Why NASA Developed a Cookbook
James Edward Malin
MA/MSLIS Food Studies and Library and Information Science
New York University

Abstract

In 2010, the 111th Congress and President Obama both published long term goals for the National Aeronautics and Space Administration (NASA). Both included a long term mission for manned space flights to Mars in the 2030s. Since that time NASA has shifted the majority of its efforts toward that target. Research on the International Space Station (ISS), for example, has focused on subjects like the long term impacts of microgravity environments. On earth NASA has focused its efforts toward a similar goal. Several projects through the Human Research Program have endeavored to research factors such as human health countermeasures, exploration medical capability, and human factors and behavioral performance in analog environments, simulating how explorers will inhabit and exist on the surface of Mars. One such project, the Hawai'i Space Exploration Analog and Simulation (HI-SEAS), began its first mission in 2013, sending six crew members to live in a 1,200 square foot dome for four months in the barren volcanic ash fields of Mauna Loa.

HI-SEAS' first campaign's objective was to research the nutritional and psychosocial issues of a proposed Mars food system. This study helped show that cooking and eating will be an important activity for Mars astronauts for physical and psychological health by improving appetites, building community relationships, and maintaining morale. The HI-SEAS team maintained a blog and youtube channel, documenting their lives and scientific pursuits. Much of this content recorded information about cooking and eating on the station, including a video series entitled Meals for Mars, a makeshift cooking show about producing meals with freeze dried and shelf stable ingredients. These psychosocial and nutritional results make an interesting comparison to the theoretical work completed at the Johnson Space Center in the previous decade.

In my presentation I will use NASA's digital Technical Reports Server to look at documents from the Human Research Program in conjunction with the HI-SEAS blog and video archives. By using these materials as primary source documents, I will show how the development of food science in human spaceflight has shifted from theoretical nutrition to a more humanistic model, incorporating personal insights on the comforts of earth.

keywords: space food, Mars food, HI-SEAS, food studies, food preferences

Introduction

On Monday, April 15, 2013, six specially selected scientific researchers, donning full space suits, stepped through an airlock at eighty two hundred feet above the ocean. This team would spend the next one hundred and twenty days in a twelve hundred square foot, semi-portable habitat, with little connection to the earth they knew, and the people they loved. They were the first Americans to live on Mars...or as close to Mars as people could get to in 2013: Mauna Loa, Hawai'i. This was the beginning of the first *Hawai'i Space Exploration Analog and Simulation* (or HI-SEAS) Mission I.

Funded by NASA and implemented by the University of Hawai'i, HI-SEAS is a station designed to simulate a Mars-like environment. As Reagan, Janoiko, and Johnson (2012) show, HI-SEAS is one of several analog studies that NASA regularly funds, hoping to aid their *Human Research Program* (HRP) in studying human health in small, closed systems, much like those that astronauts will inhabit on their way to and from, and upon Mars. For decades NASA has studied long duration human spaceflight but the topic gained momentum in 2010, when the 111th Congress and President Obama both released long term goals for manned space flights to Mars in the 2030s. HI-SEAS Mission I was the fulfillment of a 2011 grant to Dr. Jean Hunter of Cornell's Department of Biological and Environmental Engineering, and Michele H. Perchonok, Advanced Food System lead at NASA's Johnson Space Center.

HI-SEAS Mission I was developed to solve a problem that had long plagued NASA; astronauts in space tend to not eat. Douglas, Cooper, Bermudez-Aguirre, Sirmons, and Perchonok (2016, p. 14) show the longevity of this problem: from its beginnings in the short duration Mercury and Gemini missions of the early 1960s, the medium duration Apollo missions

of the late 1960s and 1970s, and through the 2010s. All the while NASA has been conducting experiments about appetite loss due to several factors including stress, preoccupation, and even something called Space Adaptation Syndrome (Perchonok and Bourland, 2002). But the answer seems to lay beyond the placid experimentation, data points, and rigorous scientific study: no matter the effort, relative to terrestrial gastronomies, space food is kind of gross. This utterance, quiet in the scientific evidence, is thunderous throughout archival records, in astronaut diaries, memoirs, histories, and reports. This project will show how the scientifically anecdotal but archival evidence of HI-SEAS Mission I has driven NASA to incorporate a more terrestrial gastronomy (including cooking) into future Mars missions, to improve health and nutrition whilst boosting morale. I will show how this archival evidence differs from but complements scientific results and ensuing protocols. I will also discuss the history of inadequate space food systems, and identify how NASA's priorities have changed to allow archival evidence to drive scientific studies.

Mission to Mars: The Human Research Program Roadmap

Developing a multiple decades long plan for a massive and original undertaking like traveling to Mars, necessitates serious planning. The *Human Research Roadmap* (HRR) is the faceted and hierarchical architecture that identifies each human factor that must be studied in preparation for Mars. Studies are solicited from an *Integrated Research Plan*, which is split into large *elements*, more acute *risks*, and further acute *gaps* of understanding. HI-SEAS and Dr. Jean Hunter's "Effects of retronasal smelling, variety and choice on appetite and satiety" aims to, as is stated in the HRR (NASA, 2015) reduce the "risk of adverse cognitive or behavioral conditions

and psychiatric disorders” and the “risk of performance decrement and crew illness due to an inadequate food system.”¹ This care for morale and mental health is a more recent administrative objective. NASA’s interest in such risks show undercurrents of a new wave of relatable, outreaching, and “human-centered design” in human space travel (Habitat Standing Review Panel, 2016). Whereas a food and nutrition technical report from as recent as 2006 (NASA, 2006) solely tabulated payload mass and macronutrient intake, a report from 2016 declares that “the food system is one of the most significant daily factors that can be altered to improve human health, and performance during space exploration,” (Douglas, et. al. 2016). The HRP’s paradigmatic shift toward what their Habitat Standing Review Panel (2016) calls *Livability, Well-being, and Performance*, is centered around “focusing on the [entire] deep space habitat rather than specific elements.” Directing scientific study toward human living systems instead of compressed biological subjects, forces STEM research to necessarily look into humanistic and cultural parts of life.

