal high above all the other kingdoms of Earthlife. He was given intelligence, imagination, ingenuity, dexterity, and ability to communicate his ideas, by a purposeful Creator. His future is placed in his own hands… in Renaissance II, our era, space flight has become reality. In our time *Earthman* has become *Spaceman*. He is now potential *Universal Man*."[153] Campbell also worries that this process must be wisely managed in order to preserve a sense of "humanity". "Basically, he is the son of Adam… he has, and must continue, to engineering himself around the slow processes and the limitations of natural evolution. He must accept 'black boxes' as aid but not as replacement."[154]

Balke was an early champion of astronaut physical fitness, and non-invasive, non-technological adjustment to the space environment. Steeped in early twentieth-century German climbing culture, Balke's body ethos carried strong nationalistic, masculine, racial, and moralistic overtones. The conditioning of the body was not just a technical exercise to aid engineers attempting to save weight, it was a moral imperative tied to preserving the nation, and a concept of "humanness" threatened by the prospect of extreme technological "improvements". In Balke's vision of the future, the body was not obsolete but perhaps more important than ever.

In 1959, Balke lamented that Americans were distressingly out of shape. After assessing the physical fitness of a few hundred airmen, he pessimistically concluded that "the over-all state of 'physical fitness' in Air Force personnel is 'poor' and that the Air Force physical fitness

[151] ibid, 231.
[152] ibid, 231.
[153] Campbell, Prologue.
[154] ibid, 161.

program, as it now stands, is ineffective."[155] For him, a fit population, especially in the military, was a key for a strong nation. Balke worried that automation and modern comforts produced an unhealthy neglect of the body, and he framed his concerns in sharp evolutionary, nationalistic, and moral terms:

Balke: "In most minds, power today rests in ideas, in motives, in organization and above all in technology. According to this thinking the evolution of the human race should tend toward the development of a strictly cerebral-visceral type of man with more and more neglect of all the body parts and organs which originally were vital for survival. Unfortunately, a nation's place among the other nations and its survival in the eternal struggle between them depends largely on the general vitality of the population. History has shown that the great accomplishments of all the ancient nations were destined to perish when a peak of civilisation slowly softened the physical resistance of man against the forces of nature, or against the onrush of a more vital enemy. We cannot expect this pattern to change in modern times despite all technologic advancements. Unless one does not care about the destiny of future generations conscious and sustained efforts should be made to maintain the physical capacities of man at high standards.[156]

Extending this view to future astronauts, Balke noted that "'normal' man cannot be expected to perform too well under 'abnormal' conditions… only the best conditioned individual will have a chance to perform adequately in the long run."[157] He argued that "the first space flyer must be capable of the most exacting human performance, must have the highest degree of tolerance to stress, and must have a demonstrated endurance to prolonged marginal conditions."[158] For Balke, there was no question about the physical superiority of the astronaut. "Our search," he wrote, "is therefore for the qualities of the superman."[159] Despite finding some of these qualities advertised in Indigenous Peruvian miners, Balke worked to challenge this purported superiority—first by himself, and then by showing that he could acclimatize American soldiers as well, thus preserving outer-space as a white-dominated zone, much like the summits of very tall mountains.

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[155] Balke, "The Present Status of Physical Fitness in the Air Force", 9.
[156] ibid, 9.
[157] Balke, "Experimental Studies for the Training and Selection for Manned Extraterrestrial Flights", 165.
[158] Balke, "Experimental Studies on the Conditioning of Man for Space Crews", 177.
[159] ibid, 177.

CONCLUSION

The Mount Evans acclimatization experiment provides an opportunity to think about the origins of astronauts in terms of the mountaineer and extreme explorer. Balke's biography situates the desire to acclimatize astronauts within the longer histories of mountaineering and high-altitude physiology. Balke's participation in the 1938 German Expedition to Nanga Parbat shows how his methods and practices emerged in the context of nationalistic and colonial mountaineering expeditions and were organized around solving the military problem of high-altitude flight for the Luftwaffe. Following his transfer to the United States in Operation Paperclip, Balke's research in the Peruvian mountain town of Morococha incorporated a racialized, colonial view of the Indigenous people into a comparative practice that produced "guidelines" for future astronauts. The history of the Air Force's interest in the bodies of Indigenous peoples thought to be specially adapted to newly-strategic "hostile" environments has been explored in other areas of Cold War environmental medicine, including tolerance to cold and radiation, but not yet in the context of space exploration. The topic of race and astronauts is often discussed in the context of the Civil Rights Movement in the 1960s, focusing on the slow integration of African Americans into the astronaut corps., and contrasts between the urban crisis and massive budgets for the Apollo Program. The experimental use of Indigenous people shows how norms for space reflected race, and performed a subtle act of exclusion. Additionally, altitude acclimatization and the figure of Andean Man was one way the astronaut factored into debates over technology and evolution.

This approach of tracing the history of a category of "space normal" can serve as a methodology for exploring other aspects of space medicine and the astronaut body. Which humans were used in their construction? How did they include or exclude others? Women, for example, were not used to define early standards of work capacity or TUC. Other physiological and psychological norms in space medicine should be investigated in this manner. Bringing the figures of the colonial mountaineer and the Indigenous person who lives at high-altitude into space history highlights how astronauts are hybrid creations, with long contributing histories and deep political resonances. The rhetoric used to promote space exploration has been peaceful and inclusive ("we came in peace for all mankind"), but as the colonization of space is increasingly positioned as imperative for securing the continued existence of humanity, we must consider the ways certain people have been excluded from this future.

CHAPTER FOUR: BETWEEN HUMAN AND ANIMAL ASTRONAUTS: ANTHROPOMORPHIZING 'SPACE MONKEYS' ABLE AND BAKER

"Think fast now. Who was this nation's first successful flyer into outer space? Alan B. Shepard, you say? Walter M. Schirra? Better guess again, friend. You're a million miles off. Actually, America's first successful space traveler wasn't a man at all, but a cute, short haired, brown eyed female! Little Miss Baker!"[1]

At 2:35 a.m. on May 28, 1959, the newly-minted National Aeronautics and Space Administration (NASA) partnered with the Army and the Navy in the launch of a Jupiter-C Intermediate Range Ballistic Missile from Cape Canaveral in Florida.[2] Following a successful lift-off, the rocket traced a sub-orbital arc eastward over the Atlantic Missile Range, with its nosecone reaching 300 miles in altitude—space—before reentering the Earth's atmosphere and parachuting into the ocean off the island of Antigua (Figure 18).[3] Guided by a radio beacon, Navy divers onboard the fleet tug *U.S.S Kiowa* raced to recover the floating nosecone.[4] "The presence of doctors suggested to us that the nose cone contained some living thing," remembered diver R. Edward Foy, who had been kept in the dark about one crucial detail of the operation. Instead of a dummy nuclear warhead, the nosecone contained an array of "biomedical experiments", and military life scientists back at The Cape were anxious for news of their condition. The manifest of NASA's "Bioflight #2" included yeast cells, e. coli bacteria, onion tissue and mustard seeds, one hundred fruit fly larvae, two live frogs, fourteen live mice, 25 ccs of human blood, and two live monkeys: a rhesus monkey named Able, and a smaller squirrel monkey named Baker.[5] After sighting a locator balloon, Foy tossed a canister of shark repellant overboard and dived into the dark Atlantic to attach a line to the partially

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[1] "D.J. Herda. "1st Space Flight? Monkey Do". in *The Milwaukee Journal* (September 25, 1971) pp. 59.
[2] "Biomedical Experiments" NASA Fact Sheet No. 2. pp.1 "As a weapons system, the Jupiter intermediate-range ballistic missile is capable of placing a nuclear warhead upon targets with extreme accuracy at ranges up to 1,500 nautical miles. In the course of its development, however, the Army has used excess space in the nose cone for scientific purposes. On three occasions Jupiter has transported scientific experiments in its heat-protected nose cone."
[3] "Two Monkeys Survive Space Trip". in *The Washington Post* (May 29, 1959).
[4] The best account of the recovery operation was given by Navy diver R. Edward Foy to *Saturday Evening Post* writer Clay Blair Jr. in "We Recovered the Space Monkeys" in *Saturday Evening Post* (August 22, 1959) pp. 13-15.
[5] Able weighted approximately seven pounds, and Baker approximately one pound. ("Biomedical Experiments") NASA Fact Sheet No. 2. pp. 2-3. See also "Space Conference on Biomedical Experiments, Jupiter 18" pp. 16. The status of the Jupiter missile as a nuclear launcher meant that certain details of the experiment, like the arrangement of specimens in the nosecone, were kept secret. "The precise positioning of the capsules, I am told, is classified, because of the fact that the nose cone is one that is designed essentially for defense purposes. So the exact positioning of the monkeys is classified, but I can say it is in the lower portion of the cone, and they were essentially side by each." "Space Conference on Biomedical Experiments, Jupiter 18." May 30, 1959, 2:25 pm. National Aeronautics and Space Administration. No. 59-158. pp. 24.

submerged nosecone. With the capsule hoisted onto the deck, one of the physicians onboard cabled the scientists at The Cape: "Able, Baker perfect. No injuries or other difficulties."[6] This was an important space "first" for America. Not because Able and Baker were the first animals in space—they were not; the Army had been launching monkeys to space altitudes since 1948, and the Soviet Union had already orbited a dog named Laika in November 1957.[7]

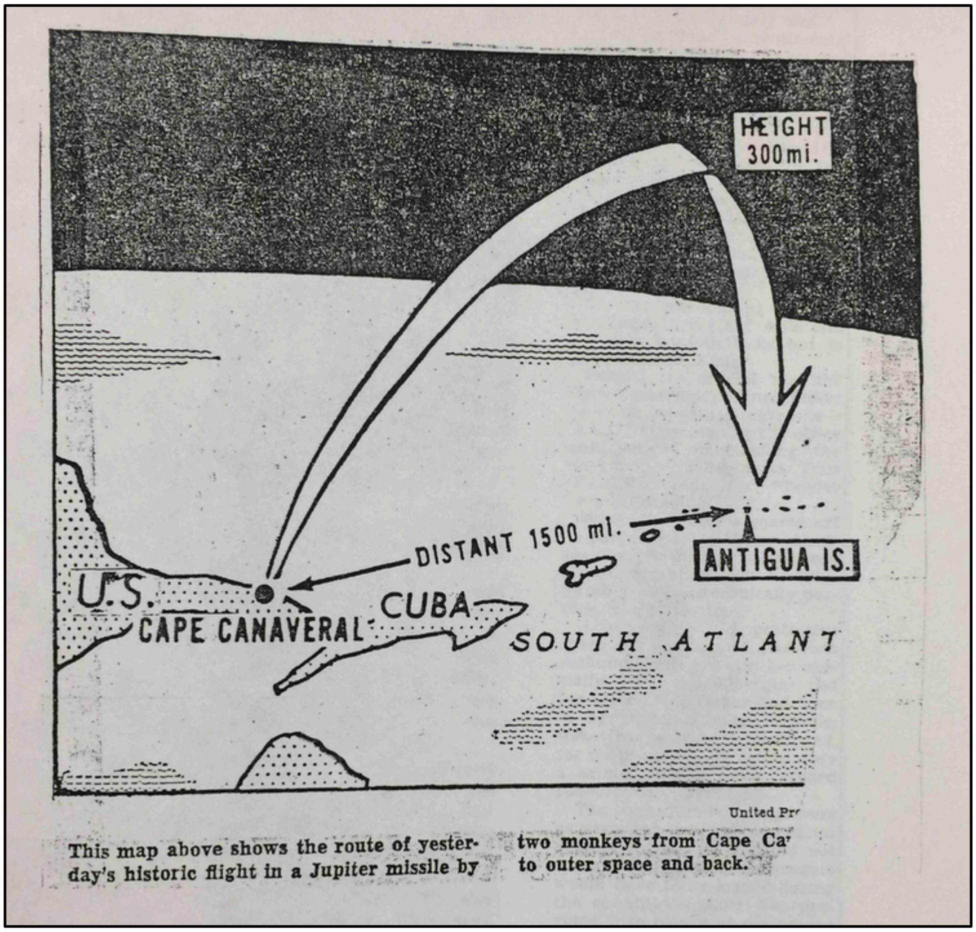

Figure 18: The flight trajectory of Bioflight #2 on May 28, 1959, from Cape Canaveral, over the Atlantic Missile Range, and into the ocean off Antigua. (Source: NASA Historical Research Collection, Folder: Able).

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[6] "Space Monkeys to be Flown Here for News Conference Tomorrow". in *The Washington Star* (May, 29, 1959).

[7] Different animals have become associated with different national space programs. Soviet researchers initially chose dogs because they were believed to be hardy survivors capable of withstanding the stresses of rocket flight. American researchers focused on primates (monkeys and later chimpanzees) because they believed them to be a close physiological analog for the human body. See: Nelson, Amy "The Legacy of Laika: Celebrity, Sacrifice, and the Soviet Space Dogs" in *Beastly Natures: Animals, Humans, and the Study of History*. Edited by Dorothee Brantz. Charlottesville: University of Virginia Press, 2010.

Bioflight #2 was important because Able and Baker became the first primates recovered alive from a spaceflight. This success was converted into both medical and political confidence that a human could also survive similar flights being planned by NASA for Project Mercury. But Able and Baker were also significant in another, less-often-noted way: they became America's first celebrity space animals. After the *Kiowa* made port at San Juan, Puerto Rico, Able and Baker were immediately transferred to a waiting USAF C-118 Liftmaster transport plane and flown directly to Andrews Field in Maryland so they could be displayed to the world at a press conference at NASA Headquarters.[8] In the blast of scientific, media, and public attention that followed, Able and Baker were transformed from anonymous, interchangeable, expendable laboratory animals into highly-valued mascots for the fledgling space program. This transformation—entirely in the minds of humans—took the form of sudden and sustained anthropomorphism, the attribution of human qualities to animals. When Able and Baker survived the flight, and were subjected to publicity, their initial role as scientific models (of human bodies in a sealed space capsule) shifted. To the public, they were presented as cultural models for future astronauts, and for the wider Cold War American citizenry. This chapter analyzes how Able and Baker were anthropomorphized in the contexts of spaceflight and wider culture by paying specific attention to portrayals of their sex and gender in various pre-and-post-flight literatures. Even though both monkeys were female, Able was popularized as a male and masculine "Cold Warrior" and astronaut, while Baker was fitted into the image of a feminine suburban housewife, partnered with a male "husband", and expected to reproduce. The gendered discourse that emerged around Able and Baker shows how enduring anxieties over the essential masculinity of the American astronaut manifested very early on—monkeys called the skills, and even the necessity of the astronaut in Project Mercury into question. Additionally, the unproblematic use of female monkeys, and the sustained interest in Baker's reproductive capacity, foreshadows later debates at NASA about women astronauts, including the near-contemporaneous testing of Geraldine "Jerrie" Cobb for "space fitness" in the cancelled Lovelace Woman in Space Program.[9] This chapter traces the origin of the long-standing tension

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[8] Now called Joint Base Andrews.

[9] For the best treatment of the Lovelace Woman in Space Program, see Margaret Weitekamp. *Right Stuff, Wrong Sex: America's First Women in Space Program*. (Baltimore: Johns Hopkins University Press, 2004); for other examples of historical instances that parallel the gendered media discourse surrounding Able and Baker, see: Jennifer Ross-Nazzal. "You've Come A Long Way, Maybe: The First Six Women Astronauts and the Media" in *Spacefarers: Images of Astronauts and Cosmonauts in the Heroic Era of Spaceflight* (Editor: Michael J. Neufeld) (Washington, D.C.: Smithsonian Institution Scholarly Press, 2013).

between humans and animals in spaceflight—specifically how anthropomorphism challenged ideals set for human astronauts—and how this often manifested in questions of gender.

On the same day that Able and Baker rocketed into space over the Atlantic Missile Range, the just-selected, all-male human astronaut group—the Mercury Seven—gathered in Washington D.C. to formally introduce themselves to the Congressional Committee on Science and Astronautics.[10] Just a few weeks earlier, on April 9 1959, they had been revealed to the world with much fanfare at a press conference held at NASA's first headquarters at the large, colonial Dolley Madison House just one block north of the White House.[11] Now the astronauts watched as two small monkeys sat in the same NASA auditorium, with the room again filled with reporters and photographers hungry for an American success story. Although not officially part of America's new man-in-space program, NASA and the press explicitly connected Bioflight #2 to Project Mercury, initiating direct comparisons between human and animal astronauts.[12] "For one small group of Americans, the Mercury Astronauts whose names were announced a few weeks ago, the news of this successful experiment was particularly important," noted one news report.[13] The fact that Able and Baker had survived the uncertain rigors of rocket flight—the acceleration of launch, nine-minutes of weightlessness, the searing heat of reentry, and a watery recovery—with "little harm indicated" suggested that a human body could too. "The monkey experiment helps pave the way for 'Mr. Mercury,' one of the seven men to be chosen by NASA to ride the first manned space capsule into orbit".[14] But more than just a study of technical and biological systems, Able and Baker's flight became a cultural rehearsal for Project Mercury and the return of future astronauts from space. Bioflight #2 reveals early versions of American spaceflight practices: launch from Cape Canaveral, recovery at sea, a post-flight press conference with the returned subjects, and sustained public relations work afterward. Able and Baker contributed vital data to space

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[10] "Meeting With The Astronauts: Project Mercury Man-In-Space Program", U.S. House of Representatives Eighty-Sixth Congress, Executive Session, May 28, 1959, pp. 1. During the proceedings, then NASA Chief of Manned Space Flight George Low stated, "After a number of unmanned flights in this Redstone, and after a number of flights with animals using the Redstone booster, these gentlemen will also fly in the Redstone as part of their training for the final mission, and as part of the qualification for the final mission." pp. 8.

[11] Dolley Madison House (now known as Cutts-Madison House) is a large colonial-style house located at corner of Lafayette Square, one block north of the White House, and served as NASA headquarters from 1958 until 1961. During the late nineteenth and early twentieth centuries, it was home to The Cosmos Club, a private social club for elite men interested in science, art, and literature.

[12] "This was a space available biomedical experiment, it was not directly tied to Project Mercury". "Space Conference on Biomedical Experiments, Jupiter 18" pp. 11.

[13] "Back from Space Alive" in *The New York Times* (May 29, 1959).

[14] "Space Flight Succeeds" *The Science News-Letter* Vol. 75, No. 23 (June 6, 1959), p. 355

medicine's early construction of space fitness, and boosted confidence in space systems, but their post-flight treatment also challenged and reinforced social and cultural aspects of the astronaut.

Starting with Able and Baker, non-human primates have become persistent icons in spaceflight, and posed implicit challenges to the masculinity, expertise, and humanity of early astronauts.[15] Before the first humans left earth, American astronauts had to contend with the uncomfortable notion that monkeys—and later chimpanzees—also flew in space (Figure 19, left). Astronauts became disparagingly zoomorphized as monkeys, just as space monkeys were anthropomorphized into honorary humans. In 1962, *The Los Angeles Times* quoted a father joking with his son, an Air Force pilot who had just been selected for astronaut training: "I understand they ran out of monkeys".[16] When John Glenn addressed a joint session of congress following his first spaceflight in 1962, he described meeting the president's daughter, Caroline Kennedy, "I think Caroline really cut us down to size, and put us back in our proper position though when after being introduced she looked up and said, 'where's the monkey?'"[17] (Figure 19, right). Following Valentina Tereshkova's flight in 1963, NASA public affairs officer John "Shorty" Powers disparagingly dismissed the first woman cosmonaut's qualifications as not meeting American standards saying, "we flew a chimpanzee in Project Mercury, but that doesn't prove you don't need an astronaut".[18] This led Jerrie Cobb, who was still in the public eye following her high-profile congressional challenge to astronaut requirements, to fire back, "female chimps get better treatment from National Aeronautics and Space Administration officials than do female humans."[19] Able and Baker's flight in 1959 was the origin of these comparisons, and their gendered post-flight treatment is critical to understanding how the masculinity of early astronauts was calibrated.

This chapter begins with an essay on sources and methods, followed by a brief survey of monkeys in space leading up to Bioflight #2, and a discussion of how anthropomorphism appears in the archive, before turning to "animal biographies" of Able and Baker.

[15] Iconic examples include *The Planet of The Apes* (1968), and the famous "Dawn of Man" opening sequence in Stanley Kubrick's *2001: A Space Odyssey* (1968). Two more recent examples of this are 20th Century Fox's animated feature film *Space Chimps* (2008), and its sequel, *Space Chimps 2: Zartog Strikes Back* (2010).
[16] Ken Lewis. "Flier Hopes to be First to Return from Moon" in *The Los Angeles Times* (May, 6, 1962).
[17] He added this punchline: "I didn't get a banana pellet on the whole ride". "John Glenn Handwritten Speech to Congress After Friendship 7 Flight", Ohio State University, John Glenn Archives.
[18] "Powers Scores Idea of Women Astronauts" in *Saturday Evening Star* (July 11, 1963).
[19] "Powers Scores Idea of Women Astronauts".

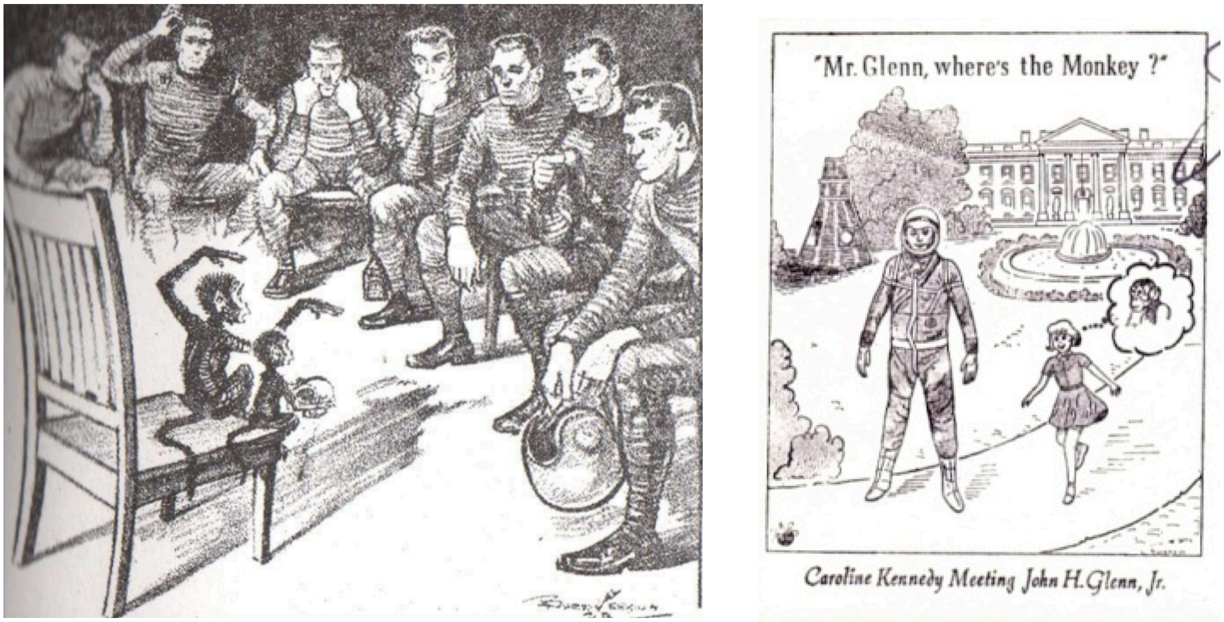

Figure 19: (Left) A French cartoon from May 1959 imagines Able and Baker briefing NASA's Mercury Seven. (Right) A souvenir envelope commemorating John Glenn's 1962 spaceflight references his self-deprecating joke to Congress about Caroline Kennedy's monkey comment. (Source: New Mexico Museum of Space History, folder "Baker")

ANIMALS & SPACE HISTORY: SOURCES & METHODS

This chapter relies on a methodological approach called "Animal biography", which is outlined as "canine biography" by historian Helena Pycior in her chapter "The Public and Private Lives of 'First Dogs': Warren G. Harding's Laddie Boy and Franklin D. Roosevelt's Fala."[20] Pycior argues that the literary genre of biography need not be restricted to human subjects, and that "canine biography"— the life stories of dogs—can be a legitimate form of historical work, if done properly. To this end, she adheres to what James Clifford calls "scholarly-historical" biography ("no unacknowledged guess-work, no fictional devices, and no attempts to interpret the subject's personality and actions psychologically") in examining dogs owned by presidents of the United States.[21] Pycior outlines two challenges facing canine biographers: the first is the temptation to engage in "reckless anthropomorphism," a problem she sees in most popular and children's

[20] Pycior, 176.
[21] ibid, 179.

literature about animal lives. The second issue is more fundamental: animals leave no conscious written records for historians to study. This turns into an important, but not fatal, barrier: when scholars study records of animals, they are always studying human representations of animals. This means that animals in the archive—including scientific and medical descriptions—are always human-generated images crafted in specific social and historical contexts. This does not, however, mean that animal biographies are impossible or meaningless, but rather that they come with certain limitations. For instance, it would be impossible to write a scholarly biography of an animal that was not sufficiently archived by humans. Pycior studies "first dogs" because their association with the President of the United States produced a historical record thick enough to be studied and interpreted. This is why in some cases "canine biography" can be expanded to "animal biography," and applied to certain primates used in American space medicine research, the public and scientific interest in spaceflight during the Cold War resulted in a few experimental animals garnering enough attention for humans to generate a significant number of records about them—an archive thick enough for historians to think and write about.[22]

To examine how different groups (officials, scientists, the media, and the public) viewed Able and Baker at different times, I use an approach to anthropomorphism outlined by Lorraine Daston and Gregg Mitman in their introduction to *Thinking With Animals* (2005). They suggest moving beyond the binary debate of anthropocentrism (animals have no mental lives) versus anthropomorphism (animals have human-like qualities).[23] Starting in the late nineteenth-century, scientists promoted and attempted to follow a reductionist, behaviorist approach to dealing with research animals, which instructs them to deny that animals have mental lives, and remain emotionally detached in their studies (anthropocentrism). "Laboratory studies of animals have stood opposed to anthropomorphizing tendencies: the proper scientific attitude is defined as cool, distanced, objective."[24] Ethicists, on the other hand, have anthropomorphized animals in attempts to free them from human machinations (anthropomorphism). To reorient the conversation and move past this binary, Daston and Mitman observe that in everyday practice, humans (scientists, ethicists, and everyone else) habitually anthropomorphize animals and zoomorphize people,

[22] Colin Burgess; C. Dubbs. *Animals in Space: From Research Rockets to the Space Shuttle* (Chichester, U.K.: Springer Praxis, 2007) In their introduction, Burgess and Dubbs admit how difficult Soviet "secrecy and propaganda" made it for them to write accurately about dogs shot on suborbital rocket flights in the early 1950s: "deciphering an ancient language would have been easier," xx.
[23] Daston and Mitman, 7.
[24] ibid, 5.

whether they are supposed to or not. It is more interesting, they argue, to examine how and why this happens, rather than the pros and cons of doing so.[25] It is the question of how and why people project human qualities onto animals in spaceflight (and animal qualities onto humans) that interests me. It is important to note how this approach intersects with Pycior's canine biography, and especially Clifford's warning not to psychologize biographical subjects. This warning could, in theory, lead to an anthropocentric denial of the mental lives of animals. However, like Daston and Mitman, I do acknowledge that Able and Baker did have mental lives, but with the understanding that the content of these is essentially lost, and should not be speculated on.

To write biographies of Able and Baker, I rely on an array of scientific, military, journalistic, scholarly historical, and cultural sources from several different space archives, ranging in date from the early 1950s to the present. The clearest divide between these sources—and one of the biggest differences between space animals and presidential pets—is this transition from scientific instrument into public mascot. Presidential pets are always recorded and represented as an extension of a specific human celebrity (the president), but space animals first anonymously stand-in for an amorphous "human factor", then get popularized as generalized gendered stereotypes. Since the main challenge in animal biography is lack of sources, all sources are in some sense helpful. But the cleavage between technoscientific and popular sources does pose a problem. Scientific sources are records of experiments in which the animal is decentered as part of a larger assemblage. The experiment is composed toward achieving knowledge for human use in some aspect of spaceflight and often these reports omit any extraneous details, which would interest animal biographers. On the other hand, popular sources often anthropomorphize, psychologize and fit these animals into existing tropes, unhelpful unless this phenomenon is the focus of analysis, as it is here.

The archives at the NASA History Office in Washington D.C. contain folders on Able and Baker with press clipping and official news releases about each.[26] The New Mexico Museum of Space History (NMSH) archive in Alamogordo has a folder for Baker, and preserves correspondence documenting the death of NASA's most famous primate, the chimpanzee called Ham. The Air Force's Historical Research Agency at Maxwell Air Force Base in Montgomery

[25] ibid.

[26] They also have folders for other monkeys used in early space medicine including SAM, Miss SAM, SAM II, and the series of monkeys known as Albert. In addition, they have extensive collections on Ham and Enos, the chimpanzees used by NASA for Project Mercury flights in the early 1960s.

Alabama have boxes with documents related to the Air Force's two main primate colonies: The Balcones Laboratory (now called the J.J. Pickle Research Campus) at University of Texas at Austin, and the 6571st Aeromedical Research Laboratory (ARL) at Holloman Air Force Base in New Mexico. While researching this chapter, I also visited the final resting places of Able and Baker. Able is preserved as a taxidermy exhibit at the Smithsonian's Air and Space Museum in Washington D.C., and Baker is buried beneath a large headstone at the U.S. Space and Rocket Center in Huntsville, Alabama.[27]

Examples of instrumental regard for non-human primates in space research laboratories during the 1950s can be found in *Bioastronautics: Advances and Research* (1959), a summary of primate research compiled by the United States Air Force (USAF) School of Aviation Medicine, and in *Animals and Man in Space: A Chronology and Annotated Bibliography through the Year 1960*, published by the U.S. Naval School of Aviation Medicine at the U.S. Naval Aviation Medical Center in Pensacola, Florida, where Baker was trained. Two USAF-produced films, *United States Air Force Presents: Animals in Rocket Flight* (1959), and *United States Air Force Presents: The Air Force Story: Volume II, Chapter VIII: Human Factors in Space Flight 1950-1960* (1960), as well as the Universal International News newsreel, "Space Monkeys Meet Press after Missile Mission" (1959) show how Able and Baker were presented by the military and media directly following their spaceflight. Articles from local newspapers and national publications like *LIFE* magazine, *National Geographic*, and *The Science Newsletter* collected in the archives at the NASA History Office and NMSH, show how they were anthropomorphized. For existing secondary literature about animals in space history, Burgess and Dubbs's *Animals in Space: From Research Rockets to the Space Shuttle* (2007) provides the best comprehensive overview of animal names and dates, but offers little analysis of the events chronicled, a limitation also found in Clyde R. Bergwin and William T. Coleman's *Animal Astronauts: They Opened the Way to the Stars* (1963). Less conventional representations of Able and Baker also offer important insights. I analyze how Able is displayed as a museum exhibit, and how she was portrayed as male in a 2009 Hollywood motion picture. For Baker, a young adult non-fiction book titled *Space Monkey: The True Story of Miss Baker* (1960) by Olive Burt provides some information and photographs about her life inside the animal house at the Naval School of Aviation Medicine, as well as examples of

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[27] I also visited the grave of Ham, located at the New Mexico Museum of Space History in Alamogordo.

anthropomorphism at play in animal biography.[28] I also examine how Baker is remembered by users of an online memorial created in 2005. In total, this archive is thick enough to allow me to write scholarly biographies of Able and Baker, and to explore how and why they were anthropomorphized. In doing so, I follow Clifford's rules of scholarly-historical biography, avoiding embellishment, and psychological speculation. But in the spirit of Daston and Mitman, I remain mindful of their agency and life experiences.

ANIMALS & ROCKETS BEFORE BIOFLIGHT #2

Many assume that Ham, the most-famous chimpanzee used by NASA in Project Mercury in 1961, was the first primate in space. In fact, the first animal spaceflight occurred thirteen years prior in 1948.[29] At the White Sands Missile Range west of Alamogordo, New Mexico, American scientists began launching monkeys into space with very little fanfare and plenty of failure. At the end of World War Two, the United States military captured many German V-2 rockets, and in the years that followed programs hatched to launch and study these technological spoils of war. In 1947, the National Institutes of Health (NIH) partnered with the Army to include a payload of fruit flies in the nosecone of one of these rockets. Reaching an altitude of 106 miles, these insects became the first known living organisms to survive a trip to space and back.[30]

From 1948 to 1952, the U.S. Army collaborated with Air Force aviation medicine experts on Project Blossom, a program utilizing the test-firings of seven captured German V-2 rockets to determine if humans could survive high-altitude rocket flights. USAF space medicine expert Dr. James P. Henry and his young assistant David G. Simons, were asked to provide "simulated pilots" to ride in the V-2 nosecone.[31] Working between his office at the Aero Medical Laboratory at

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[28] Burt notes that in drafting her account she was advised by Navy personnel including "Captain Philip B. Phillips MC, USN, Service Information Officer at the Naval School of Aviation Medicine". (See dedication).
[29] Dietrich E. Beischer; Alfred R. Fregly. *Animals and Man In Space: A Chronology and Annotated Bibliography Through the Year 1960*. (Washington D.C.: Office of Naval Research, 1960) p. 56.
[30] For more on the history of animals in military research Jared Eglan. *Beasts of War: The Militarization of Animals* (Lulu, 2015). For early ideas about animals in rocket flight see B.F. Skinner's World War Two "Project Pigeon" plan in to utilize a live pigeon's pecking action as a missile guidance system in James H. Capshew. "Engineering Behaviour: Project Pigeon, World War II, and the Conditioning of B.F. Skinner in *Technology and Culture* 35 (No. 4, 1993) pp. 835-857.
[31] Burgess and Dubbs, 37. Simons, here a junior project engineer later became head of the Aeromedical Field Laboratory and gained fame in 1957 for his daring high-altitude "Man-high" balloon ascents to the "edge of space".

Wright-Patterson Air Force Base in Dayton, Ohio, and their newly-established outpost at Holloman Air Force Base in Alamogordo (eventually called the Aeromedical Field Laboratory), Henry first had to decide what type of animal to include. He chose rhesus monkeys.

Henry considered rhesus monkeys docile enough to tolerate being restrained for long periods of time, intelligent enough to learn and perform simple tasks. He also cited their "many physiological similarities to humans".[32] A 1958 USAF report echoes this choice, stating that rhesus monkeys were preferred "because of [their] relatively small size, psychologic and physiologic similarity to man, and the rather large background of data which have accrued on this animal".[33] Other scientists agreed, noting that rhesus monkeys were "extremely inquisitive" and could repeatedly perform simulated control tasks, like pulling a lever when a small light was illuminated. They also believed that rhesus monkeys were "physically more adaptable to the range of temperatures which will be encountered in manned spaceflight… neither excessively sensitive to heat or cold."[34] Like human astronauts, rhesus monkeys used in later flights were subject to rigorous selection practices. Writing in 1959, Wade Lynn Brown, a researcher at the USAF's Balcones primate laboratory at Austin, noted that in his view, the ideal weight for a space-bound rhesus was "between 4 and 5 ½ pounds," and that beyond "perfect health", monkeys needed to score high on tests designed to measure their "emotional stability" and "performance" on simulated tasks. He did not select monkeys that had the highest score in a particular area, but instead favoured those that scored high across all of the measures.[35] While the early monkey flights in the late 1940s and early 1950s did not employ such stringent mental and physical requirements, scientists clearly intended to use the monkeys as analogs for human minds and bodies—models of humans—which was one way that primates used in spaceflight were anthropomorphized in a scientific context.

Back in 1948, the main goal for Henry and Simons, was to record and analyze biometric data during the flight. They rigged up a telemetry system that would radio back data representing heart and lung functions during stressful periods of acceleration, weightlessness, and deceleration. The specific medical question they wanted the monkeys to answer was: could a human-like

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[32] Burgess and Dubbs, 39. It is interesting to contrast the American selection of monkeys with the Soviet selection of dogs. Amy Nelson writes that in the Soviet case, "stray dogs were selected for the program based on weight (13-15 pounds), hardy constitutions, trainability, and light coat color, which would facilitate filming them during flight" (Nelson, 207).

[33] R.E. Benson. "Primates In Space: Progress Report No. 2", 73.

[34] Burgess and Dubbs, 189.

[35] ibid, 190.

circulatory system function under these new stresses? The underlying military question was: could a human soldier perform meaningful duties in this new hostile environment?[36] They were also trying to determine the exact requirements for a human life-support system. In addition to monkeys and rockets, Henry and Simons also launched mice and other living material into Strughold's region of space-equivalence, or *aeropause*, using sealed capsules lifted by high-altitude polyethylene Winzen Research-produced balloons. In 1955, Simons based the requirements for a human-supporting sealed cabin on animal data they had collected from Project Blossom, and these other Air Force biological flights. Animals were so essential to figuring this out, Simons defined the human carrying capacity of a sealed cabin in explicitly animal terms: the "mouse unit". The mouse unit was the level of life support required to keep one mouse—the smallest animal they had flown—alive in a sealed capsule. Making extrapolations, Simons figured that a Guinea pig was roughly two mouse units, while a monkey registered at "nearly seven". A human, he estimated, would work out to about 500 mouse units. Noting that their current capsules already had a capacity of 200 mouse units, Simons saw the task of producing a life support system that could sustain a human as scaling-up existing hardware, "by a factor of two and a half".[37]

Between 1948 and 1952, Henry and Simons supplied four monkeys for Project Blossom V-2 launches, and of these four, two ended up reaching "space" altitudes, 100 kilometers above the surface of the earth. These cases, and other monkey flights in the early 1950s, are significantly different from Able and Baker for two main reasons: all but one occurred before 1957 when there was far less interest in space science in American culture, and all but one ended with the death of the monkey, so there was no survivor for scientists to study or journalists to write about. As a result, these monkeys were not subject to media coverage. However, these early cases of failure and death will be useful for comparison when considering how differently Able and Baker were regarded following their successful spaceflight.

[36] "Can a man-like biological specimen think and perform useful work in the zero-g environment of space?" *Men Into Space: Aerospace Medicine at Lockheed* (Lockheed, 1961) pp. 12. For how space became figured as a "hostile" environment in the early Cold War, see Edward Jones-Imhotep, *The Unreliable Nation: Hostile Nature and Technological Failure in the Cold War* (2017).
[37] Gregory P. Kennedy. *Touching Space: The True Story of Project Manhigh*, pp. 59.

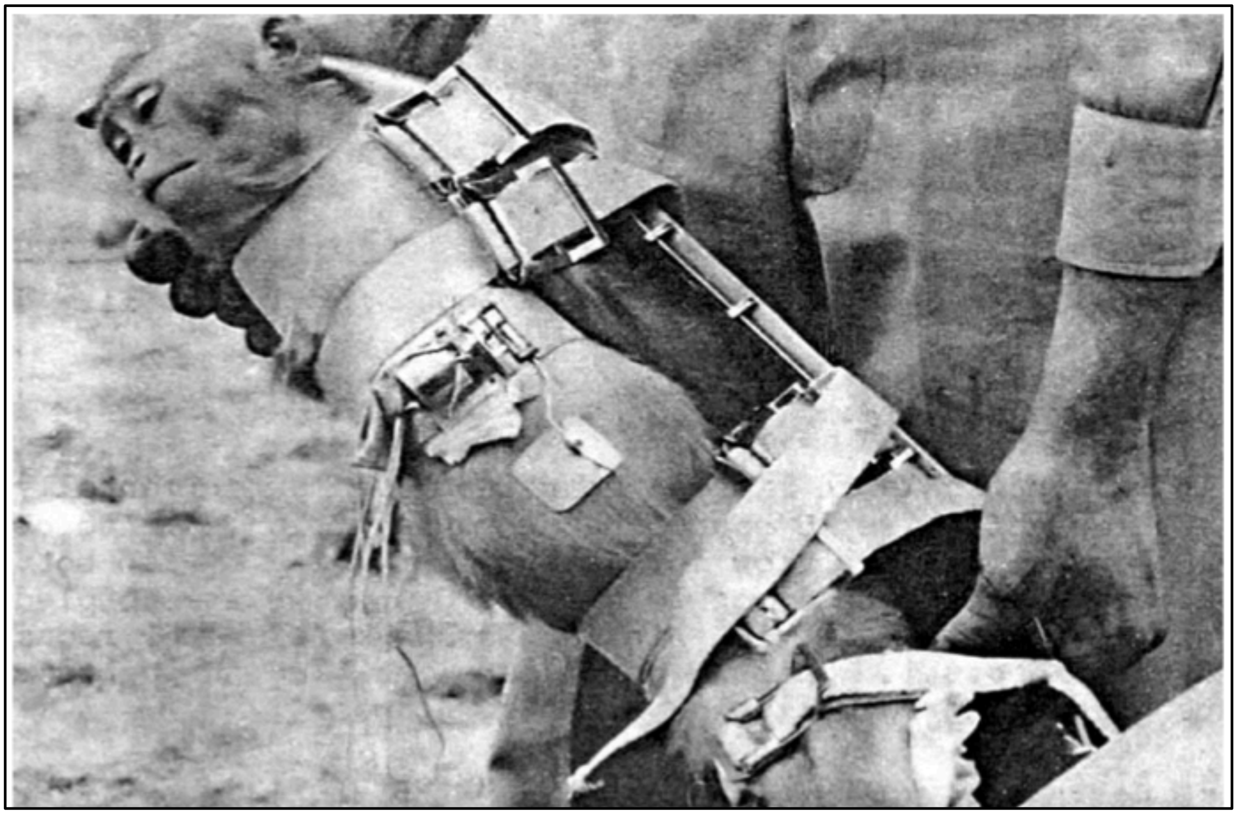

Figure 20: In June 1948, the first rhesus monkey ("Albert") used in Project Blossom was loaded into the nosecone of a captured V-2 rocket at the White Sands Missile Range in New Mexico. (Source: Colin Burgess; C. Dubbs. *Animals in Space: From Research Rockets to the Space Shuttle*. Chichester, U.K.: Springer Praxis, 2007. pp. 43).

The first monkey flight using a V-2 rocket took place at the White Sands Proving Ground on June 11, 1948 and was the third of the seven Project Blossom V-2 launches.[38] The test subject supplied by Henry and Simons was a rhesus monkey they named Albert (Figure 20). Albert was anesthetized with sodium pentobarbital, and Luminal right before launch.[39] Electrocardiographic needles and a respiration measurement unit were sutured to Albert's body, and he was strapped into a cramped metal chair and sealed inside a pressurized aluminum box which was loaded into the missile's nosecone. There was a morbid sense of foreboding on the scene. One of the crew scrawled the line "Alas, poor Yorick, I knew him well"—a slightly misquoted line from Shakespeare's *Hamlet* referencing a deceased jester's skull—onto one of the V-2's fins.[40] The rocket was blasted 63 kilometers into the atmosphere, but the recovery parachute failed, and the

[38] Beischer, 57.
[39] *The Beginnings of Research in Space Biology at the Air Force Missile Development Center, Holloman Air Force Base, New Mexico 1946-1952.* pp. 3-10.
[40] This graffito has led to Albert being mistakenly identified as "Yorick" in some memoirs.

nosecone "slammed into the ground at high speed".[41] Because the telemetry did not work, it was impossible to tell if Albert died on the launch pad, due to the combination of drugs, extreme heat, and cramped quarters, or later on impact. Henry admitted he was, "disturbed by the whole thing".[42]

Their second attempt came one year later, on June 14, 1949, when they placed another rhesus monkey—named Albert II—in a more spacious sealed capsule atop another V-2.[43] This launch, the fourth in Project Blossom, reached an altitude of 134 kilometers—space—but suffered a similar parachute malfunction. However, this time working telemetry indicated that Albert II's heart and lungs functioned effectively right up until the moment of impact, which resulted in "a crater 10 feet wide and 5 deep".[44] Despite Albert II's fiery death, he became the first primate to experience space. Henry and Simons tried again on September 16, 1949, with a third rhesus monkey named Albert III, but the V-2 exploded a few seconds into flight. A fourth attempt made December 12, 1949, with a cynomolgus monkey named Albert IV, reached an altitude of 130.6 kilometers, but ended with another catastrophic parachute failure. The final V-2 assigned to Project Blossom was fired on August 31, 1950, but carried mice instead of a monkey, however, this also ended with yet another parachute failure and the loss of the animals.[45]

Once the V-2s ran out, Project Blossom's biological flights continued, but used American-produced Aerobee rockets, which could not reach space altitudes with animals onboard. The first attempt to fly a monkey on an Aerobee happened on April 18, 1951, with a rhesus monkey named Albert V. Reaching an altitude of 58 kilometers, the re-designed parachutes failed, killing Albert V. Albert VI was launched on September 20, 1951, and reached an altitude of 70 kilometers (not space). He was recovered but died two hours later due to heat prostration. A third and final Aerobee biological flight occurred on May 21, 1952, in which two cynomolgus monkeys named Michael and Patricia reached an altitude of 26 kilometers and were recovered alive. This partial success (the recovered monkeys had only traveled a quarter of the way to space) concluded Project Blossom, and further primate flights were discontinued until 1958.

Parallel to these rocket flights, animals were used as human analogs in several ground and balloon-based space medicine experiments. These included acceleration tests on rocket-sleds and

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[41] Burgess and Dubbs, 45-46.
[42] ibid, 46.
[43] Beischer, 57.
[44] Burgess and Dubbs, 47.
[45] Beischer, 55-64. Beischer provides a table of all American "Biological Experiments in Rockets, Missiles, and Satellites" up to 1960.

centrifuges, environmental tests in vacuum and climate chambers, and radiation tests in high-altitude balloons or enclosures exposed to radioactive substances.[46] Like in the rocket flights, many of these animals died making data for space medicine. By 1958, the United States Air Force maintained two different colonies of primates for biomedical research: rhesus monkeys at the Balcones laboratory at the University of Texas at Austin, and chimpanzees at Holloman Air Force Base, in Alamogordo, New Mexico. Whether in a rocket, centrifuge, sled, or chamber, none of these monkeys received anywhere close to the amount of attention Able and Baker did following their flight in 1959. None transferred over into that other realm of military animal work that Able and Baker did, the company mascot.[47] This was due to the obscure status and questionable utility of space sciences before 1957, and the fact that every monkey that had made it to space ended up dead—inconvenient stories to tell at a time when technical ability was equated with geopolitical strength.[48] Out of the public eye, these monkeys were not anthropomorphized to the same degree or in the same way as Able and Baker. However, after the launch of Sputnik in 1957 turned America's attention to space, the primate rocket flights that were discontinued in 1952 resumed with the media and public now watching with great interest.

It was in this new moment of drastically-increased attention to spaceflight that NASA's "Bioflight #1", the final primate rocket flight before Able and Baker's, took place. On December 15, 1958, a squirrel monkey named Gordo (also known as "Old Reliable") was launched in a Jupiter medium-range ballistic missile from Cape Canaveral, Florida. The rocket's sub-orbital trajectory reached space, but Gordo drowned when the capsule sunk during the recovery effort. Another embarrassing failure, Gordo received only muted attention in the press.[49]

ANTHROPOMORPHISM IN THE ARCHIVE

To demonstrate how Able and Baker's sudden popularity drastically altered the way they were written and thought about, it is useful to paint "before" and "after" pictures comparing representations from the private realm of the research laboratory with the public sphere of the

[46] Burgess and Dubbs, 105.
[47] For the history of different kinds of animals work in the context of warfare, including mascots, see Eglan (2015).
[48] Weitekamp, 33.
[49] Burgess and Dubbs, 128.

media. Animal historians look for significant events in animal lives including acquisition, naming, high-profile experiments, public relations efforts, medical care, controversies, changes in ownership, and death and memorialization, for data generated where shifts in human regard can be discerned. One example that's useful to briefly consider at the outset of the story is the practice of naming. As it turns out, the names "Able" and "Baker" are simply the first two letters (A, and B) of the Army's phonetic spelling alphabet and were only assigned hours before launch.[50] As discussed above, the first six monkeys used in rocket flights were all named "Albert" (also, perhaps, for the letter "A") and were also only given this designation right before launch. The origin of this name is unknown, but the fact that the same name was used for six different monkeys indicates their interchangeability and conveys only the faintest sense of individuality. It seems like a practical choice made to aid humans in coordinating the overall operation. In the 1950s, naming animals used in scientific research was frowned upon for fear that it, "might induce a form of emotional attachment to the animals," and undermine their proposed expendability.[51] With only a few exceptions, most of the publicly-known names of animals used in spaceflight were assigned either right before or right after the experiment. Before this they were called something else entirely. Unlike the Mercury Seven, who became celebrities and household names upon selection—years before their first flights—American space monkeys remained anonymous and out of public view unless they were successfully recovered, which is a practice more reminiscent of secretive early Soviet cosmonaut groups.

In *Primate Visions* (1989), Donna Haraway discusses the naming practices used at Holloman Air Force Base, noting that Ham was originally named "# 65", and commonly referred to as "Chop Chop Chang", a racially-loaded nickname.[52] It was only after his successful Project Mercury mission in 1961 that he was given the new name "Ham", a promotional reference to

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[50] The Joint Army/Navy Phonetic Alphabet (Able, Baker, Charlie, Dog…) was in use from American's entry into World War Two in 1941, until 1956. It is unclear why the monkeys were eventually named in accordance with this alphabet rather than the NATO phonetic alphabet (Alpha, Bravo, Charlie, Delta…), which was adopted by the U.S. Military in 1956. In 1946, "Able" and "Baker" were the code names assigned to the two nuclear detonations in Operation Crossroads, the first U.S. atomic weapons tests after Trinity. The names were also derived from The Joint Army/Navy Phonetic Alphabet, but it is unclear if the monkeys—carried into space by a nuclear missile—were named to reference the blasts, or simply via the same convention. Army records do show that Able was initially named "Alpha", but that this was quickly switched to "Able". It's possible that the change was made merely because "Able" is similar to a human name many American in the 1950s would have been familiar with, the biblical "Abel", or perhaps they felt that "Able" could advertise the Army's can-do public image (or both).

[51] Burgess and Dubbs, 190; Daston and Mitman, 5.

[52] Donna Haraway. *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (New York: Routledge, 1989) pp. 138.

"Holloman Aeromedical" that also conjured the biblical Noah's son. This practice of naming primates after research centers appears to have been started by scientists at the USAF School of Aviation Medicine (SAM), who in 1958 named one of their experimental rhesus monkeys "Sam", who was followed by "Sam II", and "Miss Sam". However, in research literature, most USAF primates were identified only by numbers, with the suffix of X or Y added depending on whether they were born on site or purchased someplace else. Some names of these monkeys survive in the archive: "21X", "3Y", "299+", and "893" all participated in space medicine research in 1958.[53] A technical report from 1959 summarizes some of the USAF animal research, and demonstrates this instrumental regard: "Three animals (Nos. 269, 250, and 258) were selected for this test… On the first day animal 269 was given a test run of three minutes…"[54] This naming convention was designed to aid the scientists in remaining emotionally distant from their test subjects. In the report's images, the monkey obviously named Sam in everyday practice (he wears a vest with "Sam Space" stitched across the front) is only referred to "Primate restrained in seat".[55] This generally anthropocentric, instrumental regard for animals used in space medicine research is evidenced in the extreme by USAF's "Project Barbeque", a series of rapid deceleration tests conducted in August 1952. In these tests, hogs were strapped into rocket-powered sleds in cockpit-like seats and accelerated along a track to extreme speeds with sudden braking resulting in 80 Gs. As Burgess and Dubbs note, "following investigative autopsies—the unfortunate animals were cooked and eaten."[56]

Alphanumeric "names" show human regard for these experimental animals to have been quite low, and informed by the anthropocentric, scientific ideal. However, it is important to point out that in practice, this was not always the case.[57] As Paul S. White and Jed Mayer have noted in

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[53] "Notes and Editorial Background for Primate Launch" *History of Discoverer: Appendixes C, D, F, and F.* pp. 1-5.
[54] "Primates in Space: Progress Report No. 2", 74-75.
[55] "Bio-Paks: Instrumentation and Biomedical Research: Progress Report No. 2", 32. A different document titled "Members of the Chimpanzee Colony, Vivarium Branch, 6571st ARL, Holloman AFB, N.M." in the folder "Baker" at NMSH lists the names assigned to chimpanzees at the facility in 1964 in addition to their three-digit identification numbers. A sampling of the names reveals some with racial undertones, some which were common names, and some which may have been named for Project Mercury astronauts: "Paleface, Big Mean, Brownie, Little Jim, Helen, Duane, Jake, Lyndon, Lady Bird, Washo, Charlie Brown, Chang (Ham), Gus, Scott II, Walter, Donald, and John."
[56] Burgess and Dubbs, 105. See also the "Baker" folder at NMSH which contains photographs of animals strapped to the Holloman "Daisy Track" acceleration sled. One photograph contains the following inscription on the back, "'Project Barbecue', 5 August 1952. Project deceleration, Run #22."
[57] See: "School For Chimps" Air Force Missile Development Center. Release No. 64-7-R. July, 1964. pp. 5. The director of the chimpanzee colony at Holloman Air Force Base described his operation as a miniature space program where his animals get, "all the care and protection a Glenn or Grissom received in blazing the space trails."

their studies of nineteenth-century vivisection debates in Britain, different species of experimental animals elicited different levels of empathy from public spectators and scientists.[58] For example, frogs were seen as little more than laboratory instruments—living technologies for measurement—but operations on dogs and primates resulted in public outcries for ethical treatment, and also forced scientists themselves to acknowledge, confront, and manage their own emotional responses to animal suffering.[59] These studies teach us that regard for animals used in scientific experiments is flexible in many ways: based on context, goals, who is observing, and existing regard for different kinds of animals. These studies also point out that scientists—while attempting to adhere to objective rules of emotional distance and self-regulation (anthropocentrism)—did not exhibit a consistent or monolithic disregard for animal subjects in practice. For space primates, surviving a flight meant getting a new more human-sounding name, a practice that signaled and enabled a wider shift in regard that the biographies of Able and Baker will illustrate.

[58] Paul S. White "The Experimental Animal in Victorian Britain". *In Thinking with Animals: New Perspectives on Anthropomorphism*. Daston, Lorraine; Gregg Mitman (eds.) (New York: Columbia University Press, 2005).; Jed Meyer. "Representing the Experimental Animal: Competing Voices in Victorian Culture". in *Animals and Agency: An Interdisciplinary Exploration*. Sarah E. McFarland; Ryan Hediger (eds.) (Brill, 2009).
[59] Daston and Mitman, 8.

Figure 21: Able sits atop a table during the NASA press conference following Bioflight #2. Note the metal lead at right used to control her. According to one reporter, "Mostly, she sat and sulked". (Source: New Mexico Museum of Space History, folder "Able").

ANTROPOMORPHIZING ABLE

The female rhesus monkey that later became known as "Able" was born sometime in December 1957, at the Ralph Mitchell Zoo in Independence, Kansas.[60] She lived with twenty-five other rhesus monkeys inside an enclosure built around a large stone structure with castle-like turrets. Following the failed recovery of Bioflight #1 in December 1958, another biological flight

[60] Burgess and Dubbs, 131. The exact day was not recorded; it did not seem noteworthy at the time.

(“Bioflight #2”) using a Jupiter missile was organized for May 1959.[61] Instead of procuring their rhesus from the USAF Balcones colony, the Army placed an order with an animal dealer at the Miami Rare Bird Farms in Florida. This dealer, named Alton Freeman, subsequently contacted Ralph Mitchell at his zoo in Kansas, and the two agreed to an exchange: Freeman would send twenty-six of his spider monkeys to Independence, and in return, Mitchell would ship twenty-six rhesus monkeys (including the monkey later named Able) to University of Wisconsin.[62] Here, Able was among eight rhesus monkeys selected for potential inclusion in the rocket flight by experts from the Army Medical Research Laboratory (ARML) at Fort Knox, Kentucky, and the Walter Reed Army Institute of Research in Washington, D.C.

The Army handlers then began training these eight monkeys for the rocket flight, a process that took them to three different military and medical facilities: Walter Reed Army Institute of Research, in Washington, D.C., the Army Medical Research Laboratory at Fort Knox, Kentucky, and the Army Ordnance Missile Command, in Huntsville, Alabama.[63] Preparations included conditioning the animals to tolerate confinement in increasingly small spaces for increasingly long periods of time. Beyond being a passive passenger, the rhesus monkeys were also trained to tap a telegraph key at the illumination of a red light that would blink once every second. If the monkey failed to press the key, an electric shock was delivered.[64] This behavioural test—similar to simulated button-pushing work in the space cabin simulator—would be administered during flight with the hope of determining whether the stresses of rocket flight (especially the period of weightlessness) constituted a barrier to simple technical labour.

The sex of these prospective space monkeys appears not to have been an issue. The major concern surrounding Able’s selection was actually national origin. About a week before Bioflight #2, a different rhesus monkey was selected to make the flight, but officials behind the scenes raised red flags when it was discovered that this monkey was not “American born” but had instead been imported from India. A sort of “citizenship controversy” ensued with the final decision to replace this monkey with a “native-born” rhesus—the monkey later named Able—came from President Dwight D. Eisenhower himself. By then attuned to the delicate geopolitics of space ventures Eisenhower was warned about the potential for bad optics if protests arose in India, where rhesus

[61] Beischer, 57.
[62] Burgess and Dubbs, 131.
[63] “Space Monkeys Given Exacting Drills for Flight”. Folder “Able” at NASA History Office.
[64] J.W. Powell, “The Flight of Able and Baker” in *Journal of the British Interplanetary Society*, 38 (1985). pp. 94.

monkeys are considered sacred animals.[65] *New York Times* aviation editor Richard Witkin wrote that NASA officials had, "stressed at a news conference here that Able had not been born in India but in Independence, Kansas."[66] Even the apparatus Able was strapped to inside the nosecone reinforced this with the words "American Born Rhesus" inscribed on the side.[67] Following the launch, NASA administrator T. Keith Glennan wrote to George Low, then the head of the Office of Space Flight Development about "the use of Indian-born rhesus monkeys in the future", stating he promised State Department officials that from now on, "where we felt a rhesus monkey was indicated as the proper research animal, we would use American-born animals."[68] This directive prompted William Augerson, a young Army flight surgeon assigned to the human factors section of NASA's Space Task Group and involved in Bioflight #2, to inform his space medicine colleagues back at the USAF School of Aviation Medicine: "NASA is requiring USAF-SAM to 'prove' their monkeys are native-born".[69] This citizenship-like discourse was driven by Cold War geopolitical concerns rather than sex or gender.

On May 25, nearly three days before liftoff, Able was secured to a form fitting apparatus and restrained with wire mesh. It was at this point that the Army designated the rhesus "Alpha", which was subsequently switched to "Able". One news report noted that the rationale for the "unsentimental" and "unfeminine" military alphabetical naming convention was to discourage anthropomorphism. "Pet names were eschewed by authorities principally for two reasons: To

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[65] *LIFE*, June 8, 1959. pp. 40.
[66] Richard Witkin, "2 Monkeys Survive Flight into Space in U.S. Rocket and are Retrieved At Sea" in *New York Times*, May 29, 1959. pp. 2. Another report in the *Washington Star* used humour to emphasize Able's country of origin: "Two American-born tourists returned last night from the Caribbean the way most American-born tourists return—tired, broke, and in need of a shave." (May 30, 1959) pp. 1.
[67] Visible in unmarked press photograph contained in folder "Able" at NASA History Office.
[68] Memorandum from T. Keith Glennan to George Low, June 15, 1959. NASA History Office, George Low papers.
[69] "Memo to: Chief, Bioastronautics, Amed R&D Command, Subject: Transmittal of Data on 1, 2A, B to Space Task Group Personnel." 1959. NASA History Office folder "William Augerson". Note: 1, 2A, B are laboratory names for USAF monkeys. Augerson is an interesting figure for many reasons, but specifically in the context of Bioflight #2 he is important for supplying the sample of human blood that was included in the payload. He admits being the source of the blood sample during the post-flight press conference, the transcript of which can be found in "Space Conference on Biomedical Experiments, Jupiter 18" pp. 17-18. It is possible that Augerson's blood is the first human "body part" in space (although this is unclear since it is possible that there were similar Soviet "bioflights" with human blood or tissue before this date). Under questioning from the press, Augerson said he provided 75 ccs of type ORH Negative blood, 25 ccs of which were included in the payload. He noted that he was selected to provide the sample over fellow Army physician Tom Davis on account of having "the better veins". He also admitted that used to sell his blood to make ends meet in medical school (pp. 17-18).

minimize the protests from animal enthusiasts, organized and unorganized, and to soften any adverse reaction in India where the rhesus monkey is revered."[70]

Early in the morning, at 2:35 am on May 28, Jupiter missile AM-18 was launched from Cape Canaveral Complex 26B, lighting up the night sky as it streaked eastward. Riding inside the nosecone in separate pressurized compartments, Able and Baker endured 15 Gs as the rocket accelerated to over 16,000 kilometers per hour. Electronic sensors attached to various parts of Able's body radioed sixteen channels of biometric data representing everything from heart beats and breathing, to her muscle reactions, and cabin conditions back to experts at The Cape. At engine cut-off, Able's heartrate had increased to 175 beats per minute and her respiration rate was recorded as 30—both considered 'normal' for a rhesus under stress. Reaching 483 kilometers in altitude, they experienced nine minutes of weightlessness before reentering the atmosphere, briefly taking 35 Gs during deceleration. Soon afterward the recovery package was automatically ejected and two ribbon parachutes unfurled. The nosecone splashed down 2,414 kilometers downrange approximately sixteen minutes after liftoff.

After their dramatic recovery at sea, Able and Baker were extracted from their respective capsules, given a cursory medical examination, and both were found to have survived the flight without any obvious physical harm. Gerald Champlin, an Army medical officer onboard the *Kiowa* cabled news of the successful recovery to The Cape and the Army Ballistic Missile Agency (ABMA) in Huntsville, Alabama. Able and Baker were isolated in a ward room as the tug headed to port in San Juan, Puerto Rico. From here, the monkeys were flown to Andrews Field ahead of their press conference at NASA's headquarters in Washington D.C. the following day.[71] Able spent the night of May 29 in a cage at Walter Reed Memorial Hospital.

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[70] Richard Witkin, "2 Monkeys Survive Flight into Space in U.S. Rocket and are Retrieved at Sea" in *New York Times*, May 29, 1959. pp. 2.
[71] "Two Monkeys Survive 1,500-Mile Space Trip" in *Washington Star* (May 28, 1959) pp. 1-2.

Figure 22: Able and Baker presented to the world at a press conference held at NASA Headquarters in Dolley Madison House. (Source: NASA History Office, folder: "Able").

The big press conference began at 2:25 pm on May 30 at Dolley Madison House and included NASA Administrator T. Keith Glennan, brass from the Army and the Navy, as well as ten military scientists who had worked on various aspects of the biological experiments in the nosecone. Also packed into the small auditorium were over fifty members of the press with notebooks and cameras at the ready. Glennan opened the proceedings with remarks aimed at tamping down sensationalism he expected from the press regarding the use of monkeys: "We in NASA are very, very happy over the outcome of this experiment… which was, may I say, in no way a stunt. This is a serious, scientific activity and we would like to keep it on that plane."[72] Before a lengthy question and answer period about the details of the operation and various experiments, Able and Baker were brought in and placed on a table by Donald Stullken, a physiologist from the Navy School of Aviation Medicine at Pensacola, who had worked with Baker (Figure 22). William Hines, a reporter for the *Washington Star* described the scene: "The two monkeys appeared briefly for news

[72] "Space Conference on Biomedical Experiments, Jupiter 18." May 30, 1959, 2:25 pm. National Aeronautics and Space Administration. # 59-158. pp. 4.

and movie cameramen before the conference began. As promised by NASA deputy press chief Herbert Rosen, tiny Baker proved to be 'a real ham.' She performed for the photographers for several minutes before tiring. Able, by contrast, failed to live up to her advance billing for an ugly disposition. A small monkey of the organ-grinder type, with a pinched face and worried expression, she was brought on at the end of a long, inflexible metal lead (Figure 21). 'You'd think she was [soon-to-be-executed serial killer] Charlie Starkweather', one newsman remarked. Predictions of dark doings by Able did not materialize. Mostly, she sat and sulked."[73] (Figure 4) During the event, Able and Baker were photographed in front of a giant NASA emblem, and a large American flag, with the latter image appearing on the cover of *LIFE* magazine two weeks later on June 15, 1959.

For nearly an hour, reporters lobbed questions at the group of military and medical experts about different aspects of the experiments on Bioflight #2, with most focused on Able and Baker. But for this chapter's focus on anthropomorphism, the most significant exchange was a simple request for clarification that likely seemed unremarkable at the time. This brief back-and-forth is the beginning of longstanding public confusion over Able's sex, which many assumed to be male.

Question: How long was Able strapped down in the capsule before takeoff?

General McNinch [Commander, Army Research and Development Command]: He was in the capsule approximately 70 hours before takeoff.

...

Question: You just mentioned Able as "he".

General McNinch: She. I beg your pardon.

Question: Why were females used on this trip?

General McNinch: There are many factors deciding the eventual selection of a given monkey, but I think sex was a very, very minor one."[74]

[73] William Hines. "Space Monkeys Hardly Marked by Rocket Trip" in *Washington Star* (May 31, 1959) pp. 1
[74] "Space Conference on Biomedical Experiments, Jupiter 18." May 30, 1959, 2:25 pm. National Aeronautics and Space Administration. # 59-158. pp. 21.

The conference sustained Able and Baker as front-page news around the country, and around the world. In the United Kingdom, there were protests from animal rights activists. The British League Against Cruel Sports wrote that, "every animal-loving person will deplore this diabolical act and feel sickened and nauseated by the so-called civilized mentality of the persons who can submit sentient creatures to such a fiendish fate."[75] Soviet media offered a more staid assessment (probably because the USSR had decided not to attempt to recover Laika): "The U.S.A. reports a successful round-trip through space and back by two monkeys on a Jupiter rocket launched at Cape Canaveral."[76]

However, the reaction NASA feared most, from India over the use of a rhesus monkey, failed to materialize. In the days that followed, Glennan wrote to U.S. Secretary of Health, Education, and Welfare, Arthur Sherwood Flemming, who had raised the potential issue a week earlier. "As a matter of interest, I quote below a statement handed us by CIA commenting on this exercise. 'First Indian reaction to Monkeys Able and Baker and their space flight came from the Hindustan Standard (Calcutta), Indian owned and edited leading English language newspaper. The gist of its comment was that Able and Baker will join the other heroes and heroines of scientific progress, CIA's India desk officer says no criticism was reported in the editorial."[77]

In many of these reports Able began to be anthropomorphized in the image of a heroic, pioneering pilot, similar to the Mercury Seven. For example, an article in the June 5, 1959 issue of *The Science News-Letter* referred to Able as a "pioneer", and a "pilot" who "paved the way for humans" to explore space. These are descriptors normally reserved for humans, and certainly not the way Able would have been described before the experiment. Another example, from the Associated Press described Able and Baker as "two pioneering monkeys" who "from personal experience know more about space travel than Government scientists".[78] Descriptions of Able's performance on the behavioural test—or lack thereof—cast her as a human student: "Able was cleared of a charge that she flunked her test in telegraphy… scientists said that at the last moment it was found there was no room for the device in the capsule and therefore Able had no chance to

[75] "Space Monkeys to be Flown Here For New Conference Tomorrow" in *Washington Star* 5/29/1959.
[76] ibid.
[77] Memo from T. Keith Glennan to The Honorable Arthur Flemming, 7 June, 1959. Folder "Able" at NASA History Office Archives.
[78] "Space Monkeys to be Flown Here For News Conference Tomorrow" in *Washington Star* (May 29, 1959) pp. 3.

try her hand at transmitting."[79] Able and Baker were also elevated in status by R.B. Searcey, the mayor of Huntsville, Alabama, who wondered in print, "I don't know if you can make a monkey an honorary citizen, but we want the monkeys to be at home here."[80] This is not to say that they were considered fully human; a *Science News-Letter* article called them "living laboratories".[81]

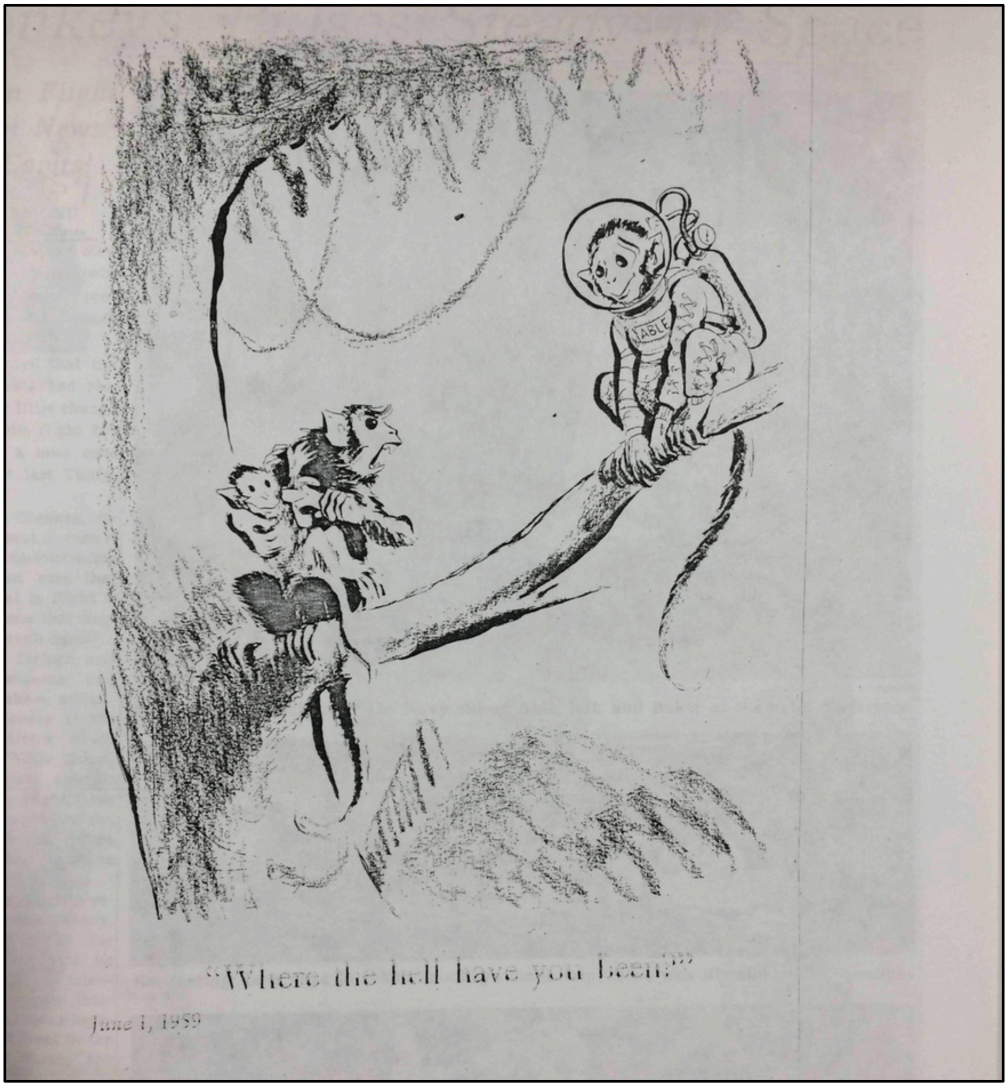

Figure 23: "Where the hell have you been?" This comic by Bill Mauldin published on June 1, 1959, in the *St. Louis Dispatch* is one of the first depictions of Able as male. (Source: NASA History Office, folder "Able").

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[79] William Hines, "Study of Animals Continues for Life" in *Washington Star* (May 31, 1959) pp. A-6. Other sources incorrectly state that there was a problem receiving the telemetry from the behavioural test when in fact it was not included at the last minute.
[80] "Space Monkeys to be Flown Here For New Conference Tomorrow" in *Washington Star* 5/29/1959
[81] "Space Flight Succeeds*" Science News-Letter*, 355.

At this stage, despite McNinch's slip during the press conference, Able was still mostly referred to as female ("Navy frogmen helped hoist the nose cone and the Nation's new space heroines"), but Able's switch from female to male in the popular consciousness was beginning, and this can be seen in a cartoon by artist Bill Mauldin that was published on June 1, 1959, in the *St. Louis Dispatch* (Figure 23). The cartoon depicts a gendered domestic scene familiar to 1950s American readers. Able, in the role of absentee husband, is returning home late from work dressed in a human-style spacesuit. Appearing guilty, Able is being chastised by another visibly irate monkey who, clutching a baby, is clearly in the role of housewife. "Where the hell have you been?", she demands. Riffing on Able's status as a working animal sent a great distance, Mauldin draws on the trope of the travelling businessman or workaholic dealing with marital tension at home. But to make the joke work, Mauldin presented her as a masculine male monkey. It is unclear if Mauldin knew Able was really a female monkey, but the impact on the audience is the same: the job of astronaut is an assumed masculine role. His joke would not work with a female Able.

After the Washington press conference and photo shoot, Able was examined by doctors at the Army's Walter Reed Institute, where she was declared to be in "excellent condition".[82] She was then transported to the Army Medical Research Laboratory at Fort Knox, Kentucky where, Army experts described her as "apparently in good condition, active, alert, and … eating immediately."[83] However, it was noticed that one of the three electrodes implanted beneath her skin to relay biometric data during the flight had become infected. Able had three electrodes—described as "consisting of a three-quarter inch square piece of silver-plated stainless steel mesh with a silver-plated copper wire attached"—implanted; one in her right shoulder, and two above either side of her groin.[84] The infection was spotted around the right groin implant, and Army doctors led by T.R.A. Davis decided to conduct a routine procedure requiring a half-inch incision to remove the electrode. The decision was made to anesthetize Able, and workers sprayed a cloud of trichloroethylene gas into her crate. This drug had been used on over 700 monkeys previously, including Able, with no ill effects. Unexpectedly, Able's heart began convulsing and she stopped

[82] Burgess and Dubbs, 138.
[83] "One Space Monkey Dies in Minor Operation" in *New York Times* (June 3, 1959) pp. 12.
[84] "One Space Monkey Dies in Minor Operation", 12.

breathing. A two-hour effort by Davis and a team of specialists failed to revive her.[85]

The attempt to save Able was captured by *LIFE* magazine photographer Don Cravens. This incident was another moment in which Able was anthropomorphized, not as a heroic pioneer, pilot, or astronaut, but as a high-profile medical patient. Four of the photographs Cravens snapped during the ordeal were printed as a photo essay in the issue of *LIFE* that featured Able and Baker on the cover.[86] The first image shows Davis blowing air into Able's pursed lips. The second image shows him delivering a series of electric shocks to Able's chest while a tube pumps oxygen down her airway. The third image is of Robert Hardin, a cardiologist, cutting into Able's chest with surgical scissors, while David Cameron, a medical technician, prepares to inject a shot of adrenaline. The final image in the series shows the defeated group of doctors frozen in frustration hovering over Able's lifeless body (Figure 24).[87]

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[85] Burgess and Dubbs, 138.
[86] *LIFE,* 22.
[87] In his article "Davis & Able" printed in *Air & Space* magazine in November 1993, author A.H. Saxon relays an anonymous claim from a "medical officer who was present" that day that Davis, conscious of the cameras in the room and a media-savvy operator, made these attempts purely for show, "Everyone knew Able was stone dead". (pp. 78-79).

Figure 24: The attempt to save Able's life, as captured by *LIFE* photographer Don Cravens. (Source: "Able's Dramatic Death And… New U.S. Advances in March To Space" in *LIFE* magazine. June 15, 1959. pp. 22).

Here, Able is anthropomorphized twice over, first by doctors treating her with the methods and regard typically only afforded human patients, and secondly by *LIFE* staff who modeled the photo essay after a high-stakes medical drama, a genre normally reserved for humans. Army doctors elevated Able's status to that of a high-priority patient and worked for two hours using increasingly elaborate and risky techniques to save her life—just like doctors might to save the life of an important human patient. Davis and his team wanted Able alive for two reasons: first so she could supply them with data about the long-term aftereffects of spaceflight, and second so that her death would not be a technical failure, an embarrassment to the team at Fort Knox, the Army, and ultimately to the nation. The photo spread in *LIFE* focuses on the sequence of medical methods used, and calls attention to the rigor and ingenuity employed by the doctors in their effort to save her life. Only hours before, her life—like the lives of all primates used in space experiments before her—had been considered expendable. Her body, now perceived to contain the capacity to generate valuable data, was suddenly treated differently. Her value for the Army was that she could make useful data and could be advertised as evidence of their technical competency.

News of Able's death was widely reported in the media that only days earlier had heralded her safe return from space. One headline proclaimed, "Space Monkey Able Dies After Operation"; another simply, "Able is Dead". Controversy quickly formed around the search for a cause. Was this an ill effect of the stresses of spaceflight, or of the extreme environment of space itself? Davis and the Army doctors had to fight a two-front battle to convince the press and the public that Able's death was not caused by space or the flight, or by their negligence or incompetence. "This is the kind of thing that makes you want to kick a door", snapped one Army medical official.[88] It was especially frustrating because of the inter-service rivalry between the Army and the Navy, which had supplied Baker. The next day at the Naval School of Aviation Medicine in Pensacola Florida, Baker underwent a similar procedure to remove electrodes without issue.

On June 3, members of the House Space Committee questioned the Army doctors about the cause of Able's death. Congressman Victor L. Anfuso, a democrat from New York, asked for proof that her death was not caused by the flight. They floated the possibility that sheer fright might have been to blame. "Clinically, as far as we have been able to determine, the animals returned in good condition," replied Colonel Robert Holmes, who went on to blame her death on a reaction to the anesthetic as the "precipitating agent". This narrative was relayed in *LIFE*, "Able had taken the same trichloroethylene before and suffered no harm. Yet this time she died. Why may always remain a mystery".[89] The fact that Able had died and could no longer be studied,

[88] ibid.
[89] "Able's Dramatic Death and New U.S. Advances in March to Space" in *LIFE* (Vol. 46, No. 24, June 15, 1959) pp., 21.

coupled with the fact that no one could explain how or why this had happened, was a source of embarrassment for the Army, and for the United States government. President Eisenhower had been personally involved in choosing Able for the flight, and this outcome was unwelcome at a time when geopolitics were so entwined with public displays of control and technical ability.

Able's death became another catalyst for her elevation in status beyond that of a typical laboratory animal. For comparison, this is how the death of two rhesus monkeys used in a barely-publicized NASA balloon experiment was reported in *Aviation Week* in 1962. "First of four high-altitude balloon flights planned by National Aeronautics and Space Administration to study the effect of cosmic rays on animals was only partially successful because failure of a life support system caused the death of two rhesus monkeys and four hamsters being used as subjects." The reporting is straightforward, cold and clinical, and avoids sensationalism or anthropomorphism. The monkeys are not described as pioneers or pilots, or sentimentally memorialized. Able's death was treated very differently. *LIFE* described it as "dramatic", a "disaster", a "minor tragedy", and as putting, "a blotch on the shining record of America's greatest space biology experiment."[90]

Sensationalized accounts of her death contributed the confusion over her sex. A photo of Able in the *New York Times* was captioned, "DEAD: Able one of two monkeys who took space flight last week. He died Monday night during an operation for removal of instrument in his body. Death was caused by anesthesia".[91] *Space Monkey* (1960), a children's book in the popular "animal biography" genre focused on the life of Baker, also casts Able as male when recounting her death. "He was fine, it seemed", wrote author Olive Burt about Able after the mission. "He had also suffered no harm from the flight into space. Later, however, for reasons not connected directly with his adventure, Able died. The doctors worked hard to save his life. One of them put his own breath into the small lungs. But it did no good. In spite of everything, Able was dead. But he was not forgotten. He has been given full credit for the information his flight afforded."[92] In 1966 a retrospective article about the flight in the *Chicago Tribune* referred to the launch of "a male monkey named Able," and went on to explain that, "the male survived the flight but died on the operating table when an electrode was being removed."[93] A 1977 article in the *Washington Post*

[90] "Able's Dramatic Death and New U.S. Advances in March to Space", 21.
[91] John W. Finney. "One Space Monkey Dies During a Minor Operation" in *The New York Times* June 3, 1959.
[92] Olive Burt. *Space Monkey: The True Story of Miss Baker* (New York: The John Day Company, 1960) pp. 55.
[93] "Life Swinging For Female Space Flyer" in *Chicago Tribune* (October 30, 1966)

recalled that, "a rhesus monkey named Able, died when doctors tried to remove medical instruments from him."[94] In contrast, Baker's sex was never mistaken for male.

The final way Able was made to appear more human and masculine was as a museum exhibit. After the Army's autopsy failed to turn up a clear reason for her death, officials decided that she was "just as valuable dead as alive", and repurposed her body from a data producing instrument into a symbolic representative for the imperative of human space exploration.[95] Able's body was stuffed, and remains on display at the Smithsonian National Air and Space Museum in Washington D.C. where she is listed as "inventory number: A19840869000". (Figure 25, left)

In her chapter "Teddy Bear Patriarchy: Taxidermy in the Garden of Eden, New York City, 1908-1936", Haraway analyzes the mounted specimens in Carl Akeley's African Hall at the American Museum of Natural History and points out that the displays were laboriously designed to eliminate evidence of human construction and instead offer city dwellers a vision of apparently-unadulterated nature as a salve to cosmopolitanism and modernity.[96] Able's presence in the Air and Space Museum promotes technology, rather than nature. In the exhibit, Able is presented strapped into the same padded contour couch used during her spaceflight. Her body is mostly obscured behind the assemblage of molded plastic and wire mesh that held her in place before and during the flight. The way curators positioned the couch makes Able appear to be in an upright "standing" position. She appears enveloped and captured by technologies, a true simian cyborg surrounded by bolts, wires, and instruments, with only her face, left hand, and legs visible from behind the tangle. No "natural" surroundings at all. Her one free hand is bolted across her chest (and onto the telegraph key from the aborted behavioural test), which makes her appear frozen in a patriotic hand-over-heart salute, her head and neck restraints contribute to this by angling her gaze slightly skyward—a trope in memorializing astronomers, aviators, rocket scientists, and astronauts. She is made to represent the risk and patriotic sacrifice that the assumed imperative of spaceflight demands in exchange for social and technological benefits.

[94] "The First Lady of Space" in *The Washington Post* (July 1, 1977)
[95] *LIFE*, 21.
[96] Donna Haraway. "Teddy Bear Patriarchy: Taxidermy in the Garden of Eden, New York City, 1908-1936." in *Social Text*, 11 (1984) pp. 20–64.

Figure 25: Left: Able as she appears today as a taxidermy exhibit at the Smithsonian National Air and Space Museum in Washington D.C. (Source: Smithsonian National Air and Space Museum). Right: Able as depicted in the 2009 film *Night At The Museum: Battle of the Smithsonian*. (Source: 20th Century Fox).

In 2009, Able was depicted in the 20th Century Fox family comedy *Night At The Museum: Battle of the Smithsonian*, where a magical artifact brings the institution's exhibits to life (Figure 25, right). In the film, Able is again presented and hailed as male ("buddy"; "guy"), and is played by a capuchin monkey, as opposed to a rhesus. In the film, the re-animated Able is portrayed as having several human characteristics: "he" exhibits a patriotic sense of duty by greeting a human character with an earnest military-style salute and wears a silver spacesuit styled after the ones worn by the Mercury Seven astronauts—very different than the plastic mold and wire mesh restraints (Figure 25, right). By removing the restraints from the picture, the filmic Able is implied to have been a willing participant. Able is also shown to be adept at using technology. In the story, "he" performs a complex technical task at a critical moment to aid the protagonist. Additionally, Able is always shown standing upright (capuchin and rhesus monkeys both normally walk on all fours or sit in a crouching position) and in one scene appears standing in front of a replica of NASA's Lunar Excursion Module, visually connecting Able's ordeal in a Jupiter nosecone in 1959 to the success of the Apollo 11 moon landing almost exactly a decade later in July 1969. On film, Able is fitted into the image of the American astronaut and more generally, the Cold Warrior: masculine, intelligent, rational, reliable, patriotic, proficient with technology, moral, and cool under pressure. Once Able's value as a scientific instrument unexpectedly ended, humans found new uses for her. Stuffed and on display, Able continues to "work" as an unwilling representative of the U.S. space program, silently vouching for the inherent value and moral imperative in pursuing space.

Before the experiment, Able was one of a group of monkeys traded *en masse* like merchandise by geographically-distant humans. The fact that Able's group of rhesus monkeys were traded for an equal number of spider monkeys shows how their species or any of their individual characteristics did not affect their perceived value for humans. Her status as a last-minute replacement for the original Indian-born rhesus demonstrates the interchangeability and expendability of the monkeys (the main fear was not that the Indian-born monkey would survive, but rather that it stood a good chance of being killed), and the low, instrumental regard afforded them by NASA and Army scientists. After the experiment, Able was represented in the media as an individual (evidenced by her now having a stable proper name), and as having a number of human characteristics. Media reports initially cast her as a "pilot" and "pioneer", and the medical drama that surrounded her death presented her as a high-profile medical patient. In death, she was figured as a heroic astronaut and Cold Warrior.

But the most interesting aspect of how Able was anthropomorphized is the initial confusion and eventual full switch of her perceived sex and gender from female to male. Before the flight, no one cared about Able's sex—it was national origin that was the focus of controversy and debate. Also, as we will see in the case of Baker, the other monkey included in the nosecone, there was never any confusion or switch, she was always presented as female. The reason for Able's switch is complex but could have started because "Able" is a homophone for "Abel", male biblical name "of the son of Adam. It may also have been the size disparity between Able and Baker that made officials like McNinch take Able and Baker up as a male/female large/small binary. Additionally, the gendered spaces of military bases and primate research labs may have also contributed to perceptions of Able as male. For example, a 1959 document produced by researchers at the Air Force's Balcones rhesus colony (affiliated with the School of Aviation Medicine) notes that "full grown rhesus monkeys weigh 40-50 pounds, stand 3 to 4 feet high and are as strong as a man. All of the foreign-born animals in the colony must be handled by male animal caretakers… 21X and 20X are so docile, in fact, that even the female technicians handle them."[97]

But it was Able's death in a military setting connected to a high-profile military and space operation that was the critical event for the public switch from female to male. Her death was interpreted as a military sacrifice as part of the Cold War, a conflict long associated with hyper-masculinity, and in which there are very few female heroes. The idea of a male monkey dying a military death fit popular notions of Cold War era soldiery. Another dimension to this is reproduction. Scientists had hoped to conduct longitudinal studies of both Able and Baker, including the study of any eventual offspring to gage the physiological impact of rocket flight and the space environment. Dying four days after recovery ended any hope that Able would produce offspring preempting the motherly tropes that soon bombarded Baker. Even the context of Able's afterlife was coded male in the sort of work/home, masculine/feminine binary suggested in Mauldin's 1959 cartoon (Figure 4). On display at the Smithsonian Air and Space Museum, Able is presented frozen in time as she appeared during the mission and surrounded by other technologies of spaceflight. In this sense, Able is always "at work" and thus in a masculine space context. Much like the social phenomenon of "male performance"—pressures that women scientists and astronauts reportedly feel to act more masculine in previously male-only social spaces of laboratories and spacecraft, Able was transformed from female to male to conform to an already male-coded space. This will become even more apparent when contrasted with the explicitly domestic and more feminine "retirement" of Baker.

INTERLUDE: THE DEATH OF HAM

Able was the first American celebrity space animal to die, and her dramatic passing shows how the circumstances of her death and memorialization shaped her public image as a male Cold Warrior. This short section turns to Ham, the most famous American primate to fly in space, and

[97] "Notes and Editorial Background for Primate Launch" *History of Discoverer: Appendixes C, D, F, and F.* pp. 4-5. The same Air Force publication goes on to describe a photograph of a woman worker holding a rhesus in the following manner: "Number one candidate for the first DISCOVERER primate launch is this female macaca mullata [rhesus] monkey designated 21X. Here the specimen is held by pretty Carolyn Kingery, University of Texas hemotology technician at the Radio-Biology Laboratory." ("DOD Approved Release for Launch of Primate" pp. 6)

the circumstances of his death and memorialization. His unexpected death in 1983 sparked a well-documented controversy that nicely demonstrates how in practice anthropomorphism is not a linear progression from less human to more human but can fluctuate wildly depending on context.

As Donna Haraway notes in *Primate Visions*, Ham was born in Cameroon, Africa in 1955, and then transferred to the United States Air Force's Chimpanzee colony at Holloman Air Force Base.[98] In January 1961, Ham was launched in a Mercury capsule on a Redstone rocket on a suborbital spaceflight designed to test the system and flight profile later flown by Alan Shepard, the first American in space.[99] "After completing his service with the National Air and Space Administration, Ham transferred to the National Zoo on April 5, 1963, where he became a celebrated resident and was viewed by an estimated 50 million people during his 17 years in Washington." In 1980, Ham left D.C. on a breeding loan to North Carolina Zoological Park in Asheboro, which became his final home.[100] Ham's death on January 18, 1983 at 26 years old was statistically premature for a chimpanzee and caught USAF and NASA officials off guard. In keeping with an agreement signed in 1963, the zoo transferred Ham's body to the Armed Forces Institute of Pathology (AFIP), at the Walter Reed Army Medical Center in Washington D.C., for examination. Initially, the plan for Ham's remains mimicked those for Able, he would be stuffed and displayed at the Smithsonian. "It is the recommendation of the AFIP that the skeleton be maintained at the AFIP for display with the skeleton of Able, the other famous space chimpanzee [sic]. It is further recommended that the skin be given to The Aerospace Museum, Washington D.C. for a mounted specimen, and that the remained [sic] of the carcass be forwarded to the International Space Hall of Fame at Alamogordo, New Mexico for burial."[101]

But when this plan to turn Ham into a taxidermy exhibit at the Smithsonian alongside Able was reported in the press, the AFIP, NASA, and the International Space Hall of Fame faced immediate criticism from members of the public, who argued that Ham deserved treatment more in line with a human astronaut. After clever headlines like "Taxidermy is the Wrong Stuff", began appearing in newspapers, letters from space enthusiasts and animal lovers expressing concern and

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[98] Haraway, 137.
[99] *Project Mercury Chronology*, 117.
[100] "Ham Will Be Remembered" in *Tiger Talk*, pp. 1.
[101] Memo: from William R. Cowan to Robert L. Flentge, Subject: "Space Chimpanzee Ham" (January 20, 1983) Folder "Ham" at NMSH.

condemnation began arriving.[102] "I was shocked and horrified to read in this evening's newspaper that Ham will be 'stuffed and displayed,'" wrote Sarah L. Bush, a high school student from New York who had once seen Ham at the zoo. "A chimpanzee is not a green pepper!"[103] Another letter casts the decision in stark, explicitly-human terms, "do you propose to stuff John Glenn as well?"[104] Both letters argue for Ham to receive a "decent burial" and "a hero's burial". Both the AFIP and the Hall of Fame quickly responded with form letters conceding the point and offering reassurance that Ham's body would be afforded a higher regard than originally advertised. "You will be happy to learn that following that initial decision, the question was reconsidered, and it was decided not to stuff and display him as originally planned... His remains will be buried at the International Space Museum in Alamogordo and comforted with a bronze plaque."[105]

However, these assurances of dignified, quasi-human treatment and regard for Ham's corpse were only part of the story. No, he would not be stuffed, but the AFIP still wanted to extract and display his skeleton. What was never mentioned publicly was that to accomplish this Ham's body was still processed like an animal destined for taxidermy: "cleaning by Dermestid beetle colony"—a process in which a corpse is placed in a sealed enclosure containing live beetles that slowly chew away all the fleshy material leaving only the skeleton behind.[106] A curator from the Air Force Medical Museum who was dispatched to the Smithsonian reported that, "Ham's skeleton was removed from the Dermestid colony on 19 April 1983, placed in a cooler to kill existing beetles, cleaned of beetle droppings, soaked in an ammonia solution to deodorize and then removed for inspection."[107] This separation of Ham's skeleton from the rest of his "remains"—exactly what these were is not clear—and the rather grisly process of "cleaning" by beetle colony, are not consistent with the high regard officials promised the outraged letter writers.

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[102] The angry editorial continues, "The only national heroes we can think of who are stuffed and on permanent display are V. I. Lenin and Mao Tse-tung. Does this nation really want to emulate the Soviet and Chinese models? There is not one shred of evidence that Ham was a Communist," and also compares Ham to human astronauts, "Talk about dreadful precedents—it should be enough to make any space veteran more than a little nervous about how he is going to be treated in the posthumous by and by."

[103] Letter: Sarah L. Bush ccc: National Air and Space Museum, Smithsonian; Institute of Pathology, Armed Forces; International Space Hall of Fame (January 28, 1983)

[104] Letter: Jack M. Horton to International Space Hall of Fame (January 28, 1983)

[105] Letter: George D. Imes Chairman Department of Veterinary Pathology, USAF to Sarah L. Bush (Feb 13, 1983)

[106] Schmidt, Dwight. "Memorandum for the record: Processing of skeleton of 'Ham'" Armed Forces Institute of Pathology (March 24, 1983) in Folder "Ham" at NMSH.

[107] To: E.R. White, Associate Director AFMM, From: D. Schmidt, Anatomical Collections, AFMM. "Subject: Status of Skeleton of 'Ham'" (April 22, 1983).

Two months later in Alamogordo, a more dignified regard for Ham was again on display when "the remainder of the carcass" was received at The International Space Hall of Fame at a public event called "Ham Comes Home". A ceremony to dedicate the "Ham Memorial Garden" and the promised bronze plaque was officiated by USAF space medicine pioneer John Paul Stapp. Records show that Hall of Fame staff had attempted to persuade Project Mercury astronauts John Glenn and Alan Shepard to attend—"It's an opportunity to pay respect to the primate that proved man could survive in space and, at the same time, create some good will for the United States Space Program"—but both declined. Glenn was then a U.S. Senator seeking the 1984 Democratic Party Presidential Nomination and explained that, "Due to ever-increasing legislative obligations I have prior commitments which I must honor."[108] Shepard, who had just become president of a Coors Beer distribution company in Texas (and replied on letterhead sporting the brewer's logo) stated, "I have limited my personal appearances to only a handfull [sic] of occasions in the interest of other persuits [sic]."[109] Unlike funerals for fellow astronauts, Ham's memorial was not a priority for the Mercury Seven, for whom space primates always provoked an awkward tension.

The case of Ham's death and burial demonstrates multiple fluctuations in human regard over the course of the process. Falling between Able's death in 1959 and Baker's death in 1984, the controversy surrounding Ham's body marks a transition in treatment of dead American celebrity space animals. By 1983, taxidermy for public display was no longer palatable, and was replaced by "dignified" human-style burial beneath a marker. Ham's burial became the model used for Baker when she died one year later in 1984 and provides a bridge between the two monkeys and respective memorial practices.

ANTHROPOMORPHIZING BAKER

Like Able, Baker was also elevated in status and heavily anthropomorphized. Unlike Able, who died 4 days after the flight, Baker survived for 26 years in captivity. Additionally, while Able was never depicted as feminine, but rather as a masculine Cold Warrior, Baker was only ever depicted as feminine, and fitted into the image of the domestic suburban housewife.

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108 Letter: Senator John Glenn to Ryita Price (March 8, 1983) in folder "Ham" at NMSH.
109 Letter: Alan B. Shepard Jr. to Ryita Price (February 18, 1983) in folder "Ham" at NMSH.

The squirrel monkey who later was named Baker was born sometime in late 1957 in the amazon rainforest surrounding Iquitos, Peru. Shortly afterwards, she was captured by hunters looking for parrots, macaws, iguanas, ocelots, and monkeys they could sell in the United States as pets or research animals.[110] The hunters eventually sold the baby squirrel monkeys they had netted to a pet shop in Miami, Florida, where twenty-six of them were acquired by the United States Navy in 1958 for potential use in Bioflight #2.[111]

The monkeys were taken to the United States Navy School of Aviation Medicine in Pensacola, Florida where they were kept in an animal house along with hundreds of white mice and guinea pigs. In charge of the monkey candidates for spaceflight was Dietrich Eberhard Beischer, head of the Biochemistry Laboratory at the School, and an ex-German scientist participating in Operation Paperclip (Figure 26). During World War Two, Beischer, who had studied under Peter Adolph Thiessen, held a chair in inorganic chemistry at the University of Strasbourg, where he pioneered electron microscopy of polymers and colloids, and also studied the effects of strong magnetic fields and radiation on living tissue.[112] He emigrated to America in 1948 and was stationed at the Navy School in Pensacola with fellow German paperclip Hermann J. Schaefer. Following his brief fame as Baker's primary handler, Beischer became a minor figure in American conspiracy lore for a controversial 1972 test where he exposed 7,000 navy personnel to potentially harmful microwave radiation. This, combined with his bizarre disappearance in 1977 as recounted by electrophysiologist Robert O. Becker, has led to a partitioning of his legacy between celebratory adulation for his work with Baker, and suspicion and condemnation for possible unethical experiments on humans as part of Project Sanguine and Project Pandora.[113]

Upon arriving in Beischer's care, each monkey was placed in a separate cage in an isolation room for two weeks where they received doses of medicine and were monitored for sickness. If

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[110] Olive Burt. *Space Monkey: The True Story of Miss Baker* (New York: John Day, 1960) pp. 3.

[111] Burgess and Dubbs, 133.

[112] Beischer's mentor and collaborator Theissen joined the NSDAP quite early in 1925, and later became Director of the Kaiser Wilhelm Institute of Physical Chemistry and Electrochemistry, where he transformed it "into a model Nazi institution", rejecting the notion that it was too theoretical and abstract, and emphasizing physical chemistry's critical role in aiding industry. Theissen's institute was connected to the use of roughly 100 concentration camp prisoners during the construction of a bunker at Falkenhagen where poison gas was to be produced.

[113] "Just before the meeting [in 1977] I got a call from [Beischer]. With no preamble or explanation, he blurted out, 'I'm at a pay phone. I can't talk long. They are watching me. I can't come to the meeting or ever communicate with you again. I'm sorry. You've been a good friend. Goodbye.' Soon afterward I called his office in Pensacola and was told, 'I'm sorry, there is no one here by that name.'" Public records list Beischer's death as occurring April 7, 1989, in Durham, North Carolina. See: Robert O. Becker. *The Body Electric: The Electromagnetic Foundation of Life* (New York: Morrow, 1985) pp. 115.

found to be free of disease and parasites, the monkeys were given a coded tattoo and admitted to the main colony. Here the squirrel monkeys were kept in groups of three in cages measuring 56 cm by 56 cm by 30 cm.[114] It was just after arrival in the main colony that the monkey later known as Baker received a lasting nickname from Joseph C. West, head of the school's animal house, that shows up frequently in the archive: "Tender Loving Care" or "TLC" for short.[115]

Next, the team led by Beischer, but which also included American scientists Donald E. Stullken, W. Carroll Hixson, and Jorma I. Niven, selected TLC along with thirteen others that they considered to be healthy, of "normal" size and weight, and "teachable", for advanced training. The squirrel monkeys were trained to tolerate being immobilized and isolated in total darkness for long period between eighteen and twenty-four hours, first for shorter periods by being held in place on their backs, and later by restraining them with straps. They were also trained to "take" instrumentation. "[Baker] had to get used to having various needle-like instruments inserted into her flesh… These instruments were electrical devices which would make a record of her heartbeat, her blood pressure, her brain waves, and other reactions if she should be the lucky one chosen for this great adventure."[116] Once tolerant to these stresses, the monkeys were subjected to simulated flights. They were dotted with biometric sensors and confined to a small cylindrical canister like the one that would be placed in the Jupiter nosecone. The canisters were then subjected to G forces on the School's human centrifuge. From these fourteen, six were selected to ride in a specially designed trailer from Pensacola to Cape Canaveral. With just hours to go, Beischer and the team had to make their final selection. "It must be a scientific choice. The 'best' monkey, and only the best, should go," Beischer proclaimed in his thick German accent. After studying data on each, it was decided that the one known as "TLC" had a slight edge, and would be their passenger.[117]

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[114] D.E. Beischer, D.E. Furry. "Saimiri sciureus as an Experimental Animal" in *The Anatomical Record* 148 (No. 4, 1964) pp. 615-624.
[115] In *Space Monkey*, Olive Burt offers a perhaps apocryphal account of this nickname's origin: West noticed one monkey being more friendly to him than the others and said, "From now on, you'll get plenty of tender loving care. You like that, huh? Well, then that's what we'll call you, Tender Love and Care." pp 23. Beischer and West were both interviewed for this officially sanctioned book, and Burt was advised by a Navy information officer.
[116] Burt, 34.
[117] ibid. "One man held her firmly while tiny electrodes were inserted under the skin at the back of her neck. These would record her heartbeat and blood pressure and body temperature. To hold the instruments firmly in place, a small white jacket was strapped onto her body. More electrodes were inserted under the skin of her scalp, to record her brain waves… to hold these electrodes in place, a white helmet was strapped snugly under her chin. This was TLC's spacesuit."

There is some confusion in the archive over how Able and Baker received their names. Olive Burt's book relays a story about Army and Navy officers awaiting the launch casually striking up a conversation about the historic nature of the flight, and wondering how to differentiate between this and future primate spaceflights. "We should think up some way of naming these space animals so that when we speak of them in the future, we'll know immediately which flight the animal went on."[118] The idea ventured here was to continue naming monkeys after subsequent letters in the military spelling alphabet, like the naming convention for tropical storms and hurricanes. A different account from 1979 printed in *TODAY* (a daily newspaper on Florida's Space Coast) dovetails with the story of high-level interest in Able's national origin: "realizing the results would become public, the Army proposed naming the passengers 'Chico' and 'Chiquita' [Spanish for 'little boy' and 'little girl'; again, Able is suggested to be male]. NASA objected because this might disturb Latin American neighbours." The account continues noting that next, "the Agency turned to the White House occupied by Dwight Eisenhower. His press secretary Jim Hagerty instructed NASA to name the Navy's squirrel monkey 'Baker' and the Army's rhesus 'Able'."[119] Their names appear to be for instrumental, or political (rather than promotional) purposes, and not to aid in anthropomorphism.

[118] ibid, 45.

[119] Gordon Harris, "U.S. Space Flier Miss Baker Made Voyage 20 Years Ago" in *TODAY* (28 May, 1979) pp. A1.

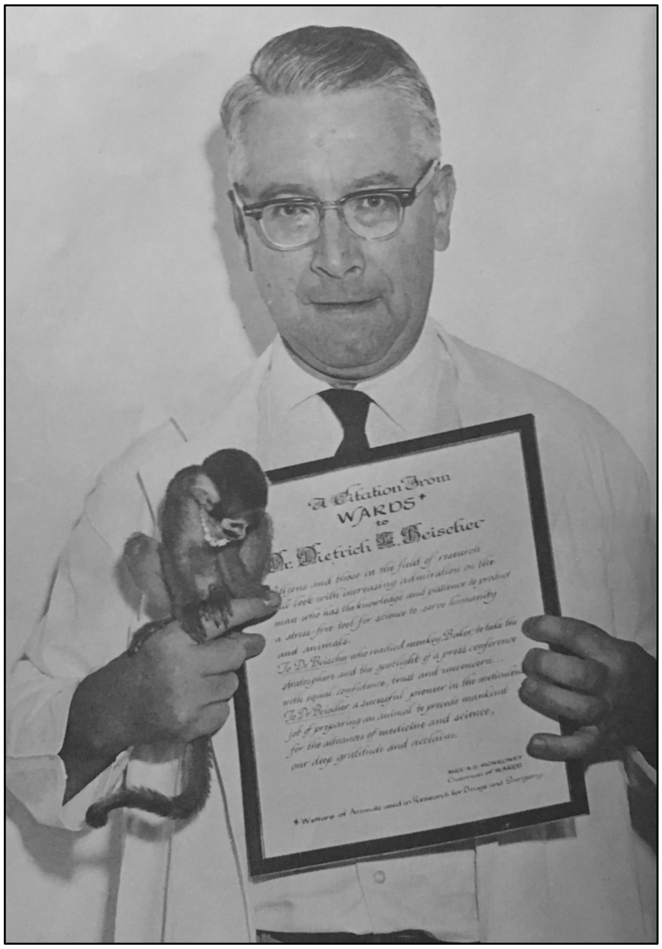

Figure 26: Dietrich Beischer, the Navy physiologist in charge of Baker poses with her and an award he received in 1959 from Working for Animals Used in Research, Drugs, and Surgery (WARDS). Beischer was a former German scientist participating in Operation Paperclip, and beyond the Baker story left a mysterious and controversial legacy of research into the effects of radiation and magnetic fields on humans. (Source: Olive Burt. *Space Monkey: The True Story of Miss Baker*. New York: John Day, 1960. pp. 60).

For the launch, Baker was restrained and anesthetized inside a small padded and insulated cylinder about the size of a thermos. This was then added to a larger box the size of a portable typewriter—the whole package weighted 29 pounds and was totally separate from the capsule containing Able. Three channels of biometric data from Baker's body were relayed to Navy experts at the Cape. Upon recovery, Baker reportedly bit the hand of the handler that removed her from the cylinder, ate a banana and a peanut cookie, and then promptly fell asleep.

Following the NASA press conference, and the media frenzy that surrounding Able's death, Baker was heavily anthropomorphized as a feminine Cold War housewife with expectations that she would procreate. "When TLC is about a year older, we hope she raises a family," Beischer is quoted as saying in *LIFE*.[120] Other publications were quick to gender her military moniker dubbing her "Miss Baker, the First Lady of Space". "Baker" in effect became her last name, whereas "Able" remained a first name or mononym. Back at Pensacola, Baker was given her own special enclosure called "Baker's Bungalow" ("it is a pleasant little home—the most modern home any monkey ever had"), another reference to 1950s domesticity and middle-class suburbanization trends especially prevalent in the American South.[121] More gendered expectations followed: "But monkeys, like people, know that family life is pleasanter than a lonely existence. So when she is old enough, her friends at the School will find a mate for her. They hope she will have many children, all as intelligent and as cute as she is."[122]

In 1962, Beischer introduced a male monkey into her enclosure with the hopes that offspring might reveal any adverse intergenerational effects of spaceflight.[123] This event was heavily publicized as a "marriage" to a "husband" named "Big George" and narrated in terms like human nuptials. She was described as "having shed the life of a single woman" and said to have "met, fell in love with, and married Big George".[124] Their "married" life is narrated in the trope of domestic bliss. "These days Miss Baker… is living in her own private, air conditioned suite with her husky mate, known as Big George."[125] In popular accounts, Baker is said to have not produced any offspring, but this is not the case. An obscure scientific report authored by Beischer in 1964 notes that in April 1962, Baker became pregnant, and on October 3, 1962 delivered a "single male infant" weighing 90.5 grams.[126] The baby was described as "well developed", but died after only a few hours.[127] The quick death of the baby is why this event was kept secret, and not publicized the way that Baker's "birthdays" and "weddings" were, or incorporated into popular biographies.

In 1971, following budget cuts to the Navy School, Baker and Big George were moved to a new home at the Alabama Space and Rocket Center in Huntsville (a space-themed science centre

[120] *LIFE*, 30. This is the same issue that contained photos of the death of Able.
[121] Even her name "Baker" references a domestic feminine activity. For the history of Bungalow-type housing in the American south, see: Clay Lancaster. *The American Bungalow, 1880-1930*. (Dover: Dover Publications, 1995)
[122] Burt, 63-64. It is interesting that this passage both promotes Baker's femininity yet also stresses that future human astronauts will be assumed male.
[123] "Then she will be helping us solve problems of space. For one of these problems is: Will flight into space harm the children of the flier, even if he himself, suffers no harm?"
[124] "Miss Baker, Big George Await Merry Christmas", *The Huntsville Times* (December 19, 1971) pp. A5.
[125] "Life Swinging for Female Space Flier" in *Chicago Tribune* (October 30, 1966) pp. A1.
[126] D.E. Beischer, D.E. Furry. "Saimiri sciureus as an Experimental Animal" in *The Anatomical Record* 148 (No. 4, 1964) pp. 616. This information is recorded on a weight graph of Baker.
[127] ibid, 617.

adjacent to the Army's Redstone Arsenal and NASA's Marshall Spaceflight Center), a decision that involved lobbying from Wernher Von Braun.[128] Local news reports in Huntsville advertised her arrival in sensational, anthropomorphic terms: "Miss Baker, an early U.S. space pioneer, will arrive at her new home, the Alabama Space and Rocket Center here Wednesday."[129]

Baker and Big George were put on display in a special climate-controlled fiberglass cube with "Miss Baker" and "First Lady in Space" emblazoned on the side. Their enclosure is described as a "home" that is "air-conditioned" and "complete with running water and exercise bars".[130] In December 1971, journalists and curators used the holiday season to cast Baker and Big George as good Christian children, wondering, "what to get two monkeys for Christmas?" *Huntsville Times* writer Edd Davis wrote that Baker and Big George, "have said their prayers every night," and that, "rumor is Santa Claus may bring them a trampoline or a tread wheel".[131] The Center's director Ed Buckbee was said to be "consulting a veterinarian to see if a special Christmas meal can be cooked up for the center's newest residents."[132] This is very different from how other monkeys used in space science research were treated and written about.

Big George died in December 1978, and a press release issued by the Space and Rocket Center, reported his death like a human obituary. "Big George, primate companion of famous space pioneer monkeynaut Baker, died last night at his home in the Alabama Space and Rocket Center. His personal veterinarian said the autopsy showed the cause of death to be kidney failure."[133] Another news report states that Baker "was quite upset at the loss of her mate… her normal handler was unable to handle her after Big George was found dead."[134]

By April, staff at the Center had decided to make "Ms. Baker a Mrs.—Again". This time she would be "married" to a squirrel monkey named Normal Norman, who was procured from the Yerkes Primate Laboratory at Emory University in Atlanta. The "marriage" of Baker and Norman was again cause for heavy anthropomorphizing along gender lines, and public relations for the Space and Rocket Center. "In what witnesses described as a brief but beautiful ceremony, Miss

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128 Burgess and Dubbs, 140.

129 "Miss Baker Arrives" in *The Huntsville Times* (June 29, 1971) pp. A1.

130 "Miss Baker, Big George Await Merry Christmas", *The Huntsville Times* (December 19, 1971) pp. A5. One article printed her "address": "her new address will soon be the Alabama Space and Rocket Center, Tranquility Base, Huntsville. Ala. 35807.

131 "Miss Baker, Big George Await Merry Christmas", *The Huntsville Times* (December 19, 1971) pp. A5.

132 "Miss Baker, Big George Await Merry Christmas", A5.

133 Press release: "Companion of Space Heroine Expires" in *News From Earth's Largest Space Museum* (Folder "Baker" at New Mexico Museum of Space History).

134 "Space Monkey's Mate Dies" in *TODAY* (January 10, 1979) pp. 12A.

Baker, America's first monkey in space, has been married at the Marshall Space Flight Center in Huntsville, Alabama. The wedding was no small affair. A crowd of 500 children and curious adults were on hand to celebrate Miss Baker's marriage, her third [sic], to Normal Norman of Atlanta. The ceremony was performed Monday by Judge Dan McCoy, presiding judge in the Madison County District Court."[135] Baker was referred to as a "bride" and the pair as "newlyweds".

At the Space and Rocket Center, Baker worked as a feminized ambassador for human spaceflight. Her many duties included interacting daily with hundreds of guests, and responding to thousands of pieces of "fan-mail" ("Miss Baker continues to receive fan mail from school children who now read books that have been published on the first successful flight of primates in space. Her address is: Alabama Space and Rocket Center, Tranquility Base, Huntsville Alabama 35807") and was made to "write back" by way of a handler inking her paw and pressing it against a glossy photograph over and over and over—an animal inscription known as a "pawtograph". In addition to this daily routine, Baker also appeared at special events including TV talk shows, and annual "birthday" parties that were attended by thousands and doubled as public outreach for the Center.[136] One staff member was quoted in a 1978 *New York Times* article saying, "Of course no one is sure when [Baker] was born, but we like to give her a birthday party every year to mark her getting older and the advances we've made in space".[137] These events were also an opportunity to convert Baker's age into "human years", with many remarking on her good health in old age; squirrel monkeys in captivity typically have a life expectancy of 10 years, and by the time she turned 20 Baker was often billed as a the oldest recorded squirrel monkey in captivity, a fact no doubt connected to her special and unusual treatment.[138]

Baker's life as a celebrity animal at the Space and Rocket Center led to her being included in lists of famous human Americans. For example Baker appeared as a "guest" on television talk shows including *Good Morning America*, *The Mike Douglas Show*, and Dinah Shore's variety show *Dinah!*, where she was included in an episode described as a "tribute to great American

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[135] "Miss Baker a Mrs.—Again" in *TODAY* (April 11, 1979) pp. 14A.

[136] See: "Space Monkey 20 Years Old" in *Daily Press: Newport News* (June 30, 1977); "Space Pioneer, 24, Feted" in *The New York Times* (June 17, 1981); "Monkeynaut Celebrates 27th Birthday" in *Birmingham Post Tribune* (May 29, 1984) "The nation's oldest 'astronaut' celebrated with Jello and bananas yesterday during a special birthday party at the Alabama Space and Rocket Center".

[137] "A U.S. Space Pioneer Marks 21st Birthday," in *The New York Times* (June 24, 1978)

[138] "Monkeynaut Celebrates 27th Birthday" in *Birmingham Post Tribune* (May 29, 1984) "According to Horton, Baker is now more than 100 years old by human standards."

ladies."[139] For the taping of this show in Los Angeles, Baker's handlers tried to convince an airline to give her a normal passenger seat so she could "occupy a seat between [Center Director] Buckbee and a trainer", rather than ride below in the cargo hold.[140] In 1983, *USA Today* included "Miss Baker" on round-up titled "Where astronauts are now" alongside details of the post-NASA activities of John Glenn, Alan Shepard, and Neil Armstrong.[141]

Baker was also given awards. In 1959 at Pensacola, Baker was presented with a medal from the American Society for the Prevention of Cruelty to Animals. Looping the prize around Baker's tiny neck, the society's president, William Rockefeller, said, "Miss Baker you have performed a unique service for mankind. You, with your companion Able, have pioneered the path into outer-space, and have widened the horizons of knowledge which will benefit all of us that dwell on upon the Earth".[142] Beischer also received a citation from a group called Welfare of Animals used in Research for Drugs and Surgery (WARDS).[143] (Figure 25) In 2005, Baker was inducted into the Alabama Veterinary Medical Association's Hall of Fame as "Miss Baker: America's First Lady of Space", and is referred to as "the unflappable Miss Baker".[144]

The final way Baker was anthropomorphized was in death. Baker died on November 29, 1984. At 27 years, she was by far the oldest squirrel monkey on record having more than doubled her life expectancy. The press took Baker up like a human medical patient, with *USA Today* running a story noting first that she was in "guarded condition" after she "developed a severe kidney infection" and that "her prognosis isn't good".[145] The next day headlines proclaimed her passing: "Kidney Failure Claims astro-monkey"; "Miss Baker, first U.S. space survivor, dead at age 27"; "Space Age monkey flier eulogized at Ala. Center". Obituaries recounted her ordeal in Bioflight #2 and noted that she would be buried at the Space and Rocket Center. Visitors to the center can still visit her grave, a large gleaming marble headstone just off a pathway to the entrance to the Visitors Center (Figure 27). The inscription reads, "Miss Baker, Squirrel Monkey. Born 1957. Died November 29, 1984. First U.S. Animal to Fly in Space and Return Alive. May 28,

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139 "Passenger Status Sought for Miss Baker on Flight" in *The Huntsville Times* (April 5, 1976) pp. 3.
140 "Passenger Status Sought for Miss Baker on Flight", 3.
141 David Colton "Where astronauts are now" in *USA Today* (September 19, 1983).
142 *Space Monkey*, 58-59. Newsreel footage of the event can be seen here: https://www.youtube.com/watch?v=VbFHG3VMFAU
143 The citation reads in part: "To Dr. Beischer a successful pioneer in the meticulous job of preparing an animal to precede mankind for the advances of medicine and science, our deep gratitude and acclaim." *Space Monkey*, 60.
144 Alabama Veterinary Medical Association's Hall of Fame: 2005. Online: http://alvma.site-ym.com/?page=2005HallofFame
145 "Monkeynaut in Guarded Condition" in *USA Today* (Thursday November 29, 1984)

1959."[146] To the right is a smaller grave marking the resting place of Big George.[147] Today, children who visit the center are instructed to place an unpeeled banana on top of her grave in tribute.[148] This is interesting in contrast to Able, who was not buried, but preserved.

In addition to her actual grave site in Huntsville, Baker is remembered through an internet memorial created in 2005 where users have posted around 150 short messages.[149] Part of the "Find-a-Grave" network, a collection of webpages featuring user-submitted photographs of famous human burial sites, the page dedicated to Baker contains photographs of her headstone and allows users to post publicly-visible comments. Most comments posted here follow the form of a short message written to Baker, as if she could somehow read them. Three themes overlap in many of the comments: Christianity, patriotism, and animal rights activism.

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[146] "Miss Baker" http://www.findagrave.com/cgi-bin/fg.cgi?page=dfl&GRid=10621868
[147] The fate of "Normal Norman" is unknown.
[148] ibid.
[149] ibid.

Figure 27: Baker's headstone at the U.S. Space and Rocket Center in Huntsville, Alabama. (Source: findagrave.com).

The religious comments generally focus on the idea that Baker has a Christian soul which is now in Heaven reading these messages: "God love your little heart! I bet you were so scared. I hope they treated you extremely well after putting you through that. I bet there are bananas in Heaven—and Circus Peanuts too. Can't wait to feed you, good girl!"; "Safely home. Rest in Light and Peace".[150] Some are more patriotic in focus, but also contain religious and animal rights threads: "You are an American hero. May God bless you and keep you safe always in Heaven";

150 ibid.

"My brother-in-law, Robert A. Jackson was your P.R. man while he served in the Navy. We are so proud of your achievements. His family still talks about you. Robert just died 3 Jul 2011 so hopefully you two are getting to know one another again"; "Miss Baker; You were indeed the first heroine in space. The debt humans owe animals is incalculable"; "Thank you for your service to America".[151] Other commenters use this space as a site of resistance, questioning the use of animals in experiments: "You were truly one of God's lovely creatures. I'm sure you weren't treated well during your time on earth, after all, man can be quite cruel. I know you must be so much happier where you are now. Rest In Peace"; "Born Free, Its [sic] a pity you didn't die free".[152] What these comments have in common is that they address the monkey as it was regarded after the experiment. They all call her by her post-experiment name and take her up as the feminine individual she was figured as by doctors and the media. This anthropomorphizing is underlined by the basic assumption that somehow these messages are being read by Baker's immortal soul.

There is stark contrast between Able and Baker and all the monkeys that were used before them. Those animals were always regarded primarily as instruments, traded in groups, and recalled only by a seemly random alphanumeric code. After their flight, Able and Baker, and later, Ham, were taken up as individuals with many human qualities including bravery, patriotism, gendered work and domesticity, and ideological support for space exploration. Before the experiment, Baker was regarded as expendable living material, but afterward was refigured into a model citizen-subject; specifically, the role of housewife and mother-to-be. She was enrolled in the fashioning space technologies as "civilizing technologies" imbuing her with the contradictory Cold War American ideals of individuality, freedom, and feminine domesticity.[153] That being said, Able and Baker never stopped being used instrumentally, even though human regard for them obviously shifted. The only thing that changed was the way that they were used. After the experiment, Baker remained an object of study (a scientific instrument generating longitudinal data) but also became a celebrity animal used to promote both spaceflight, and more subtly, early Cold War-era social norms, especially a sharp divide between astronaut masculinity and feminine domesticity.

[151] ibid.
[152] ibid.
[153] Lynn Spiegel. *Welcome to the Dreamhouse: Popular Media and Postwar Suburbs* (Durham: Duke, 2001) pp. 107. In her chapter, "From Domestic Space to Outer Space: The 1960s Fantastic Family Sitcom", Cultural studies scholar Lynn Spiegel shows how the preservation of feminine domesticity was prominently featured in visions of techno-utopian futures enabled by spaceflight.

CONCLUSION

Starting in the late 1940s, American space medicine experts began launching monkeys in rockets to develop physical and mental requirements for future astronauts. In 1959, Able and Baker became America's first celebrity space animals, and extended animal contributions the nation's space program from technical to cultural. Able and Baker were the first American space animals to be heavily anthropomorphized, and far from the last to receive this kind of treatment. Since Bioflight #2, anthropomorphizing animals involved in space activities has become an enduring phenomenon in American culture that is seldom recognized, treated skeptically, or viewed through a critical lens by historians, scientists, media, or the public. Through these animal biographies of Able and Baker, this chapter has highlighted the different moments when anthropomorphism occurs, the various forms it takes, and the types of archetypal characters that tend to get generated, with a specific focus on gender in the early Cold War. Following Able's unexpected and accidental death soon after the flight, she was fitted into the image of the fallen Cold Warrior and transformed into a male and masculine taxidermy figure at the Smithsonian Air and Space Museum. Baker was cast as "Miss Baker" a feminine housewife whose job at the U.S. Space and Rocket Center was popularizing spaceflight and bearing offspring. These complementary characters—astronaut and housewife—and the work/home binary they represented, reflected and reinforced post-war gender norms in both the Cold War culture of spaceflight, and wider American society.

Even before the first human spaceflights, anthropomorphized space monkeys and chimpanzees posed an awkward challenge to human astronauts, calling their skills, and even the rationale for their presence in the spacecraft into question. On the surface, the reaction was to further shore-up the astronaut persona and professional identity as hyper-masculine, to the point where Able needed to be reimagined as a male monkey to better align with this emerging figure. But as female monkeys Able and Baker also prompted the question, "Why can't women be astronauts?" Able and Baker were selected for the flight without their sex being a major consideration; with Able, the obsession was over whether she was "American-born", not whether she was male or female. However, it is very telling that at the same moment that female monkeys were used unproblematically in early spaceflights, NASA effectively banned women from becoming astronauts citing “complicated physiology”.[154] Able and Baker’s inclusion in the flight, as well as their gendered afterlives is an interesting precursor and foil for the Lovelace Woman in Space Program discussed in the next chapter. On one hand, the explicit and divergent gendering of Able and Baker served to reinforce American astronauts as masculine, but the unproblematic use of female monkeys in a moment when women were effectively banned posed a challenge to the masculinity of the astronaut, and even provided another rationale for including women.

The case of Able and Baker shows when and how humans first began to habitually anthropomorphize animals in the context of spaceflight—a persistent and unacknowledged trend that continues today. By foregrounding the persistent interplay between humans and animal astronauts at the very beginning of spaceflight, and drawing attention to the theme of gender, I hope to foster an awareness in readers that will help them be more critically attuned of these discourses both in the archive and in current events. Anthropomorphism of animals in space obscures the reality that these are not little humans choosing to help, but unwilling participants in dangerous experiments designed to yield data for scientists and astronauts. (Figure 13) If animals continue to be used in spaceflights—and there is no reason to predict they will not be—their contributions and agency should be recorded and discussed accurately; after all, affording animals dignity and respect should not hinge on projecting human qualities onto them. Finally, and perhaps most deeply, this stubborn impulse to portray animals in space as human-like caricatures should prompt critical reflection about how, in the distant future, humans might attempt to understand, represent, or relate to extraterrestrial life forms that resemble neither microbes or humans.

[154] See Weitekamp, as well as Chapter 5, “Challenging Astronauts: The Lovelace Woman in Space Program” in this volume. The same year that Able and Baker flew in space, Randolph Lovelace II, NASA’s head of Life Sciences, initiated an independent study to see if women pilots could match or exceed the results of the all-male astronaut candidates on his Project Mercury medical screening program. The initiative’s hasty cancellation after it became pubic resulted in a congressional showdown in which NASA argued that women were not qualified to be astronauts, in part because male space medicine experts considered female physiology—mainly the mensural cycle—to be “too complicated”.

CHAPTER FIVE: CHALLENGING ASTRONAUTS: THE LOVELACE WOMAN IN SPACE PROGRAM

The most consequential challenge to the figure of the early astronaut came from within space medicine in 1960. Randolph Lovelace II, the physician who had developed and conducted the medical screening for NASA's Project Mercury astronaut candidates in 1959, began a privately-funded clinical study of women pilots for "space fitness", known as the Lovelace Woman in Space Program.[1] Lovelace, and his long-time collaborator, USAF human factors chief Brigadier General Donald Flickinger, speculated that women might be "right" for spaceflight because they seemed to offer significant physiological advantages—efficiencies—over male bodies in the strict economy of spaceflight. "On the average, women are smaller and lighter than men and also consume less food, water, and oxygen… the weight savings achieved by having a female astronaut would cascade through the entire design."[2] Doctors at The Lovelace Clinic, part of the large eponymous Foundation Lovelace oversaw in Albuquerque, New Mexico, gathered physiological and performance data from twenty-one women pilots to compare with results from the all-male NASA applicants.[3] In August 1960, Lovelace publicly declared his first woman test-subject, pilot Geraldine "Jerrie" Cobb, fit for spaceflight at a space medicine conference in Stockholm, Sweden.[4] After national publicity, including an article in *LIFE*, prompted NASA to awkwardly re-justify selecting only male test-pilots for Project Mercury, enthusiasm and support for Lovelace's on-going tests evaporated, and he quietly cancelled the incomplete study in 1961. Undeterred, Cobb secured high-level meetings at The White House, and a congressional hearing on "Qualifications

[1] Historians have debated what to call this unofficial, yet scientifically and culturally significant, program. In her organizing and advocacy, Geraldine Cobb referred to herself and the other participants, who never met as a group, collectively as Fellow Lady Astronaut Trainees (FLATs), but this term has been criticized by some space historians seeking to downplay the significance of the tests including James Oberg, who argues that what the women pilots received amounted to "testing" but not "training" in the strictest sense of the word. Since many of the tests constituted training for spaceflight or very close equivalents, the term is valid, but it was never used by Lovelace to describe the program, just retroactively by the test subjects. The program is probably best known to the public as "The Mercury 13", but that name was invented by a Florida television producer in 1999 for an eponymous documentary accompanying the launch of NASA's shuttle mission STS-93 during which Eileen Collins became the first female commander of an American spacecraft. "Mercury 13" linked the unofficial program with both NASA's Project Mercury, and the recent popularity of the film *Apollo 13* (1995), as well as the idea that at one point there were 13 women candidates in this group (of about 20 total) had who passed a series of tests (but the exact numbers of this unofficial, incomplete study are still a matter of debate). I follow Margaret Weitekamp in using "Lovelace Woman in Space Program". NASA History Office, Folder: "Mercury 13".

[2] Weitekamp, Margaret A. *Right Stuff, Wrong Sex: America's First Women in Space Program* (Johns Hopkins University Press, 2005) pp. 65.

[3] These grueling and exhaustive tests are famously depicted in Tom Wolfe's book *The Right Stuff* (1979), and its 1983 film adaptation.

[4] "A Lady Proves She's Fit For Space Flight." *LIFE* 29 Aug. 1960: 72-76.

for Astronauts" in 1962 in an unsuccessful bid to get NASA to form a parallel all-women program separate from Project Mercury.[5] In 1964, two doctors from The Lovelace Clinic published an article in the *American Journal of Obstetrics and Gynecology* justifying the exclusion of women from spaceflight on medical grounds: "monthly physiologic changes complicate the epoch woman space explorer more than the male counterpart."[6] No American women flew in space until 1983.

Thanks to recent books by Martha Ackmann and Margaret Weitekamp, the story of Cobb and the other women test-subjects is the best-known of the four obscure astronaut episodes covered in this project.[7] Now remembered as a significant moment in space history, the story is often told from the perspective of Cobb and the other test subjects as an unsuccessful precursor to second-wave feminism, and the social and political struggle for equal treatment of women in the workplace and access to the professions during the 1960s.[8] However, many of these accounts conclude that while space medicine suggested women *could* survive in space, it was only powerful people, institutions, and prevailing cultural attitudes disagreeing that women *should* be hired as astronauts. Here is one recent example: "This is the story of a remarkable aeromedical physiologist who had a vision that was driven purely by scientific and pragmatic considerations, and how this vision was lost by a combination of personal ambition and the prevailing cultural mores of the time."[9] Space medicine is cast as a force for equality and progress that gets distorted and stymied by conservative American social and cultural values. What gets lost in these explanations is that space medicine had already constructed a militaristic, masculine, elitist view of the body that, far from value-neutral or "pragmatic", was built around the idea that male bodies were normal and female bodies

[5] "Qualifications For Astronauts" in *Hearings Before the Special Subcommittee on the Selection of Astronauts of the Committee on Science and Astronautics U.S. House of Representatives* (Washington, DC: U.S. Government Printing Office, 1962)

[6] Johnnie R. Betson, Robert R. Secrest "Prospective women astronauts selection program" in *The American Journal of Obstetrics and Gynecology* (Vol. 88, Jan-April, 1964) pp. 421-423.

[7] Martha Ackmann. *The Mercury 13: The Untold Story of Thirteen American Women and the Dream of Space Flight* (2004); Margaret Weitekamp. *Right Stuff, Wrong Sex: America's First Women in Space Program* (2004).

[8] See Kathy L. Ryan; Jack A. Loeppky; Donald L. Kilgore Jr. "A forgotten moment in physiology: the Lovelace Woman in Space Program" *Advances in Physiology Education* (Vol. 33, 157-164, 2009) pp. 157. "In 1963, two seminal events in women's history occurred. First, Betty Friedan published her highly influential book, *The Feminine Mystique*, which questioned the cultural gender roles of the time. Second, Congress passed the Equal Pay Act, making it illegal for employers to pay a woman less than what a man would receive for the same job." pp. 157. Marie Hick's book *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing* (2017), offers an important counterpoint to "progress narratives" in feminist Cold War technology studies, one that is echoed here in this chapter.

[9] Ryan, Loeppky, Kilgore Jr., 157.

were complicated variants. Emerging in the military, space medicine had a fundamental lack of interest in women that "othered" them when compared to more familiar male soldiers. This extended to the material infrastructure of space medicine laboratories and clinics, and to medical opinions about the viability of women in space. Along these lines, the title of Weitekamp's book, *Right Stuff, Wrong Sex*, invites the question: how were women made to seem "wrong"? This chapter makes the historiographical claim that space medicine was among the various factors shaping the idea of women being unsuitable for spaceflight in the first place. Rather than view the Lovelace tests as pragmatic, straight-forward evaluations of women for spaceflight, I argue this was the moment when a gendered subject was created and problematized in space medicine.

To explore the various ways that existing sex-and-gender biases became features of early space medicine, rather than obstacles in its path, this chapter avoids a re-telling of the Lovelace Woman in Space Program story to instead focus on how discourses, concepts, practices, and material cultures "othering" women built-up and reinforced the early American astronaut as essentially male. After brief background sections surveying the history of gender and aviation technology, and space medicine precursors to the Lovelace Woman in Space Program, the first main section offers a military history of Lovelace, Flickinger, and the Lovelace Foundation. Lovelace is remembered primarily as a civilian contractor and advisor to NASA, but his World War Two career as a SAM-trained flight surgeon, as well as his Cold War work supporting covert aerial reconnaissance programs that favoured "civilian" organizations over military facilities provides crucial context for his later work on Project Mercury and the Woman in Space Program. It suggests a connection between his work on convert aerial reconnaissance and his perception of women as weight-saving human factors and highlights the clinic's familiarity with "normal" male pilots, and orientation toward Cold War military problems. The next section explores another little-known but contemporaneous project at Lovelace: the introduction of machine-readable cards for astronaut selection. Developed by Lovelace, Flickinger, and another ex-military collaborator, the cards served as two dimensional virtual representations of astronaut candidate bodies that could be stored, duplicated, sorted, screened, and recalled in the absence of a physical body. Introducing the term "data body" to refer to the constellation of anthropometric, biographical, physiological, and performance data captured in the cards, the section explores how women were accommodated, but also othered by early computing technology in space medicine. The final section uses moments from the Woman in Space Program to show how space medicine experts constructed menstruation as abnormal, and women as dangerous, error-prone system components, while articulating this belief in the lexicon of human-machine integration and systems theory.

GENDER AND JETS

The history of flight shows women were among the first pilots of balloons and airplanes. So why not American spacecraft? For the Project Mercury astronaut selection, NASA added a requirement they knew no American woman could meet—experience flying jet-powered aircraft. During Cobb's congressional hearing on Qualifications for Astronauts, NASA used her lack of experience with jets to justify and rationalize maintaining their all-male astronaut group.[10] For almost all of the Cold War, jet cockpits were reserved for military (or ex-military) men because for decades no branch of the armed services would accept women as pilots (the Air Force waited until 1976 to allow women to train as pilots, and until the end of the Cold War to send them on combat missions in jets).[11] In his defense of NASA's qualifications for astronauts before congress, Project Mercury astronaut John Glenn said, "I think this gets back to the way our social order is organized, really. It is just a fact. The men go off and fight the wars and fly the airplanes and come back and help design and build and test them. The fact that women are not in this field is a fact of our social order."[12] But jet technology was constructed as exclusively masculine in ways older forms of flight were not. Most obviously, military control of this technology limited access to men. But the jet and Cold War masculinity were co-constructed in other important ways as well. First, through changes in approach to aircraft control and associated pilot virtues, an area explored by other aviation and space historians including Chihyung Jeon and David Mindell. Less appreciated, is

[10] There were a few exceptions to this, famous women pilots including Jaqueline Cochran and Ruth Nichols were on rare occasion given the chance to pilot USAF jets, but only as one-time opportunities.
[11] Rosemary Skaine. *Women at War: Gender Issues of Americans in Combat* (Jefferson: McFarland & Company, 1999) pp. 61. Skaine notes how the vast numbers of American women who joined the Armed Services in support roles for World War Two decreased drastically in the post-war period, with a smaller uptick again during the Korean War. The *Women's Armed Services Integration Act of 1948* normalized and codified a presence for women in the U.S. military, but with several sweeping limitations. "It imposed a two-percent ceiling on the number of women in the military, restricted promotions, and limited the number of women who could serve in command positions to ten percent. Women could not attain any rank above lieutenant colonel in the WAC or above commander in the Navy." (pp. 58)
[12] "Qualifications for Astronauts", 67.

how space medicine constructed new extreme environments of the upper atmosphere and space as requiring a masculine pilot to guarantee success.

Unlike in American spaceflight, women *were* early and active participants in other forms of flight including ballooning and airplanes. In *The Sublime Invention: Ballooning in Europe, 1783–1820*, historian Michael R. Lynn writes that, "women were involved in ballooning at every stage", noting that in 1784, just eight months after the first-ever untethered balloon ascent, Élisabeth Thible became the first woman aeronaut during a 45-minute flight reaching 1,500 feet over Lyon, France.[13] In *Space and the American Imagination*, historian Howard McCurdy writes that within just a few years of the first airplane flight in 1903, American women like Bessica Raiche and Harriet Quimby joined men as celebrity pilots setting records, winning races, and spreading what historian Joseph Corn calls "the winged gospel" of progress and technological utopianism.[14] "More than men," Corn writes, "women pilots domesticated the sky, purging it of associations with death and terror." By making flying seem easy and safe, women pilots helped sell airplanes to skeptical airlines, and tickets to nervous passengers. But this was still a misogynistic view, casting women as less smart, less skilled, and less brave than men, implying that if *they* could do it, any self-respecting man should too.

Developed in World War Two's aerial arms race, jets were the first new form of powered flight to emerge within the military, as opposed to balloons, propeller aircraft, and rockets, which were civilian inventions later adopted in wartime. Women had never been welcome in military aviation, with only a very brief exception during World War Two when between September 1942 and December 1944 Women Airforce Service Pilots (WASPs) ferried new planes from factories to bases, and towed targets for aerial gunnery practice as part of the Army's wider effort to utilizer women as workers to counter the wartime labour shortage.[15] With the arrival of jet and rocket powered aircraft in the mid-1940s, women were no longer able to pilot the most advanced aircraft, and compete with men for top speed and altitude records as they had in the past.

In the jet age, new methods of aircraft control seemed to require a reassertion of the cockpit as a masculine space, and the pilot as essentially male. The shift from propeller to jet-powered aircraft coincided with the culmination of a fundamental shift in pilot virtues: from flying by

[13] Michael R. Lynn. *The Sublime Invention: Ballooning in Europe, 1783–1820* (New York: Routledge, 2016) pp. 74.
[14] Joseph Corn. "Making Flying Thinkable" in *The Winged Gospel: America's Romance With Aviation* (Baltimore: Johns Hopkins University Press, 1983).
[15] Weitekamp, 44-49.

feeling and intuition, to aviating by rational reliance on rules and instruments. This put women—historically stereotyped as less-rational then men—at an instant disadvantage. This shift in virtues which edged women out is captured by Mindell in *Digital Apollo* in a quote from Apollo 11 astronaut Michael Collins: "[Barnstormer] Roscoe [Turner] had flown with a waxed mustache and a pet lion named Gilmore… We flew with a rule book, a slide rule, and a computer."[16] Historian of technology Chihyung Jeon argues that The Link Trainer flight simulator, first used in 1929, was key in introducing a younger generation of "instrument pilots" to a new approach to flying, and indoctrinating them with a new set of virtues that gradually became the archetype for Cold War military aviation and the astronaut. "A new kind of pilot was implicated in the practice of instrument flying: those who could 'believe in their instruments rather than themselves.' It meant a transition from 'natural pilots' with feel and intuition to 'mechanical pilots.'"[17] This progression from 'natural' and 'mechanical' pilots can also be read as a 'feminine' to 'masculine' shift, gendering existing of forms of flight. 'Natural' pilots were less disciplined and relied more on their bodies and sensation, while 'mechanical' pilots privileged the mind and prioritized self-restraint. As Mindell puts it, the active 'throttle jockey' was replaced by the passive 'systems manager'. But this critical shift in technologies, context, and pilot virtues also had gender implications: the contrast between emotional propeller pilots and cool-and-rational "airmen" reasserted the old feminine/masculine binary of irrational/rational. Automation and inherent stability challenged the masculinity of the old natural pilot, but perhaps because of this (rather than in spite of it) the passive jet pilot became even more essentially-masculinized and 'mechanical' than its predecessors. In *Inventing the American Astronaut*, space historian Matthew Hersch notes that the Mercury Seven intervened in the design of the Mercury capsule to make it feel more like the interior of a jet cockpit. In a related way, the social space of the interior of early American spacecraft was also an extension of the all-male social space of the jet aircraft cockpit.[18] This amounted to a self-reinforcing cycle: gender discrimination was built into the material design of jets which in turn became a form of structural discrimination.

Ideas about how to approach new environmental challenges posed by the upper atmosphere and space also alienated women. Americans were told that jet and rocket flights into the upper-

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[16] David Mindell. *Digital Apollo: Human and machine in spaceflight* (Cambridge, MA: The MIT Press, 2008) pp. 10.
[17] Chihyung Jeon. "The Virtual Flier: The Link Trainer, Flight Simulation, and Pilot Identity" in *Technology and Culture*, 56. (No. 1, 2015) pp. 30.
[18] Matthew Hersch. *Inventing The American Astronaut* (Palgrave MacMillan, 2013)

atmosphere and space were extremely hazardous, and that only certain men were "man enough to take it".[19] "NASA officials advanced a vision of spaceflight as something too dangerous for women to try and women as too fragile to engage in it."[20] It is telling that the period some space historians refer to as the "heroic era" of spaceflight in America (1961-1981) ends around the same time women astronauts appear.[21] Unlike general and commercial aviation in the lower atmosphere, the upper-atmosphere and space were viewed as a risky theatre of Cold War military and covert operations, and constructed as an elite masculine preserve.[22] Historian of mountaineering Michael Reidy has written about how nineteenth-century European alpinists constructed a vertical zonation for mountains that reflected the perceived strength of different human bodies, moving upward from civilization to wilderness, and from feminine to masculine.[23] He also notes that the symptoms of anoxia, one of the key hazards faced by mountaineers, military pilots, and astronauts—"weakness, lack of will, timidity, lassitude, muscle deterioration, slow decision-making ability"—aligned with mental and physical shortcomings historically attributed to women. Reidy's observations about the gendered co-construction of the mountain summit and altitude physiology's idealized hyper-masculine subject apply equally well to space and the astronaut.

In October 1959, in a development unrelated to Lovelace or space, Geraldine "Jerrie" Cobb was given the chance to pilot a jet aircraft. Cobb worked as a marketing executive for Oklahoma-based aircraft manufacturer Aero Design and Engineering Company, then a subsidiary of Rockwell-Standard, and was attending a weapons industry meet at Tyndall Air Force Base in Florida, when the rare opportunity materialized. Base officials, sensing the potential for some good press, arranged for Cobb, who was then "Aviation's Woman of the Year", to fly a supersonic interceptor, the Convair Delta Dagger TF-102A. Historian Martha Ackmann describes Cobb's hour-long flight: "Along with an Air Force pilot, Cobb flew at 46,000 feet and broke the sound barrier, streaking over the Gulf of Mexico at night at Mach 1.3. Cobb reported that she found the plane easy to control… the only new experience was the push of the afterburner."[24] Later, Cobb wrote about the experience to a fellow woman pilot and future fellow Lovelace test subject Jerri

[19] McCurdy, 299.
[20] ibid, 298.
[21] *Spacefarers: Images of Astronauts and Cosmonauts in the Heroic Era of Spaceflight* (ed. Michael J. Neufeld) (Washington D.C. Smithsonian Institution Scholarly Press, 2013).
[22] Michael S. Reidy. "Mountaineering, Masculinity, and the Male Body in Mid- Victorian Britain" in *Osiris,* 30 (2015) pp. 163. With the exception, of course, of animals like monkeys.
[23] Reidy, 160.
[24] Ackmann, 52.

Sloan, "I think we're in the wrong type planes." Ackmann notes how Cobb, who was skilled at crafting her public image as an accomplished pilot and successful business executive, valued the press photographs taken of her beside the jet—dressed in military flight gear with one leg up the cockpit ladder and head turned skyward—as much as the actual flight itself.[25] "There was only one thing wrong with the image Cobb wanted to project to the public: the ID tag around her neck. 'Official Visitor' it read. However permanently Cobb wanted to fix her image as a jet pilot, the military saw it another way. Jerrie Cobb was always a visitor with interloper status."[26]

PRECURSORS TO THE LOVELACE TESTS

In *Space and the American Imagination*, Howard E. McCurdy laments that "practically nowhere in early science fiction can one find memorable female characters of strength and independence."[27] Sadly, something similar can be said of early space medicine. Before 1959, all prominent experts and research subjects establishing space medicine were men, or animals. The fact that in the first decade of space medicine research, Strughold and life scientists at the School of Aviation Medicine (SAM) conducted multiple studies of simulated Martian microbes, but zero studies of women, reveals their priorities. One rationale they floated for ignoring women was that with limited resources, expensive tests should only be conducted on men who might "return the investment" in military service.[28] This was based on the initial assumption that early spaceflights would be military missions, which ended up not being the case. As Weitekamp notes, when women were first mentioned as potential astronauts in the early 1950s, it was either as a misogynistic joke ("if women went into space it would be because the astronauts were allowed 120 pounds of recreational equipment") or in limited and highly-gendered "pink-collar" support roles only made available after space had been appropriately domesticated by men.[29] When America's German space experts first popularized spaceflight in a famous *Colliers* magazine series in 1953 spearheaded by Wernher

[25] Cobb used this image on the cover of her 1963 memoir. Geraldyn Cobb; Jane Rieker. *Woman Into Space* (New York: Prentice-Hall, 1963).
[26] Ackmann, 52.
[27] McCurdy, 294.
[28] Space medicine shapes the astronaut, but the astronaut also shapes space medicine.
[29] Weitekamp, 121. The joke is often attributed to Von Braun, but the source Weitekamp cites is Mercury Seven astronaut Wally Schirra, noting though that this kind of derogatory humour was "widespread" throughout NASA.

von Braun, women seemed unwelcome and "other". One article, "Testing the Men", included the bolded section heading: "Reasons for Ban on Women". "Women won't go along on long interplanetary journeys… but may beat out men for certain jobs… [on] the shorter flights they will make."[30] Before women became objects of study in space medicine, they were already figured by male space medicine experts as lacking physical and mental virtues considered essential for early astronauts. The article also predicted that women, if they were eventually evaluated for spaceflight, would take the tests separately from men, which is what ended up happening with Project Mercury and the Lovelace Woman in Space Program.[31] This historic lack of interest leads to the question: why, in 1959, did Flickinger and Lovelace decide to finally include women in a study?

When Flickinger was asked in 1960 what he thought the ideal woman astronaut would be like, his answer was ridiculously specific. So much so that it likely excluded everyone who read it and was probably off-putting-by-design, to dis-interest women from seeking access to space. "[Flickinger] and his colleagues felt that such a person should preferably be flat-chested… under 35, married, and a licenced pilot. She should be well adjusted to isolation and have precise coordination. Her personality should be such that she will be able to boost the morale of other members of a space team living in the close quarters of an orbiting capsule… the best candidate will probably double as the scientific wife of one of the spaceship engineers, besides performing her zoological, biological, and astronomical duties aboard the vessel and on other worlds. Her menstrual cycle will probably be eliminated through inhibiting medicines, and all feminine candidates for spaceflight will have to face the risk of possible sterility, because of the radiation effects."[32]

In the fall of 1959, both NASA and the United States Air Force each allowed a woman to take some of the space medicine tests used in Project Mercury. *Look* magazine partnered with NASA and pilot Betty Skelton to produce a feature titled "Should a Girl Be First in Space?" The article included photographs of Skelton undergoing tests at several space medicine facilities, including the SAM. For NASA, this was a public relations effort to promote their growing network of facilities, not a serious attempt to consider women for spaceflight. At SAM (by then relocated to Brooks Air Force Base also in San Antonio), Skelton quickly encountered physical

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[30] Cornelius Ryan. "Testing the Men" in *Colliers* (March 7, 1953) pp. 63.
[31] Ryan, 63.
[32] Donald Cox. "Women Astronauts" in *Space World*, 1 (No. 10, September 1961) pp. 58-59.

manifestations of space medicine's disinterest in women. Measuring 5 feet, 3 inches in height, Skelton repeatedly faced garments and equipment that could not easily accommodate her smaller physique—she was literally unsuitable. Military anthropometry based on exclusively male subjects had established sets of data, and material constraints that assumed a universal white, male subject. "Since a female test subject had never been anticipated, the school could not provide anything for her to wear," writes Weitekamp. Photographs of Skelton at SAM taking tilt-table, treadmill, and breathing tests show her doing so in bare feet, with the baggy legs of a too-large jumpsuit rolled-up.[33] "The lack of appropriate clothes visibly marked Skelton as out of place."[34]

Only weeks after Skelton finished her space medicine photoshoot tour, Flickinger granted 57-year-old celebrity pilot Ruth Nichols permission to undergo some space medicine tests at the Aero Medical Laboratory at Wright-Patterson Air Force Base in Ohio, provided they remain out of the press. Nichols had come to aviation fame and fortune in the 1930s, and most recently in 1957 had convinced the Air Force to let her pilot a Delta Dagger jet—a rare exception to the gendered access to this technology—to 51,000 feet. At Wright-Patterson, Nichols felt the space medicine experts were actually interested in the results of her weightlessness, isolation, and centrifuge tests. Afterward, Nichols lobbied Flickinger and other Air Force officials to go a step further and take the idea of women astronauts seriously. But their firm answer to her was that they had no plans to do so.[35] When the Lovelace group of women pilots finally was subject to an organized research program, they did so within this hyper-masculine cultural environment, and male-normal built environment of American space medicine infrastructure.

While both of these episodes were unfolding in late 1959, Flickinger was planning a more serious long-term study of women for space fitness, which differed from these precursors in that he envisioned testing a group of women pilots similar in number and age to the male Project Mercury candidates on the same array of tests to enable a direct comparison of results. After bringing Lovelace onboard this unconventional USAF project, the pair encountered Cobb at an Air Force conference in Miami and invited her to be their initial test-subject. Cobb enthusiastically agreed to participate in what Flickinger was then calling Project WISE, for Woman in Space Earliest, although it was sometimes also referred to as Woman in Space Soonest (WISS) after the

[33] Betty Skelton Collection, National Air and Space Museum Archives.
[34] Weitekamp, 69.
[35] "Women in Space Urged: Ruth Nichols Believes They Would be Better Than Men" in *The New York Times* (Aug 16, 1959) pp. 80. This rejection has been suggested as a contributing factor in her suicide less than eight months later.

Air Force's cancelled Man in Space Soonest (MISS) program. However, just as soon as planning was picking up, a leak to the press about Ruth Nichols's space medicine tests led Flickinger to seek cover and withdraw the Air Force's support. As he had done with sensitive programs before, he quietly handed control to Lovelace, who promised to continue the study privately.

THE RECONNAISANCE PILOT & THE ASTRONAUT: LOVELACE'S MILITARY CAREER

Lovelace is best remembered as a civilian physician and advisor to NASA. But just like NASA, and the astronauts he produced for them, Lovelace's civilian status obscures a significant and far-reaching military history, worth considering. Before his work on Project Mercury and the Woman in Space Program, Lovelace performed the medical evaluations for the CIA's top-secret high-altitude reconnaissance aircraft, the U-2, which required pilots to don a full pressure suit and fly into regions of the atmosphere considered medically equivalent to space. This detour from the explicit topic of women-as-astronauts into Lovelace's military career is essential to understand the medical, political, and strategic context in which Lovelace became interested in women pilots, which has been missing from scholarship on the Lovelace Woman in Space Program.[36] This section focuses on Lovelace's early Cold War partnership with USAF human factors chief Flickinger, and their long-running work on several classified U.S. reconnaissance programs in the 1950s and 1960s including the CIA's U-2, NASA's Project Mercury, and the USAF's X-20 Dyna-Soar and SR-71 Blackbird. By providing "civilian" cover for American covert action and strategic reconnaissance programs, the clinic, and the pilots it approved, reflected wider Cold War anxieties and geopolitical strategies, including Eisenhower's fear of a nuclear sneak attack, and his "Open Skies" and "Freedom of Space" proposals.[37]

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[36] The wider history of women in Cold War intelligence operations is only beginning to be told, for a sample of American women in reconnaissance—in the field for the OSS in World War Two, and in uniform for the services during the Cold War—see Jerri Bell; Tracy Crow. "Unconventional Operations, Espionage, and the Cold War" in *It's My Country Too: Women's Military Stories from the American Revolution to Afghanistan* (Washington D.C.: Potomac Books, 2017) pp. 132.

[37] Space historian Dwayne A. Day has written about Eisenhower's choice to constitute many important projects of the early Cold War as nominally "civilian". Dwayne A. Day "Invitation to Struggle: The History of Civilian-Military Relations in Space" in *Exploring the Unknown: Selected Documents in the History of the U.S. Civilian Space Program Volume II: External Relationships* (Eds. John Logsdon, Dwayne A. Day, Roger Launius) (NASA History Series, 1996).

Lovelace was born in 1907 in Springfield Missouri and received his MD from Harvard Medical School in 1934.[38] He first became interested in aviation medicine one year later while completing a surgical fellowship at the Mayo Graduate School of Medicine in Minnesota under pioneering physiologist Walter M. Boothby.[39] In 1937, Lovelace completed a training course at the School of Aviation Medicine (SAM) that qualified him as an Army Air Forces flight surgeon. It was at SAM that he first met Donald Flickinger, a classmate who already had a Master's degree from Stanford Medical School and additional training at Harvard and Vanderbilt.[40] Back in Minnesota, Lovelace became chief surgical assistant to Charles W. Mayo, and forged an ongoing association between the Mayo Clinic and SAM in Texas. Boothby directed Lovelace to investigate problems related to anoxia and methods for delivering supplemental oxygen to military pilots at high-altitudes. Their subsequent collaboration produced the Boothby-Lovelace-Bulbulian (BLB) oxygen mask, which won Lovelace, Boothby, and SAM's commandant Harry G. Armstrong the prestigious Collier trophy for achievement in aeronautics in 1939. Also in 1939, Lovelace travelled to Berlin where he was introduced to Strughold, then Germany's leading aeromedical researcher, who gave him a tour of the Luftwaffe's state-of-the-art aeromedical laboratory.[41] At some point during this visit, the future space medicine collaborators received word that Britain had declared war on Germany, and Lovelace made hasty arrangements to return to the United States.

Lovelace was called to active duty in Spring 1942, just after Japan's stunning surprise attack on Pearl Harbor. Colonel Lovelace quickly became commander of the Aero Medical Laboratory at Wright-Patterson Field, where he distinguished himself as a daring self-experimenter. In 1943, to develop procedures for high-altitude bailouts in freezing, low-pressure regions of the atmosphere, Lovelace performed a risky high-altitude parachute jump, which made him a noteworthy figure in aviation circles. To determine if pilots should pull their chutes immediately upon exiting high-flying aircraft or wait until they fall to a more pressurized region of the atmosphere, Lovelace jumped from 40,000 feet, a world record at the time. For his bravery, he was awarded the Distinguished Flying Cross.[42] Like his old SAM classmate, Flickinger also

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[38] "Biographical Data: Dr. William Randolph Lovelace II" (National Aeronautics and Space Administration, 1965) NASA History Office, Folder: Lovelace, William Randolph. pp. 1-2.
[39] Richard G. Elliot. "On a Comet, Always: A Biography of Randolph Lovelace II" *New Mexico Quarterly*, 36 (No. 4, 1966) pp. 360.
[40] "Brigadier General Donald D. Flickinger, USAF" (Department of the Air Force Information Services, Public Information Division, 1959) pp. 1-2. NASA History Office, Folder: "Donald Flickinger".
[41] Elliot, pp. 361.
[42] This was also Lovelace's first-ever parachute jump.

gained notoriety for daring wartime parachuting, but for rescue rather than research. In 1943, while flight surgeon for the Air Transport Wing flying "the hump" in the China-Burma-India theatre, Flickinger parachuted into the dense jungle to rescue stranded pilots. His first jump is remembered as the beginning of the practice of pararescue, for which he also won a Distinguished Flying Cross.

After the war, Lovelace briefly returned to the Mayo Clinic in Minnesota, but soon decided to relocate to his hometown of Albuquerque following the deaths of his two young sons from polio. Back in Albuquerque, Lovelace partnered with his uncle who was also a well-known physician with an existing private practice there. Together they formed The Lovelace Foundation for Medical Research and Education, which included the clinic and new laboratory facilities. Intended to be a "Mayo Clinic for the West", Lovelace hired experienced staff from the military (including SAM) and developed a specialized focus on aviation medicine and other "biological and medical problems associated with the air-nuclear space age."[43] The Foundation became a center for "biomedicine", the melding of biology and medical practice that began in the Manhattan Project during World War Two, and flourished during the Cold War around problems of survival in extreme environmental conditions including nuclear war (and its aftermath), and spaceflight.[44]

In 1951, one of Lovelace's first moves was to collaborate with the new German contingent at SAM on an important early space medicine conference. "Organized and arranged" by The Lovelace Foundation, "Physics and Medicine of the Upper Atmosphere: A Study of the Aeropause" was held in November at the Plaza Hotel in San Antonio Texas, and featured 38 speakers including members of the Department of Space Medicine, Strughold, Konrad Buettner, Heinz Haber, and Ulrich C. Luft.[45] Strughold's talk introduced the concept of "space equivalence", the idea that all the problems of keeping a human alive in space are present at much lower altitudes, starting around 50,000 feet, where USAF bomber crews were already beginning to operate.[46] The resulting eponymous publication edited by Strughold became "the basic reference for investigations of the aerospace environment in the early nineteen-fifties."[47] Also in 1951, the

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[43] "Biographical Data: Dr. William Randolph Lovelace II.", pp. 1

[44] Peter Keating; Alberto Cambrosio. *Biomedical Platforms: Realigning the Normal and the Pathological in Late Twentieth-Century Medicine*. (Cambridge MA: The MIT Press, 2003). pp. 53-55.

[45] "Program for Physics and Medicine of the Upper Atmosphere", 1951. Box: M.S. White, 17. Folder "School of Aviation Medicine" AFHRA Iris #0481360.

[46] "From the viewpoint of respiration physiology, the borders of space are found at an altitude of about 16 kilometers or 10 miles. It is at this height that the atmosphere's function of supporting the oxygen supply vanishes." in Strughold et. al. "Where Does Space Begin?" pp. 343.

[47] Green Peyton. *50 Years of Aerospace Medicine: 1918-1968* (AFSC Historical Publications Series No. 67-180, 1968) pp. 156.

Foundation was awarded a contract from the Atomic Energy Commission (AEC) to study the effect of shockwaves from nuclear detonations on living organisms (presumably pilots).[48] Flickinger, for his part, remained in the Air Force when it became independent in 1947, and in 1951, he was made Director of Human Factors at the Air Force's new Air Research and Development Command (ARDC) in Maryland.

When Dwight D. Eisenhower assumed the Presidency in 1953, his biggest fear was a Soviet sneak-attack on the United States—an atomic Pearl Harbor.[49] Right away, he received intelligence reports warning of the possibility that the Soviet Union was out-pacing the United States in producing bomber aircraft and developing long-range missiles, issues that entered 1950s political discourse as the "bomber gap" and "missile gap". Since the USSR would not permit foreign overflights of its territory, American intelligence on the Soviet Union's air-and-rocket bases was limited to nearly-decade old photographs captured from the Luftwaffe in 1945, and vague stories extracted from defectors.[50] In early 1954, Eisenhower created the Technological Capabilities Panel (TCP) which published the report, "Meeting the Threat of Surprise Attack". It recommended accelerating both ballistic missile development and the construction of the Distant Early Warning (DEW) Line network of arctic radar stations. The report also urged the gathering and use of intelligence to prevent hostilities in the first place, specifically, via the use of high-altitude reconnaissance aircraft. Eisenhower had already ordered work on one in August 1954 but decided the project should be run by the CIA, a civilian agency, as a covert action with plausible deniability.

In the immediate post-war period, President Truman's National Security Act of 1947 restructured America's military and intelligence operations. Another reverberation of the Japanese sneak attack on Pearl Harbor, this law created the United States Air Force as an independent branch and established the Central Intelligence Agency (CIA) as the nation's civilian foreign intelligence

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[48] Weitekamp, 36.

[49] In *The Closed World*, Paul N. Edwards includes Pearl Harbor as one of six "key events from World War Two", informing American foreign policy and military affairs in the Cold War, specifically a perpetual fear of sneak attack. (pp. 55) Like many of his cohort, Eisenhower remained deeply scarred by the Japanese attack on Pearl Harbour and took office fearing the Soviet Union was preparing to make a similar move. Soviet leaders including Josef Stalin and Nikita Khrushchev were also motivated by fear of an American sneak attack, theirs stemming from Hitler's violation of the Molotov-Ribbentrop pact and surprise invasion of the USSR in Operation Barbarossa in 1941.

[50] As R. Cargill Hall notes, "Any unauthorized penetration of another state's airspace represented a certain violation of international law; a violation unless the leaders concerned agreed to such flights beforehand." (pp. 222) R. Cargill Hall, "Origins of U.S. Space Policy: Eisenhower, Open Skies, and Freedom of Space," in *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume I: Organizing for Exploration* (Washington, DC: NASA SP-4407, 1995), pp. 213–29.

service at the same time.[51] In the Cold War, the CIA's stock-in-trade became covert action. Covert action is narrowly defined and differentiated from clandestine action. Clandestine action describes a situation where an actor attempts to conceal the fact that an action has taken place. Covert action attempts to conceal only the true identity of the sponsor of the action. Successful covert operations give government officials *plausible deniability*, the ability to deny the knowledge or the hostile intent of a given action. This allowed a strategic objective to be met without an adversary gaining enough evidence to justify a retaliatory response in the court of world opinion. Covert action was understood to be fundamentally risky, but when CIA and USAF atmospheric measurements detected the first Russian atomic test in August 1949, the need for intelligence became acute.[52]

Eisenhower knew the risks of getting caught illegally overflying the USSR, so he first made a series of diplomatic appeals to Soviet leaders starting in 1954 that became known as "Open Skies". Eisenhower sought to define the atmosphere in terms similar to international waters and proposed the United States and the Soviet Union agree to permit overflights of each other's military bases in a mutual monitoring program. The Soviets, who valued military secrecy above everything else, viewed "Open Skies" as a thinly-veiled American attempt to acquire targeting data for a first-strike, and rejected it almost immediately. But, in the court of world opinion, forcing Khrushchev to shoot down "Open Skies" let Eisenhower set a precedent for how the United States intended to utilize and operate in the upper-atmosphere and space.

Eisenhower realized Churchill's "iron curtain" only reached as high as Soviet air defenses, which in 1955 was roughly 60,000 feet. To peer over, he directed development of a high-altitude reconnaissance aircraft capable of overflying the Soviet Union north to south without refueling at altitudes above 70,000 feet—beyond Russian interceptor jets and surface-to-air missiles.[53] The Lockheed U-2, a single seat, stripped-down jet-powered glider with enormous wings, was designed

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[51] It also established the Department of Defense and Secretary of Defense. The CIA was in many ways a continuation the Office of Strategic Services (OSS), which was modeled after the British Mi6 during World War Two and had also initiated the recruitment of German scientists to the United States in Operation Paperclip.

[52] Hall, 217. In May 1946, researchers for the Douglas Aircraft Company's Project RAND (forerunner to the RAND Corporation) authored *Preliminary Design of an Experimental World-Circling Spaceship*, the first American proposal to build and launch an artificial Earth satellite. The report listed reconnaissance as one of the first anticipated uses for this new technology, and work on military applications satellites proceeded at RAND and various defense conferences during the early 1950s. "By the early 1950s… the most valuable, first-priority use of a satellite vehicle involved one application: a platform from which to observe and record activity on Earth."

[53] For histories of the U-2, see: Gregory W. Pedlow; Donald E. Welzenbach. *The Central Intelligence Agency and Overhead Reconnaissance: The U-2 and Oxcart Programs, 1954-1974.* (Washington D.C.: Central Intelligence Agency, 1992) and Gregory W. Pedlow; Donald E. Welzenbach. *The CIA and the U-2 Program, 1954-1974* (Washington D.C.: Central Intelligence Agency, 1998)

by Clarence "Kelly" Johnson (famous also for the SR-71) and quickly developed at the famous "Skunkworks" plant in Burbank, California between 1954 and 1955.[54] It was the first aircraft designed specifically for aerial reconnaissance, and even more specifically, the job of flying heavy high-resolution cameras developed by the Polaroid Corporation over the Soviet Union's air defenses as they existed in 1955, a route requiring pilots fly well into Strughold's area of space equivalence. The covert nature of the mission was built-in in ways beyond the plane's extended range and altitude. Eisenhower had the CIA invent a cover story for the existence of the aircraft. Officially, they were research planes being used by the National Advisory Committee for Aeronautics (NACA) in something called the High-Altitude Sampling Program (HASP) into turbulence and weather.[55] They even gave the plane an intentionally innocuous and benign-sounding designation: "U" for "Utility".[56]

Crucially for Lovelace, Eisenhower also decided to disguise the pilots. In keeping with the CIA's doctrine of covert action, Eisenhower wanted to be able to exercise plausible deniability if a U-2 was lost over Soviet territory.[57] Like other CIA activities unfolding at the same time, Eisenhower first tried to have U-2s flown not by Americans, but by foreign nationals. However, after initial attempts to train a group of foreign pilots stalled due to language barriers and a lack of preexisting skills, Eisenhower took a different approach. U-2 pilots were recruited from Strategic Air Command's (SAC) reserve bomber pilots—a population trained for long flights and identifying targets on the ground. Upon selection, however, these pilots were required to resign from the military, so they could be instantly re-hired as "civilian contractors" by the CIA. The Agency promised they could return to their units with rank and any missed promotions in-tact following their employment, but while flying the U-2 they were not even referred as pilots, but rather, euphemistically, as "drivers". In intelligence lexicon, this process of superficially transitioning an agent from military to "civilian" is called "sheep dipping", a reference to treating farm animals with fungicide, symbolic of the erasure of problematic elements from a person's past.

[54] "Historical Notes on the U-2: 1954-1959" NASA History Office. Folder: "U-2". pp. 1-3.
[55] See: Albert K. Stebbins. "HASP: Special Report on High Altitude Sampling Program" (DASA 532B, June, 1960)
[56] The "SR" designation in SR-71 overtly advertises its role as "Strategic Reconnaissance".
[57] U-2 pilots were said to be "civilians employed by the All-Weather Service (MATS) of the USAF", engaged in scientific research. One example of this cover-story in action can be seen following the crash of a U-2 in Arizona in 1956. "The pilot, a civilian who identified himself as Robert J. Everett, parachuted to land unhurt… and was engaged in a joint NACA-Air Force research study of upper air turbulence." "Research Plane Explodes" in *The Washington Post* (December 20, 1956) pp. A2.

Eisenhower's need for military intelligence, and his desire to do so delicately, without causing the very conflict he was seeking to avoid, can be seen in every aspect of the U-2 program, right down to the organization tasked with evaluating and caring for their sheep-dipped "drivers": The Lovelace Foundation. Eisenhower gave control of the U-2 program to the CIA, but the Air Force remained involved as "a 49% partner", overseeing pilot recruitment, evaluation, selection, protection, and training. Flickinger was assigned to the U-2 program as USAF liaison officer and was put in charge of determining the medical requirements for pilots. Eisenhower's desire for a civilian cover extended to this process as well. In 1955, the civilian Lovelace Clinic, rather than the military School of Aviation Medicine, was awarded the contract to screen the U-2 pilots and facilitate their transition to "civilians". Once past a rigorous background check including a lie-detector test, candidates reported to the Lovelace Clinic in Albuquerque for a week of intense medical evaluations.[58] Next, while still under the purview of the Clinic, they proceeded to the Aero Medical Laboratory at Wright-Patterson Air Force Base for stress tests, which also included interviews with CIA and USAF psychologists. Crucially, this screening program Lovelace and Flickinger developed in secret for the CIA's U-2 pilots became the template for Project Mercury in 1959, and the Woman in Space Program in 1960.

After selection, Flickinger and Lovelace continued to care for the U-2 pilots, with Flickinger spending "nearly a decade" on the project.[59] The route above the reach of the Soviet's air defenses took U-2 pilots well into Strughold's area of space equivalence, and compromises to the environmental system and pilot safety (described with the euphemism "pilot comfort" in the CIA-produced manual) were made to accomplish the goal of covert overflights. Pilots wore full pressure suits made by the David Clark Company in case they had to bail out above 70,000 feet.[60] The cockpit was only pressurized to 29,000 feet (higher than the peak of Mount Everest, and

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[58] In the memoir collection *Remembering the Dragon Lady* (2008) U-2 pilot Harry N. Cordes recalls, "Despite my Top Secret Q clearances from Nuclear Weapons training, CIA insisted I attend orientation classes, physiological tests and interviews and the infamous lie detector tests. I passed all the tests and was admitted to Project AQUATONE. The headquarters for the project was in a super secure area of the Motomic Building at 1717 H Street in downtown Washington D.C." pp. 30.

[59] The USAF still operates U-2 variants today.

[60] In typical CIA fashion, the pilots were fitted for these in secret meetings held in nondescript hotel rooms and a factory basement in Worcester, Massachusetts. Their travel plans included multiple unnecessary stopovers to thwart any Soviet agents tailing them. In *Remembering the Dragon Lady*, U-2 pilot Gerald E. McIlmoyle recalls: "The entire process was done 'in the black' with CIA directing every aspect of the trip… we made the trip to Worcester dressed in civilian clothes, no military uniforms were allowed. The trip itself was by a circuitous route and we had no military documents with us." pp. 50.

beyond the mountaineer's so-called "death zone") requiring pilots to pre-breath pure oxygen for one to two hours before each mission. Monotony was also a hazard with overflight missions lasting up to eight hours, as was disorientation when flying near the North Pole.[61] In addition to environmental hazards, there was always the possibility of being shot down by new surface-to-air missiles which the U.S. government suspected could be deployed as early as 1958. In 1961, the Lovelace Clinic also began providing similar screening and support for pilots of another secret reconnaissance aircraft, the CIA's A-12, which later became the USAF SR-71 Blackbird.[62] In 1963, when A-12 test pilot Ken Collins ejected over Utah, the recovery team flew him, "directly to Albuquerque, New Mexico to the Lovelace Clinic for my physical check-up."[63]

U-2 planes and pilots proved to be crucial actors in the course of the Cold War.[64] The program is now considered one of the most successful intelligence operations in American history. The first overflights of Soviet territory occurred in 1956 and followed at a rate of around one per month for the next two years. Right from the first flight, Soviet air defenses were able to track the U-2, but they could not prove it was the supposed NACA "research" plane. Secret analysis of U-2 photos quickly established that the feared bomber and missile gaps did not exist. Despite this revelation, Senator John F. Kennedy made the missile gap a key issue in his 1960 presidential campaign against Vice-President Richard M. Nixon who knew the truth but could not reveal it.

When NASA was created in 1958 by the National Aeronautics and Space Act, it was constituted as a civilian organization.[65] This was also part of Eisenhower's strategy to prevent nuclear war by enabling reconnaissance. According to Cargill R. Hall, former chief historian of

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[61] In October 1962, disorientation near the North Pole caused a U-2 pilot to accidentally stray into Soviet airspace during the Cuban Missile Crisis, nearly compounding the tense situation. See Dobbs' account of USAF pilot Charles W. Maultsby's harrowing U-2 ordeal in *One Minute to Midnight: Kennedy Khrushchev, and Castro on the Brink of Nuclear War* (2009). pp. 196-198.

[62] See: *SR-71 Blackbird: Stories, Tales, and Legends*, pp. 22. "I was scheduled for my 'astronaut' physical at the Lovelace Clinic in Albuquerque, New Mexico. This is the same facility where the original astronauts received their medical evaluations, and the medical facility for the original U-2 pilots."

[63] Richard H. Graham. *The Complete Book of the SR-71 Blackbird: The Illustrated Profile of Every Aircraft, Crew, and Breakthrough of the World's Fastest Stealth Jet* (Minneapolis: Zenith Press, 2015) pp. 20.

[64] See the 1960 "U-2 incident" that followed the Soviet Union's shoot-down and recovery of pilot Francis Gary Powers, as well as the key role U-2 photographs played in The Cuban Missile Crisis in October 1962.

[65] "The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. The Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States … and that determination as to which such agency has responsibility for and direction of any such activity shall be made by the President." "National Aeronautics and Space Act of 1958," Public Law #85-568, 72 Stat., 426. Signed July 29, 1958. Record Group 255, National Archives and Records Administration (NARA).

the National Reconnaissance Office (NRO), "in the spring of 1955… the president's closest advisors determined, if at all possible, to keep outer space a region open to all, where the spacecraft of any state might overfly all states… with all that implied for overflight."[66] This concept, similar to "Open Skies", became known as the "freedom of space", and was embodied in proposals for the non-aggressive, scientific use of space for scientific purposes, like the artificial Earth satellites American scientists suggested launching as part of the International Geophysical Year (IGY) in 1957-1958, and the civilian status of NASA.

Among the first things NASA's first administrator T. Keith Glennan did when the Agency commenced operations in October 1958 was appoint Lovelace as Chairman of the Special Committee on Life Sciences, with Flickinger also a member. Their task was to draw-up the requirements and selection process for screening and selecting astronauts for Project Mercury. At the same time, The Lovelace Foundation was chosen to conduct the medical screening planned to begin in February 1959—"they know how to keep a secret".[67] Astronaut candidates recruited from the ranks of military test-pilots who also held degrees in engineering retraced the steps of the "civilian" U-2 pilots, proceeding from the Lovelace Clinic in Albuquerque to the Aero Medical Laboratory in Dayton. When the Mercury Seven group was unveiled to the public on April 9, 1959, Lovelace and Flickinger sat next to each other on the dais at NASA Headquarters fielding questions alongside Glennan, Space Task Group head Robert R. Gilruth, and the astronauts.[68]

Following their work on Project Mercury, Lovelace and Flickinger collaborated on another project before the Woman in Space Program, this time directly for the Air Force. Just weeks after the launch of Sputnik in October 1957, the USAF combined several concepts for a boost-glide spaceplane into a program called Dyna-Soar (for "Dynamic Soarer"). Boeing won the contract to supply the vehicle (designated the X-20), which was to launch atop a Titan-III rocket, complete a single orbit, and re-enter the atmosphere gliding to a runway on Earth—similar to NASA's Space Shuttles. The Air Force intended to use the X-20 for different military missions, including aerial reconnaissance and disabling Soviet spy satellites.[69]

On June 23, 1959, a secret conference was held at the Air Research and Development Command (ARDC) at Andrews Air Force Base in Washington D.C. to determine the selection

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[66] Hall, 13.
[67] *Project Mercury: A Chronology*, see pp. 30 and 40.
[68] "Press Conference Mercury Astronaut Team" NASA History Office, pp.1.
[69] Roy F. Houchin II. *US Hypersonic Research and Development: The Rise and Fall of Dyna-Soar, 1944-1963*.

procedure for X-20 pilots. Flickinger and Lovelace are the first two names listed in attendance on a memo detailing the proceedings titled "Air Force Astronaut Selection Conference." Also present were doctors from The Lovelace Clinic and SAM. The document describes how the program would also function as a hand-off of responsibility for the medical screening of astronauts from The Lovelace Clinic to SAM (something doctors at SAM felt was long overdue). "The proposed schedule for examination of the astronauts will be four candidates to be examined starting 20 July at the Lovelace Clinic. The School of Aviation Medicine will have observers at the Lovelace Clinic during the processing and is expected to perform the clinical processing on groups which are processed after SAM has completed the move to their new quarters [at Brooks Air Force Base] in September."[70] In April 1960, the first group of seven Dyna-Soar pilots was selected in secret. They included former Man in Space Soonest (MISS), and X-15 selectee Neil Armstrong. Armstrong resigned from the Dyna-Soar program in 1962 and was subsequently selected for NASA's follow-up to Project Mercury, Gemini.[71] His medical screening for this was conducted at SAM.

Weitekamp quotes one of Lovelace's doctors saying, "Lovelace was the de facto medical department of NASA because there wasn't any."[72] But to an even greater extent, Lovelace was a de facto military (or at least "quasi-military") facility, a view acknowledged by USAF personnel there. In a NASA oral history interview, Flickinger explained that medical work he and Lovelace contributed to classified reconnaissance programs became the basis for the new Agency's space medicine expertise: "NASA didn't then have to go through long periods of tests and evaluations. They could pick up where we left off, for instance like in the U-2 Program, the Dinosaur [sic] Program and save themselves time and money".[73] In planning for Project Mercury, Lovelace cited key work by USAF colleagues, "the material from the 1958 Symposium on the Physics and Medicine of the Atmosphere and Space sponsored by Benson and Strughold at the School of Aviation Medicine was very valuable."[74] Alfred H. Schwichtenberg, head of Lovelace's Department of Aerospace Medicine and Bioastronautics and himself a retired USAF Brigadier

[70] Memorandum for Colonel Bollerud, Subject: "Air Force Astronaut Selection Conference" (Headquarters Air Research & Development Command, June 23, 1959) pp. 1-3. AFHRA Folder: "Med – Aerospace Weapons Systems (Dyna Soar)" IRIS # 1008336. pp. 2.
[71] For Armstrong and the X-20 program see: Hansen, James *First Man: The Life of Neil A. Armstrong* pp. 171.
[72] Weitekamp, 41.
[73] "Oral history interview with General Donald Flickinger" Interviewer: John Pitts, October 18, 1979. NASA History Office: Folder: "Donald Flickinger". pp. 11.
[74] William Randolph Lovelace II. "The Man in Space Program", January 28, 1959. pp. 13. NASA History Office: Folder: "Man-in-Space Mercury".

General, recalled, “almost everybody in the medical department of NASA was ex-military… so I handled what really amounted to a military interface… I guess you could say [we] all spoke the same language and had a lot of the same ideas.”[75]

This section has highlighted the extensive role Lovelace, Flickinger, and The Lovelace Foundation played in early Cold War strategic reconnaissance. The screening practices Flickinger and Lovelace developed for the CIA’s U-2 program in 1955 became the template they later adapted for NASA’s Project Mercury and the Lovelace Woman in Space Program. Appreciating the extent to which the Woman in Space Program was in the orbit of these other active, covert Cold War government projects is crucial for understanding Lovelace and Flickinger’s interest in women. They both later explained their interest in women was driven by a quest for weight-saving. But in the context of the U-2, an aircraft designed in almost every way around a problem of weight, their subsequent interest in women as efficient human factors can be more clearly seen as a military concern, rather than fair-minded pragmatism, or a progressive stance on equality.

[75] “A.H. Schwichtenberg” Oral History interview. University of New Mexico Medical Center Library Oral History of Medicine Project (recorded February 20, 1985) Conducted by Jake Spidle, University of New Mexico Department of History. pp. 4.

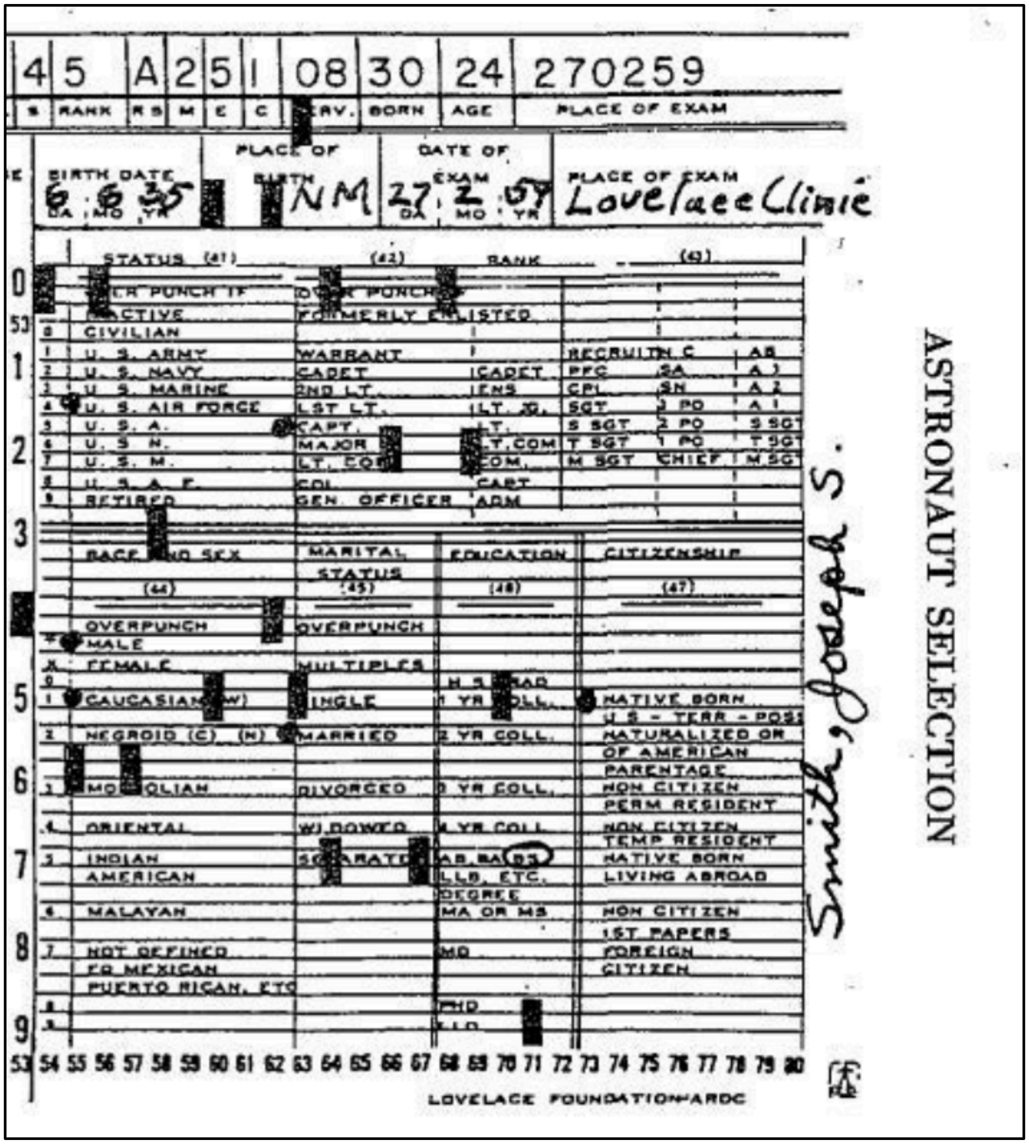

Figure 28: "Mark Sense" computer cards designed by Lovelace and Flickinger for Project Mercury in April 1959. (Source: Albert H Schwichtenberg; Donald Flickinger; Randolph Lovelace II. "Development and Use of Medical Machine Record Cards in Astronaut Selection" in *U.S. Armed Forces Medical Journal*. Vol. 10, No. 11, 1959. pp. 1347.

WOMEN IN THE CARDS: COMPUTING BODIES OF DATA AT LOVELACE

At the Lovelace Foundation, the Woman in Space Program intersected with another important development in space medicine: the introduction of computers for astronaut screening and selection. Starting in 1958, Lovelace and Flickinger along with Schwichtenberg, the retired USAF Brigadier General and former CONAD flight surgeon now serving as head of the Clinic's

Department of Aerospace Medicine and Bioastronautics, collaborated to develop a system of machine-readable cards to standardize hand-written medical records generated during astronaut evaluations (Figure 28).[76] Early space medicine experts often viewed bodies in machinic terms, as assemblages of mechanical components. Now Lovelace sought to convert these into information for efficient storage, transfer, duplication, and sorting. This disembodiment and abstraction of the body to data, translated into a constellation of holes in a piece of paper, was a new development in medicine, a new rendering of the body, and part of the wider biomedical turn that took place after World War Two. The body reduced to data offered many new possibilities, among them the chance to refigure old articulations of sex and gender within medicine. But as is often the case, the cards became a site for the reproduction of binary biological sex, one that reproduced the modern body stereotype of women as complicated, abnormal versions of men. This section connects Lovelace's lesser-known work with computers to his contemporaneous Woman in Space Program to show how even in this highly-abstracted version of the body, sex and gender were reproduced. This adds to recent scholarship about women and computers in the Cold War—and notably space history—that have recovered the crucial and foundational work of women in the history of computer science, and as "human computers".[77] This is another example of how the design of computers, programs, and the information economy reproduced sex and gender inequalities.[78] Lovelace's drafting of cards in what we might call "the computer turn" in space medicine, offers an important glimpse of what aspects of the body experts were interested in, worried about, and sought to control.

In March 1960, just one week after Cobb finished her astronaut tests at The Lovelace Clinic, CBS broadcast an episode of the realistic science-fiction television drama *Men into Space* (1959-1960), which depicted the selection of a woman astronaut.[79] The episode opens with USAF

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[76] Albert H Schwichtenberg; Donald Flickinger; Randolph Lovelace II. "Development and Use of Medical Machine Record Cards in Astronaut Selection" in *U.S. Armed Forces Medical Journal* (Vol. 10, No. 11, 1959) pp. 1324-1351; W. Randolph Lovelace II, Ulrich C. Luft, Albert A. Schwichtenberg, and Robert R. Secrest "Selection and Maintenance Program for Astronauts for the National Aeronautics and Space Administration" in *Aerospace Medicine*, June 1962. pp. 667-684. See also the sections under "Use of Machine Data Cards" in: Siegfried Gerathewohl. "Manned Space-Flight Missions" in *Principles of Bioastronautics* (Englewood Cliffs, NJ: Prentice-Hall, 1963) pp. 546-549.

[77] Jennifer S. Light. "When Computers Were Women." *Technology and Culture*, 40. (No. 3, 1999) pp. 455–483; Margot Lee Shetterly. *Hidden Figures: The American Dream and the Untold Story of the Black Women Who Helped Win the Space Race* (William Morrow and Company, 2016)

[78] Marie Hicks. *Programmed Inequality: How Britain Discarded Women Technologists and Lost Its Edge in Computing* (Cambridge, MA: The MIT Press, 2017)

[79] The show's end credits also included production designer Chesley Bonestell, famous for his illustrations depicting spaceflight in *Colliers* and *TIME*. See Margaret Weitekamp. "Setting the Scene for Human Spaceflights: Men into

astronaut Edward McCauley (William Lundigan), the hero protagonist, struggling to choose between thirty strong applications for two astronaut positions. Out of ideas, McCauley mutters something about "the wisdom of Solomon", referring to the wise King of ancient Israel. The off-hand remark gives another Air Force officer in the room an idea: "That's it, we turn the whole problem over to Ol Solomon!" The punchline, delivered visually in the next scene, is that "Ol Solomon" is the name of their new computer.[80] "We let the computer pick the top three candidates, there's no chance of human error, and the results are purely scientific, right?" one officer marvels, loading in machine-readable cards. "Ol Solomon here is just a machine," cautions McCauley. "It'll give us the right answer, if we ask the right question." In the next scene, the group is reviewing the computer's selections when the "physical description" of the top-ranked pick, an astronomer named M.C. Gallagher, catches McCauley's eye. "Height, five feet, three-and-a-half inches, weight a hundred and seventeen pounds—he's a little fella isn't he?" His deadpan delay in realizing the applicant is in fact a woman, Dr. Muriel Catherine Gallagher, is played for laughs. Then another officer explains, "Ol Solomon doesn't have any concept of sex." Angered by the prospect of a woman USAF astronaut, the Program Director quickly intervenes, "She's out. I won't allow it. Space is man's last refuge from the female sex, and I don't intend to see it invaded."[81]

The scene hinges on an amusing (and telling) failure of imagination on the part of these fictional space medicine experts, one that highlights a problem with converting bodies into data. Using a computer for the first time, the USAF officers had not thought to record the sex of each applicant. Like McCauley warns in the set-up, they end up with a surprising result because they failed to ask, "the right question". It was not that the computer "doesn't have any concept of sex", it was that assuming an all-male applicant pool, the experts had not asked applicants to indicate their sex. Depending on their design, computers certainly can embody and reproduce "a concept of sex", but this sci-fi parable suggests that sex and gender needed to be shored-up and reproduced in new ways when bodies are abstracted into new regimes like data. This scene both needles and warns space medicine about their historic lack of interest in women: continue ignoring women and you might accidentally select one.

Space and The Man and the Challenge" in *Spacefarers: Images of Astronauts and Cosmonauts in the Heroic Era of Spaceflight* (ed. Michael J. Neufeld) (Washington D.C. Smithsonian Institution Scholarly Press, 2013). pp. 9-35.

[80] I speculate that the "O" and lowercase "l" are also meant to symbolize a binary "0" and "1". 01 Solomon implies the machine embodiment of the virtue of fairness as delivered by King Solomon in the Bible.

[81] "Dark of the Sun" *Men into Space* (Ziv Productions, broadcast March 9, 1960).

Men into Space, which depicted the adventures of a muscular USAF space program ten-to-twenty years in the future, drew heavily on existing military space research, and credited SAM and the Department of Defense with supplying technical advice. In this episode, the computer mix-up is based on Lovelace's machine-readable medical cards. In real-life, Lovelace's cards were inspired by work done by the U.S. Navy on machine-readable medical sheets, and IBM's card-based in-house employee medical records program. It was Flickinger who first brought the idea of using machine-readable cards for astronaut selection to Lovelace in 1958 as part of the USAF's "Man in Space Soonest" (MISS) program.[82] Lovelace in turn assigned the task to Schwichtenberg. The cards were not ready in time for the USAF's MISS selection in the summer of 1958, but in February 1959 they arrived just in time for Lovelace's next contract: Project Mercury.[83]

They called the system "Mark Sense" after the method of filling in the cards: medical staff used a special electrographic pencil to mark parts of the cards that corresponded to pre-determined multiple-choice answers. After the tests, the "cards were taken to the IBM facility at Kirtland Air Force Base, New Mexico, where the original cards were automatically punched and a number of duplicate decks made."[84] Duplicates were sent to Lovelace and the Aero Medical Laboratory, and when testing was finished, "the data were assembled and considered at the Langley National Aeronautics and Space Administration Laboratory", with "the final selection of candidates made in light of this".[85] The idea was to standardize all the medical data generated about a person during the screening process so it could be efficiently stored, compared, sorted, and recalled as part of a larger candidate group. In the end, it was not a physical body that was sorted and selected, the object of analysis became a paper representation standing-in for a physically-absent body.

Lovelace recalled the hardest part of developing the cards was deciding what to incorporate about a person. Which tests to conduct? Which questions to ask? Science studies scholar Karen Barad calls these experimental choices "cuts", and argues that they affect the knowledge produced,

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[82] "The use of these cards free more of the physician's time and talents for diagnosis and study, and insure accuracy and comparability of records, as well as ready accessibility to the data. Marks are made on the cards with a special electrographic pencil. As the cards pass through a machine, which has small metal brushes, electrical contact is made across the pencil mark causing a hole to be punched automatically just under it." See: W. Randolph Lovelace II, Ulrich C. Luft, Albert A. Schwichtenberg, and Robert R. Secrest "Selection and Maintenance Program for Astronauts for the National Aeronautics and Space Administration" in *Aerospace Medicine*, June 1962. pp. 667-684.
[83] Lovelace, 1341. "The time elements were such, however, that the completed cards were received from the printer only a few days before the astronaut candidates arrived."
[84] Lovelace, 1350.
[85] ibid, 1351.

or in this case, the specific contours and constitution of the data-set.[86] Lovelace remembered teams of physiologists from the Clinic's various departments jockeying for card space, each doing "the utmost to ensure that the important aspects of their respective fields were covered by the data on the machine record cards."[87] The large number of tests they ended up including produced a specific body of data: a two-dimensional representation that constituted a virtual body, one fit for electronic processing that could be stored, duplicated, sorted, shipped, and recalled—manipulated in ways that a cumbersome physical body could not. But when bodies are abstracted to data, certain aspects are necessarily omitted. There is a tendency to think that 'data bodies' might obliterate differences like gender, race, and class, like in *Men into Space* when Gallagher's sex gets lost in translation. But those inequalities are not erased, but instead reproduced in new ways and in new places. For instance, additional tests given only to women, or comparisons to a historically-biased normal. Abstract and reductive, the data bodies captured by Mark Sense cards also reflected a "normal" type of person the doctors expected to take the tests: the white male military pilot they had been studying for years. The universal white male subject came to space medicine from physiology and human factors, where it had been built-up over more than a century in military anthropometry's vast statistical studies of all-male populations for use by the state.[88]

In 1950, the newly-independent USAF commissioned its first anthropometric study of flying personnel in order to aid designers of new jet aircraft and skin-tight anti-G flying suits. In both cases, the fit between humans and technology would be tighter than in World War Two, and new and more precise measures than previously existed were sought. Under USAF contract AF 18(600)-30, a team of twelve untrained college students visited fourteen USAF bases and took 132 different measurements of 4,063 airmen, processing between 100 and 120 people per day at a rate of about one every 2.5 minutes.[89] All the subjects were men, no women were included. In June 1950, the project was halted short of its goal of measuring 5,000 subjects by "the communist

[86] Karen Barad. "Meeting The Universe Halfway: Realism and Social Constructivism Without Contradiction".
[87] Lovelace, 1341.
[88] Adolphe Quetelet, the Belgian mathematician who coined the term "average man" in his *Social Physics* (1835), did so by applying expertise from astronomy involving statistics to the study of humans and society. In the United States, military anthropometry began in the immediate post-Civil War period with an extensive analysis of data gathered about Union and Confederate troops, sponsored by the U.S. Sanitary Commission. *Investigations in the Military and Anthropological Statistics of American Soldiers* was published in 1869 by Benjamin Apthorp Gould, who is better known as the first American to earn a doctorate in astronomy, and namesake of The Gould Belt.
[89] H.T.E. Hertzberg, G.S. Daniels, E. Churchill. *Anthropometry of Flying Personnel – 1950* (Dayton: Wright Air Development Center, 1954) pp. 5.

invasion of Southern Korea".[90] The authors of the resulting compendium hoped the data would be "applicable to many problems of human fit, whether of clothing, personal equipment, or some phase of the ever-increasing man-machine complex."[91] In addition to the 132 different measures of bodies, the trio of researchers running the project also sought sociological and biographical data from subjects including their birthplace, religion, education, and race.[92]

There is no mention of sex. The questionnaire correctly assumed that all USAF "flying personnel" at the time were male. The authors of the study implicitly justify this omission (or "feature"?) in the following manner, "[since] such clothing was intended only for Air Force flying personnel—a group highly selected by various criteria from the population at large—the new survey would have to be limited to that group."[93] Another place the questionnaire assumes a male subject is "marital status", where the choices are: "single, married, divorced or separated, widower". Widow, which would accommodate a female subject, is not an option. Nowhere is it explicitly stated that this questionnaire is a male data body, but in a close reading the questions and possible responses provided, the assumption is clear.

In December 1952, in anticipation of the publication of this study, one of the three authors, G.S. Daniels from the Aero Medical Laboratory, issued a short companion piece titled "The 'Average Man'?" In it, he cautioned users of the data that "it is virtually impossible to find an 'average man' in the Air Force population," due to, "the great variability of bodily dimensions which is the characteristic of all men."[94] He called the average man "a misleading and illusory concept as a basis for design criteria" and "an abstract representation of a mythical individual most representative of a given population… he doesn't exist."[95] The idea was not to design for the abstract average (calculable but non-existent) but to accommodate a decided-upon range of body types derived from the study. To illustrate, he described a hypothetical design that would limit use to people measuring between five feet, five inches, and six feet, one inch in height. "This is shown to cover 90% of the Air Force population, the range having been trimmed to leave out the tallest 5% and the shortest 5% of the men."[96] In the average, we must see a diverse population, rather

[90] H.T.E. Hertzberg, G.S. Daniels, E. Churchill, 3.
[91] ibid, 9.
[92] The options for race are: "White, Negro, Indian, Mongoloid, other". The options for religion are: "Protestant, Catholic, Jewish, other." pp. 4.
[93] ibid, 1.
[94] ibid, 1.
[95] ibid, 2.
[96] ibid, 2.

than a singular individual. But the Air Force's "average man" was still an amalgam or composite of white men, and not women. This excluded women through the design of clothing, equipment, and vehicles produced using this data.[97] This also entrenched the universal white male subject in aviation and space medicine, charged with managing the users of these Air Force designs.

The first USAF anthropometric study of women officers and enlisted airmen occurred in 1968, and was published in 1972.[98] The study compiled and analyzed 137 body measurements of 1,905 Air Force women, none of them pilots. The 1968 survey looks similar to the all-male 1950 survey, with a few exceptions. Unlike the 1950 survey which assumed all subjects would be male, this survey is explicitly marked "USAF Female Anthropometric Survey", and along with birthplace, religion, and marital status, researchers also wanted to know "Age First Menstruation (Years)". It was not until 1993, with the Cold War over and Bill Clinton in the White House that women in the Air Force finally achieved a number of pilot firsts: Susan Helms graduated test-pilot school, Jacqueline Parker became the first woman fighter pilot, and Jeannie Flynn began jet-fighter training for combat missions.[99]

Working on their astronaut computer cards back in 1959, Lovelace, Flickinger, and Schwichtenberg wanted anthropometric, biographical, physiological, psychological, psychiatric, and performance data on their subjects—far more than could possibly fit on a single card. All in, it took a stack of 75 machine-readable Mark Sense cards—referred to as a "deck"—to represent a single candidate. 37 cards were needed for the clinical tests at Lovelace, 34 for the psychological and stress tests at the Aero Medical Laboratory, 3 for further clinical use, and one "master card", recorded "basic information on the patient or examinee, such as name, identification numbers, age, sex, marital status, and race."[100]

Unlike *Men into Space*, the Lovelace Mark Sense cards *did* record the sex of applicants. This was accomplished upfront on the "master card", with a binary choice between "male" and "female". The fact that men were considered the normal and expected subjects can be seen in something as minor as the ordering, which lists male first and female second on the card space.

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[97] Rachel N. Weber. "Manufacturing gender in military cockpit design" in *The Social Shaping of Technology* (eds. Donald Mackenzie and Judy Wajcman). (Open University Press; 1999) Weber calculates that accommodating the 5th through 95th percentile in men excludes all but the 65th to 95th percentile of women. pp. 375.
[98] Charles E. Clauser, et. al. *Anthropometry of Air Force Women* (Wright-Patterson Air Force Base: Aerospace Medicine Research Laboratory, 1972). Women in the United States Air Force are referred to as "Airmen".
[99] Skaine, 205.
[100] Lovelace, 1343.

The appearance of this option on the Lovelace cards is noteworthy because the earlier Navy machine-readable "physical examination work sheets" cited as inspiration did not include a record of sex.[101] But as historian of women in the military Rosemarie Skaine notes, milestones can also be millstones.[102] Despite the inclusion of sex in Lovelace's Mark Sense cards, the figure that emerges from reading the other 74 cards in a deck, turns out, unsurprisingly, to be the "universal" white male military subject (for instance, every card has a place to record the subject's rank, and serial number). Lovelace, in a piece titled, "Maintenance Program for Astronauts", briefly acknowledged working from a bias, noting that "most of the values we have obtained on young healthy men".[103] Forcing a subject to declare their sex upfront shows not only that they were finally beginning to anticipate women as potential subjects, but that they felt a need to control and manage populations within space medicine in this way. Some might see the addition of the option of sex to Mark Sense cards as evidence that Lovelace was progressive in his gender politics. A different view is that this facilitates control over women—specifically, control seen lacking in *Men into Space*. Including a record of sex translates this aspect of a person onto the abstracted data body. It imprints and reproduces a physical sex differentiation that extends the gendered social management of physical bodies to virtual ones processed electronically. This came in handy in 1976, when NASA finally decided to actively recruit women astronauts ("NASA is committed to an affirmative action program with a goal of having qualified minorities and women among the newly selected astronaut candidates"). The medical questionnaire NASA sent to all prospective candidates included many of the same questions asked by Lovelace but added a bolded check-box section: "Females only: Have you ever; Been treated for a female disorder; had a change in menstrual pattern". Not only were women added to these studies in ways that perpetuated notions they were non-standard versions of "normal" men, they marked and reproduced sex in a physical and virtual sense that enabled the extension of gender discrimination to the level of abstracted medical data. The same can also be said for race and non-White subjects. Rachel N. Weber's

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[101] The Navy's "sheets" did include five options for "race": "Caucasian, Negroid, Oriental, Indian (Amer.), Malayan." (Lovelace, pp. 1329). Mark Sense cards appear to have followed this convention with some additions: "Caucasian (W), Negroid (C) (N), Mongolian, Oriental, Indian American, Malayan, Not defined: eg Mexican, Puerto Rican etc." (Lovelace, 1347).
[102] Skaine, 58.
[103] Lovelace, 668.

observation about male bias in military jet cockpits applies equally well to Lovelace's machine-readable computer cards: "The technical artifact has functioned to delineate the 'other.'"[104]

PERIODS OF RISK: MENSTRUATION & TEMPERMENTAL BODIES IN SPACE

In one of many extensions of aviation medicine, space medicine experts saw their job as selecting, improving, and maintaining the "human factor" in complex technological systems. Despite often employing machinic and, later, systems metaphors to describe the body and its constituent parts, they also knew that it was their job to secure a fleshy mass that often evaded, defied, and confounded technical analogy. Still, they saw themselves as in charge of "biological components" to be slotted interchangeably into complex technical weapons systems.[105] They often described their job as attending to the "human factor" or "human component" in a system. Writing in 1964, Siegfried Gerathewohl, SAM's German psychologist and space medicine generalist, explained that, "Since the human operator has been accepted as part of the space-vehicle system, it becomes necessary to take him into the laboratory and measure his capacity, actions, and responses in a manner similar to that applied to measuring any other part of the system for strength, speed, stability, fatigue, reliability, endurance, application, and tolerance."[106]

In her memoir *Woman into Space* (1963), Jerrie Cobb recalled how during her week at The Lovelace Clinic in in February 1960 she strove to impress the staff with strong performances on the long list of over 80 different tests. In the end, space medicine experts fixated on only one: her gynecological exam, arguing her menstrual cycle made women incompatible with spacecraft. This section offers an account of how Lovelace doctors arrived at this conclusion, and how the gendered subject in space medicine became articulated as an error-prone system component. In space medicine, women became viewed as abnormal versions of "male hardware" that lowered the

[104] Weber, 376.
[105] Roth, 124. It is worth noting that the USAF space medicine investigations were started by a group of former Luftwaffe life scientists transferred from Germany to the United States following World War Two. Hubertus Strughold, long considered "the father of American space medicine," was convicted as an accessory to lethal high-altitude experiments performed on concentration camp prisoners. Strughold was a mentor to Lovelace even before the war, and the two worked closely once Strughold's war record was erased. One of the staff physicians at Lovelace's clinic, Ulrich C. Luft, served as Strughold's deputy in Berlin before emigrating under Operation Paperclip.
[106] Gerathewohl, 8.

overall reliability of spacecraft, threatening not only individual missions, but also American national security.

Cobb opened *Woman into Space* by recalling a grueling test administered by the head of Lovelace's Physiology Department, Ulrich C. Luft.[107] Cobb recalls Luft, with his "grizzled grey head" and "gruff, Teutonic accent that could hide neither his gentleness nor his humour," explaining the set-up: "Miss Cobb, this test is to see how your body reacts to hard physical work. It is part of our special dynamic examinations here to measure your body efficiency."[108] Cobb needed to pedal a stationary bicycle in time to a metronome to the point of physical exhaustion. Her exhalations, collected in a large plastic bag, would be analyzed by Luft's team. Covered in sensors and breathing through a tube, Cobb clambered onto the bike and mentally preparing herself. "I knew that the Mercury astronaut candidates had taken this test, as well as the examinations that had preceded it. I knew that my achievement or lack of achievement would be measured against the men's, since no other standards for my sex had been established."[109] This was only one of the over eighty tests Cobb was subject to in six days at the Clinic. There were laboratory tests; X-rays; examinations of her eyes, ears, nose, throat, and heart; work capacity tests on Luft's bicycle ergometer, and on the fifth day she was even flown two hours south to Los Alamos Scientific Laboratory—formerly the nerve center of the Manhattan Project—for a test called "Total Body Radiation Count".[110] "In no physical examinations had I ever undergone such minute scrutiny," she recalled of the entire Lovelace experience.[111] She was determined to match the male candidates, but the Program was designed so that this was not possible.

In *Woman into Space*, Cobb omits one crucial test. The program was supposed to be so similar to Project Mercury that Lovelace staff did not bother to draw up new clinical schedules for the women; they simply issued them duplicates of the men's itinerary. However, under "Schedule I" ("day one"), there is a test listed called "Sperm count". This test, which required astronaut

[107] Luft, a former Luftwaffe researcher who had ventured up Nanga Parbat with Bruno Balke in 1938, began working at SAM a decade later. He made the transition to "civilian" work when Lovelace hired him in 1954. During World War Two Luft was a specialist in respiration at the Luftwaffe's Aviation Medicine Research Institute in Berlin. Rodway, George W. "Ulrich C. Luft and the Physiology of Nanga Parbat: The Winds of War" in High Altitude Medicine and Biology (Vol. 10, No. 1, 2009) pp. 89-96. Annie Jacobsen. *Operation Paperclip: The Secret Intelligence Program That Brought Nazi Scientists to America* (New York: Back Bay Books, 2014) pp. 457.
[108] Cobb, *Woman into Space*, 2-3.
[109] ibid.
[110] "Medical Evaluations Performed at the Lovelace Foundation" NASA History Office, Folder "George Ruff". pp. 1-2. See also: Ryan, Loeppky, and Kilgore, 160.
[111] Cobb, 139.

candidates to produce sperm samples, was famously lampooned in the film version of *The Right Stuff*. The effects of cosmic radiation on human reproductive potential had been a concern since the start of space medicine. Obviously, Cobb and the other women pilots did not take the "Sperm count" test. Curiously though, Cobb does not mention in her memoir that she was given a gynecological exam instead. Weitekamp notes that even though it was not officially printed on the schedule, "all of the women who underwent the Lovelace tests recall having this test… adding a gynecological component was the only systemic adaptation that the Lovelace physicians made to the Project Mercury physical."[112] Gene Nora Stumbough, one of the other twenty-or-so pilots who followed Cobb through the Lovelace tests a year later in 1961, recalls that her pelvic exam occurred "on the first day". In a letter to her parents back home, she wrote, "End of the day—Dr. Barber at OB x Gyn—pelvic exam. He says I'm a nice normal-type girl."[113] Whether this was the intended goal or not, the gynecological exam symbolically marked Cobb's "data body" as different from the men's. Another test—also missing from Cobb's account—was a basal temperature record (used to track ovulation) that the doctors instructed her to keep.[114]

These tests, focused on the female reproductive system, translated sex differences from physical bodies into their data body equivalents. This allowed data bodies to be subject to gendered stereotypes and treatment even in the absence of the physical body. On some level, Cobb knew this was happening, and attempted, as far as she could, to resist by downplaying or omitting aspects of the testing that marked her as different from men. Leaving out any mention of a gynecological exam in her memoir was an attempt to de-gender her body as it was reconstituted by the constellation of tests. This can be understood as "male performance", a concept feminist technology studies scholar Judy Wajcman outlines in *Feminism Confronts Technology* (1991). Wajcman observes that women who wish to participate in historically masculine domains, like science, the military, and spaceflight, are compelled to either de-gender themselves, or to model their appearance and behaviour after men.[115]

On February 20, 1960, Cobb's seventh and final day at Lovelace, she met with Robert R. Secrest, another physician at the clinic, who gave her the good news: she had passed the Project

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[112] Weitekamp, 102.
[113] Judy Wajcman. *Feminism Confronts Technology* (The Pennsylvania State University Press, 1991) pp. 2.
[114] Weitekamp, 102.
[115] Wajcman, 2. Cobb's use of the male-sounding nickname "Jerrie" rather than her given name Geraldine was another way she altered her persona to fit into the masculine culture of American aviation.

Mercury medical screening.[116] Her results had been analyzed by Schwichtenberg, Lovelace's head of Space Medicine and Bioastronautics, who attached the following summary: "Miss Cobb is the first female to receive the astronaut-type examinations as given at the Lovelace Foundation. She is a very highly-motivated, intelligent, and stable adult female who created a very good impression throughout the clinic… it is considered that from all information available and tests done here that she would qualify for special missions… it is recommended that she proceed to the aeromedical laboratory for stress tests followed by a final evaluation based upon all available test information."[117] However, Secrest warned Cobb not to tell anyone about the result. Lovelace (who was not actually present for any of Cobb's tests) wanted to be the first to publicly announce his findings, and was planning to wait for a space medicine conference six months later.[118]

On Friday, August 19, 1960, at the Space and Naval Medical Conference in Stockholm, Sweden, Lovelace publicly reported the first results of the Woman in Space Program: "We are already in a position to say that certain qualities of the female space pilot are preferable to those of her male colleague."[119] He told the audience that Cobb had passed the Project Mercury clinical examination, and was therefore medically approved, in theory, to work in space.[120] "For example," he continued, "You will note that Miss Cobb requires less oxygen per minute than the average male astronaut—this means less oxygen by *weight* will need to be carried for the women crew members than the men."[121] Ten days later, Cobb and Lovelace appeared in a *LIFE* magazine photo essay titled "A Lady Proves She's Fit For Space Flight".[122] It showed Cobb re-enacting some of the tests, and highlighted ways Lovelace thought she differed from the male astronaut candidates: "Jerrie's test results suggest that female astronauts may even have definite advantages: they have lower body mass, use much less oxygen, and need less food, hence may be able to go up in lighter capsules, or stay up considerably longer than men on the same supplies."[123]

Lovelace's rationale for testing and recommending the potential inclusion women in space crews was an argument from efficiency—not from ideals of equal treatment or opportunity. The argument from efficiency says women can only be justified as astronauts if they are less expensive

[116] Cobb, 147.
[117] ibid, 148-149.
[118] ibid, 148. "I was instructed not to discuss the astronaut testing."
[119] Weitekamp, 77.
[120] This was purely a prediction. The first human spaceflight did not occur until April 12, 1961—236 days later.
[121] Cobb, 148.
[122] "A Lady Proves She's Fit For Space Flight." in *LIFE* (29 Aug. 1960) pp. 73.
[123] "A Lady Proves She's Fit For Space Flight", 73.

human factors than men—if they prove more efficient "components" in the system. This rationale excludes all women who are not lighter and more oxygen-efficient than Lovelace's "average male astronaut". Lovelace's interest beyond white male military populations seems to only to appear when other bodies promised some potential strategic cost-savings. Under this regime, any "non-standard" person's worth as an astronaut is determined by resources conserved against a white male normal. Moreover, Lovelace's interest was explicitly expressed in terms of total weight-savings, a problem informing the design of spacecraft, but also a driving factor in his covert reconnaissance programs running concurrently, especially the U-2.

After Lovelace's big announcement, debate over whether women should be astronauts erupted space medicine and the press. A journalist interviewing Flickinger, initially enthusiastic behind the scenes, now found him eager to publicly quash interest in women. Flickinger hoped Lovelace would keep the results quiet, like their work for the CIA and the military, and questioned the veracity of Lovelace's results. He pointed out that the program was not an exact duplication of the male selection process, and that with only one test-subject at this point, it lacked an adequate sample size to draw actionable conclusions. Flickinger also zeroed-in on menstruation: "Women have been ruled out of pioneer space flights for practical as well as valid medical reasons, Gen. Flickinger explained. Practically, there is the problem of designing and fitting a space suit to accommodate their particular biological needs and functions."[124]

In June 1963, when Soviet cosmonaut Valentina Tereshkova's flight on Vostok 6 made her the first woman in space, the stunned U.S. media turned to John "Shorty" Powers, the hard-drinking USAF Colonel detailed to NASA as "the eighth astronaut" and "the voice of Project Mercury" for coining the catch-phrase "A-OK" during the launch of Freedom 7, to ask: why were American women not readying for space? *The Evening Star* described his prickly response as giving "would-be American space girls a de lux going over". "We haven't found a woman in the country who is totally qualified… we flew a chimpanzee in Project Mercury, but that still doesn't prove you don't need an astronaut… anyway, what would you get from putting women into the space program? What would you prove?"[125] An enterprising reporter tracked down Cobb, who was still actively campaigning for a flight, for a rebuttal: "The aviatrix said yesterday she once tried to swap places with a chimpanzee named Glenda so she could become the first woman

[124] "No Women in Space" in *Science News Letter*, 78:230. October 8, 1960. pp. 230.
[125] "Powers Scores Ideas of Women Astronauts" in *The Evening Star* (July 11, 1963)

astronaut. But, she says, female chimps get better treatment from National Aeronautics and Space Administration officials than do human females."[126]

In 1964, Secrest, the physician who told Cobb she had passed the Project Mercury medical examinations, along with another doctor at the Lovelace Foundation, used Cobb's gynecological exam to medically justify excluding American women from spaceflight. They refigured menstruation not as a normal physiological process for female bodies, but as abnormal in their understanding of an astronaut body in a spacecraft system. Their article, "Prospective Women Astronauts Selection Program" in *The American Journal of Obstetrics and Gynecology*, was the only scientific publication resulting from the Lovelace Woman in Space Program. The article contradicts Lovelace's rhetoric of recommendation from August 1960, citing "serious problems" with sending women into space. Specifically, the authors contended that "monthly physiologic changes complicate the epoch woman space explorer more than her male counterpart."[127] This argument, that the menstrual cycle makes women unreliable operators of vehicles or machinery has a long history. The authors themselves cite some of these older studies claiming that "mental illness is higher, [the] crime rate increases, and there are more attempted and successful suicides just prior to and during menstrual flow."[128] From the beginning of powered flight until after World War Two, there were a number of regulations in place to ban women from flying airplanes during their periods simply because men believed women's physical and mental abilities suddenly became compromised.[129] Not only did the doctors extend older cultural ideas about menstruation to body-as-machine rhetoric, they adapted this stereotype to the challenges of Cold War human-machine integration, writing, "the intricacies of matching a temperamental psychophysiologic human and the complicated machine are many, and obviously both need to be ready at the same time."[130] The implication of their fixation on and problematizing of menstruation was that women's bodies were unpredictable and error-prone system components. Given the choice between a "normal" male "component" and a "temperamental" female "component", doctors and engineers who were already fighting the problem of human error in complex weapons systems, cast the inclusion of women as not only inefficient for the system, but as potentially dangerous for

[126] "Powers Scores Ideas of Women Astronauts" in *The Evening Star* (July 11, 1963)
[127] Betson and Secrest, 422.
[128] ibid, 422.
[129] Weitekamp, 166.
[130] Betson and Secrest, 422.

the nation. Their worry was that a woman operator might, "be incapacitated at a critical time," resulting in a delay, or failure to take the right action at the right time. It was imagined that the unpredictable behaviour or performance of women would compromise spacecraft, and by extension, American national security. The authors explain that "menstruation may complicate the use of the female astronaut in an environment of time tables and rigid schedules needed for a perfectly manned space voyage."[131] At first Cobb's body was advertised as more efficient and durable then male astronauts, but then a different part of her data body, which explicitly marked her as female, became the focus, rationalizing in medical terms, the exclusion of women from spaceflight.

CONCLUSION

In 1983, when Sally Ride was preparing to become the first American woman in space, NASA offered her a choice between depot medroxyprogesterone acetate, oral contraceptives, or Danazol to suppress menstruation during her mission, thus bringing her body closer in-line with her male crewmates.[132] After saying no to the drugs, she recalled a male NASA engineer asking her if one hundred tampons would be enough for a one-week flight.[133] Upon Ride's return to Houston following the flight, at an event with the rest of the STS-7 crew, NASA representatives attempted to present her (and only her) with a bouquet of roses and carnations. Ride refused to accept them.[134] Ride also waited until after her death in 2012 to posthumously come out as gay.[135] Ride's resistances offer a glimpse of how tensions between medicine, technology, and gender initiated and unresolved in the cancelled Lovelace Woman in Space Program still resonate today, and continue to have repercussions for women and LGBT people subject to screening and on-going care by space medicine experts. There is a temptation to see the Lovelace Woman in Space

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[131] ibid, 422.

[132] Laura S. Woodmansee. *Women of Space: Cool Careers on the Final Frontier* (Toronto: Apogee Books, 2003) pp. 133.

[133] Lynn Sherr. *Sally Ride: America's First Woman in Space* (New York: Simon and Shuster, 2014) pp. 146. Sherr claims Ride recalled that "jogging twenty-five miles a week stopped her periods. The engineers didn't need to know that." pp. 146.

[134] Amy Foster. *Integrating Women into the Astronaut Corps* (Baltimore: Johns Hopkins University Press, 2011) pp. 146.

[135] Alan Boyle. "Why Sally Ride waited until her death to tell the world she was gay" *NBC News*. Source: https://www.nbcnews.com/science/science-news/why-sally-ride-waited-until-her-death-tell-world-she.

Program as “the right stuff at wrong time”. But this ignores prohibitive male biases built in to space medicine. Systemic heteronormative male biases remain largely unchecked in space medicine today, resulting in a culture of “male performance” among women astronauts sometimes involving the concealment of physiological differences and downplaying of femininity in order to appear “normal”, or, at least not too abnormal.

Rather than a re-telling of Cobb’s experiences, this chapter suggest space medicine was one of the factors making women seem unfit for spaceflight. Examining the concepts, rhetoric, practices, and artifacts that cast women astronauts as more complicated than men shows the Lovelace Woman in Space Program to be the moment when a gendered subject was established and problematized in space medicine, which had long-lingering effects within NASA. Redirecting attention from the subjects of the tests to Lovelace, Flickinger, and their USAF colleagues, puts their interest in women, and their beliefs about their bodies, in the context of Cold War medicine and military strategy. Lovelace’s work supporting covert strategic reconnaissance programs, and the abstraction of bodies onto machine-readable computer cards, shows how women were alienated by space medicine’s reliance on a universal white male normal, and constructed as “other” when apprehended into new regimes of biomedical data. Tension in the clinic between Cobb and doctors over tests which differentiated her from male astronaut candidates eventually resulted in a fixation on her menstrual cycle, seen as evidence that her “abnormal” body was temperamental, error-prone, and dangerous; unfit for high-stakes integration with spacecraft.

CHAPTER SIX: CONCLUSION

"Such a person must be all that the best aviator is today as well as being constitutionally and emotionally suited for the physical and emotional traumatic influences of sealed cabins speeding, heaven knows where, through the awful silence of a timeless and a darkened sky." – Dan C. Ogle, Surgeon General of the United States Air Force, 1957.[1]

In his design history, *Spacesuit: Fashioning Apollo*, Nicholas de Monchaux includes a story about the obscured military origins of this iconic technology. He describes examining one of Alan Shepard's old Project Mercury spacesuits, kept in a Smithsonian storage facility. He recalls how the silvery "space age" exterior dazzled a public primed on science-fiction during the astronauts' debut in April 1959. But he also notices something else. Over the years, a greasy residue has slowly dissolved the suit's aluminum coating, revealing it to be a "thin, sprayed-on veneer".[2] "Originally a brilliant silver, the suit now bleeds army green".[3] Underneath the metallic dusting, de Monchaux finds an older military design: The Navy's Mark IV high-altitude pressure suit, which took naval aviators flying Vought's F-8 Crusader and McDonnell's F-4 Phantom II to altitudes above 50,000 feet starting in 1955.[4] Indeed, in a 1966 interview, NASA engineer Matthew Radnofsky admitted, "this suit doesn't differ much from the Department of Defense model".[5]

This project makes a similar claim for the human inside the spacesuit. The early American astronaut was also a military creation, adapted from earlier Cold War research and development for NASA's civilian Space Race. Peering beyond the space-race gloss and heroic mythos surrounding Project Mercury brings the earlier military origin of the astronaut into focus. Just as De Monchaux turns to the Navy and the Mark IV's manufacturer, B.F. Goodrich, for the lineage of the Project Mercury spacesuit, this project examines the creation of the astronaut in military space medicine. Space medicine, initially conducted in the United States Air Force (USAF), and the United States Navy, actually began in the immediate post-war period—a full decade before test-pilots with degrees in engineering were invited to NASA's inaugural astronaut selection. In

[1] D. C. Ogle. "Man in a Space Vehicle" in *U.S. Armed Forces Medical Journal,* 8 (1957) pp. 1561-1570.
[2] Of the few minor modifications made by manufacturer Goodrich, "the silver covering was the most substantial visual difference". De Monchaux, 99.
[3] Nicolas De Monchaux. *Spacesuit: Fashioning Apollo* (The MIT Press, 2011). pp. 81. De Monchaux is writing about this suit: https://airandspace.si.edu/collection-objects/pressure-suit-mercury-m-8-shepard-training
[4] A physical description of the Mark IV suit, which was also adopted by the USAF, can be found here: https://airandspace.si.edu/collection-objects/helmet-flying-full-pressure-mark-iv-united-states-navy
[5] "Suited for Space" *Science Reporter*. Television Series. (MIT/NASA, 1966). Online: https://www.c-span.org/video/?411184-1/science-reporter-suited-space [4:53-5:27]

1949, an interdisciplinary group of military medical doctors, physiologists, biologists, physicists, and psychologists began solving the problems of human survival in space, a process that established standards and practices definitive of the early astronaut. When NASA was created from the engineer-heavy National Advisory Committee for Aeronautics (NACA) in the summer of 1958, the new Agency turned to the military's space medicine community to deliver their first group of astronauts. But as this project shows, the history of the astronaut in space medicine is not as simple as experts homing in on the military test-pilot as the "right tool for the job". Similar to Peter Galison's work on the antagonistic origins of the cyborg in Second World War anti-aircraft gunnery, the astronaut, so frequently associated with utopian visions of technology, triumph, liberation, and the future, also emerged from a surprisingly dystopian earlier military career.[6] This past has slipped out of everyday view, and once recovered, changes how we think about and view this iconic figure, and human ventures in space.

One place to see this older obscured vision of the astronaut is in NASA's first call for candidates in late 1958, which included the possibility of civilians and non-pilots being the first Americans in space. Devised by three "aeromedical consultants" on loan from the military, it sought college educated men between the ages of 25 and 40, who were less than six feet tall. Applicants also needed to have professional experience or an advanced degree in engineering, physics, math, biology, psychology, or medicine. Or they could hail from a hazardous profession or sport, with test-pilot, balloonist, submariner, polar explorer, parachutist, SCUBA diver, mountaineer, and aeromedical test-subject all listed.[7] A thin slice of elite American men to be sure, but still more diverse a vision than the actual eventual outcome. This call for "Research-Astronaut Candidates" was rescinded almost immediately in December 1958 when President Eisenhower backed an alternate proposal from administrators to limit their search to active-duty military test-pilots with degrees in engineering. But this short-lived plan is one place in official NASA documentation where this more complex history of astronaut formation in military space medicine bleeds through.[8] Rather than freewheeling ideas that needed to be reined in, this unused set of

[6] Peter Galison. "The Ontology of the Enemy" in *Critical Inquiry* (Autumn, 1994) pp. 228-266.
[7] Loyd S. Swenson, Jr.; James M. Grimwood; Charles C. Alexander. *This New Ocean: A History of Project Mercury* (NASA SP-4201, 1966) pp. 129.
[8] Another is a speech made by NASA's first administrator T. Keith Glennan in January 1959, heralding important figures in space medicine: "I simply note what is perhaps the most difficult of our problem areas — our understanding of the capabilities of man himself in this new and exciting adventure. Others who are expert in this field have discussed the questions in detail earlier today. Dr. Randolph Lovelace, Brigadier General Don Flickinger, and Dr. Hubertus Strughold — the illustrious "Father of Space Medicine," who has … defined many of the

qualifications gestures back to a set of non-test-pilot subjects studied in early military space medicine. These included the non-flying airmen, mountaineers, high-altitude Indigenous people, non-human primates, and women pilots central to this study. Although many were still excluded by these requirements, the document's existence prompts the animating question: what do these non-test-pilot subjects from space medicine tell us about the earliest visions of the astronaut? And, what in turn can this tell us about post-war American science, technology, medicine and society?

Based on archival research in USAF, NASA, and NARA archives, this project has examined four revealing episodes in military space medicine between 1949 and 1960: a young airman's week-long ordeal playing the role of astronaut in the first Space Cabin Simulator; a mountain-based study of high-altitude Indigenous people for astronaut acclimatization; the post-flight lives of monkeys Able and Baker, America's first celebrity space animals; and the Lovelace Woman in Space Program, a comparative study of women pilots for space fitness. Rather than historical dead-ends, these older, unfamiliar test-subjects offer glimpses of astronauts-in-the-making. In addition to highlighting different types of subjects serving as physiological and psychological models for the astronaut, each case focuses on the emergence of constitutive practices in space medicine—simulation, experimentation, public relations, and scientific representation—demonstrative of ways a new type of person is constructed. Together, these case studies make three main claims about the astronaut. The first is that the astronaut emerged in the aftermath of the Second World War and developed in concert with the Cold War itself for a full decade before NASA began operations. The second is that the astronaut was a military creation, adopted for use in NASA's civilian program. The third is that the astronaut at the center of this early Cold War military research was not solely determined by the requirements of spacecraft control and environmental systems, but also by cultural ideas about bodies, minds, and technology in post-war American society. Analysis of these military space medicine experts, their practices, and their non-test-pilot research subjects highlight four themes fundamental to the construction and current conception of the American astronaut: *surveillance*, while in space astronauts are subject to close medical and electronic monitoring by ground controllers and have a low-degree of autonomy; *hostile environments*, ideas about who should be an astronaut emerged enmeshed with

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physiological and psychological conditions that will be faced by the early pioneers in space flight." T. Keith Glennan. "A National Program for Space Research" Remarks delivered to Honors Night Dinner, Institute of the Aeronautical Sciences. January 27, 1959. NASA History Office, Folder: "T. Keith Glennan". pp. 10

a view of space as an antagonistic "proxy enemy", similar to the Arctic and high mountain summits; *biological appropriation*, military space medicine experts looked to the bodies of high-altitude Indigenous people and women pilots for physiological efficiencies, and often endeavored to replicate these in the bodies of white, male pilots; and *masculinity*, space medicine's masculine epistemology and historic focus on male subjects created male-normal medical standard that reinforce the masculine archetype of the astronaut, and manly culture of spaceflight.

Histories of the astronaut that begin in 1957 with Sputnik, and then chronicle the organization of NASA, the initiation of Project Mercury, the selection of test-pilots, and the events of the Space Race reinforce the image of the astronaut as a peaceful, civilian figure.[9] In biographies of individual astronauts, hero-worship and mythologizing deflects and discourages deep critical engagement with NASA's human-focused work. Together, these trends have directed attention away from this crucial earlier moment when astronauts were not selected but *made*. Without dismissing the central role test-pilots eventually played in developing the astronaut at NASA, this project extends the historiography to this prior decade of military research, and this understudied set of actors. It also expands the historical analysis of the few existing histories of space medicine, which have been mostly progress narratives celebrating scientists, experiments, and administrative milestones. The preceding chapters focus on social and cultural dimensions of this work to demonstrate how space medicine produced a new type of person reflective of certain values and anxieties that NASA later adopted, adapted, or altered beginning in 1958. But more than just extensions or shapers of national identity or culture, astronauts came to embody politics inherent in the various strands of science, technology, and medicine that linked up in early space medicine.

Within the longer histories of science, technology, and medicine, the astronaut appeared at an interdisciplinary nexus within a new type of large-scale government-funded military research and development project. Historians of science, technology, and medicine have explored how moments of change or rupture in particular fields have brought new types of people into existence.[10] The case of space medicine and the early astronaut shows how human-focused

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[9] Colin Burgess. *Selecting the Mercury Seven: The Search for America's First Astronauts* (Springer, 2011); For how NASA "disguised" the military status of space-race astronauts, see: Maura Phillips Mackowski. *Testing the Limits: Aviation Medicine and the Origins of Manned Spaceflight* (College Station, TX: Texas A&M University Press, 2006) pp. 226.

[10] Daston and Galison. *Objectivity* pp. 38; Chihyung Jeon. "The Virtual Flier: The Link Trainer, Flight Simulation, and Pilot Identity. *Technology and Culture*, 56. No. 1, 2015. pp. 28-50.; Annemarie Mol. *The Body Multiple: Ontology in Medical Practice.* (Durham: Duke University, 2002)

research and development played out in the context of Cold War Big Science. One facet in an enormous undertaking, space medicine was responsible for delivering the "human component" into a larger technical project: a complex spacecraft secured atop an intercontinental ballistic missile and connected to a globally-scaled network of communication and control infrastructure. In the history of technology, the astronaut is a bench-mark for the tight-coupling and near-total integration of humans and machines. Midcentury historians of technology including Lewis Mumford examined the astronaut in the context of utopian and dystopian visions of technology, but these contrast sharply with more nuanced and focused analyses given to other twentieth-century technical workers by Gabrielle Hecht and Edward Jones-Imhotep.[11] Viewed within the longer histories of science and medicine, space medicine can be seen as both part of the "biomedical" turn in the immediate post-war era, and as part of the emerging subfield of environmental medicine which sought to guarantee human survival in a range of inhospitable areas suddenly of urgent strategic importance in the Cold War.[12] Biomedicine, the melding of biological research and medical practice, originated in the Manhattan Project to counter the deleterious physiological effects of atomic attack and its aftermath. But in space operations (conceived early on as a method for detecting or deploying nuclear attacks) the biomedical approach produced a new type of idealized person. Not an injured or sick disaster victim in need of lifesaving aid, but someone doctors could certify would stay strong and healthy enough to function indefinitely in "hostile" places like the polar regions, deep seas, nuclear wastelands, and space.

Astronauts are products of the cultures that produce them. Beyond the purely technical problem of "Who can survive a spaceflight?", work on the astronaut posed a more fundamental but unspoken question about Americans: "Who should fight the Cold War?" Constructing the "right" type of person who could be trusted to operate an expensive, complex machine on a risky mission through an unknown extreme environment, both reinforced and challenged existing American virtues of autonomy and masculinity. New emerging virtues of passive vigilance, and total dependence on automatic systems and artificial environments were at odds with the central tenant of American cultural identity: liberty. But emerging during the early Cold War, astronauts

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[11] Lewis Mumford. *The Myth of the Machine: The Pentagon Of Power* (Harcourt Brace, 1970); Gabrielle Hecht. *The Radiance of France: Nuclear Power and National Identity after World War II* (Cambridge MA: The MIT Press, 1998); Edward Jones-Imhotep. "Maintaining Humans" in *Cold War Social Science: Knowledge Production, Liberal Democracy, and Human Nature* (Palgrave-Macmillan, 2012).

[12] Peter Keating, and Alberto Cambrosio. *Biomedical Platforms: Realigning the Normal and the Pathological in Late Twentieth-Century Medicine*. (Cambridge MA: The MIT Press, 2003). pp. 53-55.

also embodied separate sets of ideas about technology, the environment, the body, the mind, and humanity's future.[13] The challenge is to see them in this way, rather than as simply as "the best" a nation has to offer as determined by experts. This view expands the "societal impact" model popular in aerospace histories to also account for the social shaping of the astronaut by science, technology, and medicine.[14] It also adds to histories of space medicine that focus on this pre-NASA period, but avoid discussing social and political aspects. This project also contributes to growing scholarship in Cold War history and American Studies focused on the interrelationships between bodies, technologies, and the nation in the mid-to-late twentieth century.[15] It shows how post-war particularities of race, sex, and gender were inseparable from concerns about technology and extreme environments. Relocating the history of space medicine and the astronaut within post-war American history, the early Cold War, and the social shaping of science, technology, and medicine—rather than the Space Race—reveals the astronaut to be more than simply a hero of the Space Race, but one of the crucial products of the Cold War military-industrial-academic-complex.

The four episodes here also point to how early visions of the astronaut interacted with post-war utopian and dystopian musings about technology and society. Unsurprisingly, pensive space medicine experts saw themselves as managing the beginning of an epochal biological transformation enabled by technology. Many compared humans entering space to "the moment life transferred from the ocean onto land", placing themselves at the center of grand evolutionary progress narratives. Paul Campbell's 1965 book *Earthman, Spaceman, Universal Man?* is a prime example of this utopian philosophizing.[16] Outside observers, however, painted a bleaker picture of space medicine and the astronaut in critiques of technology's encroachment on autonomy and identity. Historian of technology Lewis Mumford worried that spaceflight might be a preview of

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[13] Matthew Farish. "Frontier Engineering: From the Globe to the Body in the Cold War Arctic" in *The Canadian Geographer*, 50 (No. 2, 2006) pp. 190. Farish makes a similar observation about the militarized Arctic body.

[14] See the NASA History series Historical Studies in the Societal Impact of Spaceflight beginning with: Steven J. Dick; Roger D. Launius (Eds.). *Societal Impact of Spaceflight* (NASA History Series, SP-4801, 2007). Some historians of technology, including Glen Asner, have already highlighted the limitations of this approach. See: Jordan Bimm. "Historical Studies in the Societal Impact of Spaceflight ed. by Steven J. Dick (review)." *Technology and Culture,* 59 (No. 1, 2018) pp. 183-185.

[15] David Serlin. *Replaceable You: Engineering the Body in Postwar America* (Chicago: University of Chicago Press, 2004)

[16] Paul Campbell. *Earthman, Spaceman, Universal Man* (New York: Pageant Press, 1965). More recently, this utopian vision has been synthesized into the so-called "overview effect". Frank White. *The Overview Effect: Space Exploration and Human Evolution* (American Institute of Aeronautics and Astronautics Inc, 1998)

a dystopian technocratic future with human life totally regimented by machines.[17] Space medicine expert Toby Freedman and science writer Thomas B. Allen were among those predicting space medicine would go beyond sealed cabins and space suits to alter the human body itself through implanted technologies, environmental conditioning, and selective reproduction. They openly debated the ethics of "improving" bodies and minds for space, advocating instead for the preservation of "natural man", while wondering how much humans could be changed before becoming something else.[18] In 1965, philosopher Hannah Arendt offered perhaps the bleakest take of all: spaceflight would lead to a Faustian bargain where the steep cost of leaving Earth would be our very humanity itself.[19] So far, histories of space medicine and the astronaut have avoided engaging with these dystopian themes.

Like de Monchaux's story about seeing through the silvery space-age exterior of a spacesuit, this study has looked beyond the "right stuff" space-race mythos cloaking NASA's Mercury Seven to apprehend the astronaut itself as an older Cold War military creation. Demilitarizing the astronaut is only possible if the full extent of its militarization is appreciated in the first place. Galison has shown how artifacts and figures forged in antagonistic circumstances retain limiting aspects when transferred to other peaceful and utopian domains. As is the case for both Galison's cyborg, and the early astronaut studied here, the effect of military shaping becomes much more insidious if this origin is obscured. Demilitarizing the astronaut requires challenging the enduring gendered and racialized vision of the white, male pilot, at its origin. Even before airmen and aviators were recruited for the first astronaut positions, the person-type itself was developed as a military concern inseparable from Cold War politics. The result of this is that space medicine and subsequent expert determinations of who can access space remain conservative and elitist. This project, however, appears at a crucial moment in space history, when control of large aerospace projects is shifting from government-funded agencies like NASA to corporate public-private partnerships like SpaceX and Blue Origin. Accompanying this reconfiguration of management, policy, technology, and overall goals, is also a revaluation of the human. Exploring the early work of military doctors and scientists with a set of unfamiliar experimental subjects parses the iridescent and hybrid nature of this important figure at a crucial moment of flux when

[17] Lewis Mumford. *The Myth of the Machine: The Pentagon Of Power* (Harcourt Brace, 1970)
[18] Thomas B. Allen. "The Quest for Optiman" in *The Quest: A Report on Extraterrestrial Life* (Philadelphia: Chilton Company, 1965).
[19] Hannah Arendt. "The Conquest of Space and the Stature of Man" in *The New Atlantis*, 1965. pp. 55

change is more possible than at any point since the founding of NASA. Seeing the astronaut in this new light is a critical step in questioning and reshaping space medicine, the figure of the astronaut, and access to space. Recognizing the astronaut as a historical product of the Cold War is a necessary first step if we are to extend human diversity as it exists on Earth, as well as the principle of equality, out into the cosmos.

Beyond the body, the mind, and the spacecraft environment, early space medicine experts were also very interested in where their military astronaut would end up going. Far from the current state of space exploration—with international crews occupying one modest science-focused station in low Earth orbit—early astronauts were assumed to be part of a vast and vigorous program of exploration and colonization carried out by the military in competition with their Soviet adversaries. In the 1950s, the Air Force had detailed plans to construct permanently-staffed bases on the Moon and Mars, and space medicine experts studied the biological prospects of different planetary bodies in support of these.[20] At the beginning of the Space Race, President Kennedy framed space for Americans as "this new ocean" and "a new frontier". These potent allusions to American history also conjure military figures—sailors and soldiers—animated by military goals, namely colonization. Right from the start, antagonism, domination, and colonialism have shaped human interactions with space, and the understandings we glean from these pursuits. With national space agencies and private corporations promising to send astronauts to the Moon and Mars in the near-future, humans are poised to continue extending more than just colonial metaphors into space. Remembering the military origin of the astronaut prompts an uncomfortable but necessary reevaluation of practices, goals, and ideology in spaceflight, as well as what we have learned through space ventures about the universe, about life, and about ourselves.

[20] See USAF's Lunar Expedition ("Lunex") plan, compiled in 1961. Online: http://www.astronautix.com/data/lunex.pdf

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