Space Food History

To contextualize HI-SEAS Mission I will begin by discussing perhaps the first space food experiment; *Project Manhigh*. Similar to NASA, space food research originates in the military. Four years before Soviet cosmonaut Yuri Gagarin became the first human in space, the United States Air Force’s Project Manhigh sent three crafts just under the barrier of the Earth’s atmosphere via hot air balloon. In *Manhigh II*, David Simons, a military doctor, spent forty hours

¹ Respectively, Hunter’s study is meant to fill the gaps that “we need to identify and quantify the key threats to and promoters of mission relevant behavioral health and performance during autonomous, long duration and/or long distance exploration missions,” and that “we need to determine how the sensory and psychosocial acceptability of the food system changes due to microgravity, processing, storage, choice, and eating environment” (NASA, 2015).

in a bullet shaped metal capsule, suspended one hundred thousand feet above the earth's surface. According to Simons (1957) After being hermetically sealed, he enjoyed a tranquil trip to the launch site accompanied by a cheeseburger "in a paper box which smelled slightly of the oils of a short-order kitchen" (p. 119). But during the distracting beauty and stress of flight, Simons barely consumed any food at all. Colonel John Stapp, the mission's flight surgeon, was forced to regularly shake Simons to remind him to eat. The first time this happened eight hours into flight, Simons (1960) remarked "I'm almost ashamed to tell you, Colonel Stapp. I've been so darned fascinated all day that I didn't recognize it myself until you just mentioned it. I haven't eaten anything since we got into the pit this morning" (p. 149). Simons reached into his food pack, pulled out a chocolate bar and reflected that "somehow the thought of food had never crossed my mind."

A parallel scene occurred in the thirteenth hour as well, when Simons remarked on his exhaustion. Stapp suggested Simons ensure he keep his blood sugar up, to which Simons "smiled. Once again I had forgotten food completely...I had no interest in opening the flight rations for a full meal. So I munched two of the candy bars" (p. 159). Only when Simons neared touchdown, after hours of eluding a towering thundercloud, did he allow himself a full meal. He "gulped cold ham and eggs and savored the canned peaches of [his] breakfast. It was relaxing and satisfying" (p. 173). Although one might attribute Simons' initial failure to eat to stress induced anorexia (Marriott, 1995), a satiety problem studied in combat situations since World War II, Simons' choice to eat candy bars over his *in-flight feeding no. 8* ration can more likely be correlated to its agreeability. This matter is far more distinctive in Project ManHigh III, conducted the following year.

Manhigh's dietician, Beatrice Finkelstein determined that food choices needed not only to be "adequate in quantity, variety, and acceptability," but also stored in containers easily disposed (Air Force Missile Development Center, 1961, p. 214-215). Unfortunately, as Simons explains, the solution she decided on of "collapsible tubes [of] thoroughly creamed food" did not much improve the appetite of test pilot Lieutenant Clifton McClure (Simons, 1960, p.229). Eight hours into the mission Simons, now flight surgeon, reminded McClure to eat. However, McClure, who disliked the unfamiliar food tubes, expressed that Simons "tell the dietician that the prospects of a tooth-paste-tube lunch are not too thrilling" (p. 229). However he relented, realizing his last meal of steak and potatoes had been nearly fifteen hours previous, and "consumed a tube of chicken, a can of juice and two cookies."

Simons and McClure's textured and specific reflection on their relationship with the Manhigh food system starkly contrasts with the project's results, for which, the nutrition report (AFMDC, 1961) contains inventories, timelines, tables of macronutrients, and Finkelstein's *low residue diet*--the preparatory plan that omitted the balloonists' need for a toilet, and which would later become standard prelaunch practice at NASA. Interestingly, in a section on an earlier preparatory isolation experiment, Finkelstein does note that she might capitalize on "the emotional and social role of food in situations of stress," (p. 215) but does not expound. Instead Finkelstein's final conclusions are simply that the "organized feeding program, both prior to and during flight, should be mandatory" (p. 218). It would take researchers nearly half a century to become interested in food as a terrestrial comfort.

Now we are going to skip ahead to the present. Space food history is really fun and there are a lot of little pieces and parts that are wonderful to discuss, but, although it has changed much

since 1958, NASA's priorities that resulted in the HI-SEAS study did not change until recently. The *International Space Station* (ISS) has greatly improved the space food system in a number of ways. In the first place, the ubiquity of practicing Hazard Analysis and Critical Control Points (HACCP) in the American industrial food system (a system originally developed by NASA during Gemini) has allowed for Natural Form Foods in its supply. As Bourland (2010) explains, Astronauts can enjoy familiar packaged products, such as "nuts, granola bars, M&Ms, and cookies," (p. 9) in their diet. Furthermore article 19 of *the ISS Intergovernmental Agreement* (1998) stipulates that although each country's space program owns its own piece of the ISS, all parties "shall transfer all technical data and goods considered to be necessary" (article 19). This has, as Vickie Kloeris, ISS Food Systems Manager has described, permuted into a system in which each agency provides food for its own astronauts, but that "it is up to the crew on the orbit to decide how they share the food and how often they share the food," (NASA Johnson, 2014). Today, therefore, the astronauts enjoy a gastronomy as varied as the partnership itself. In a single day, astronauts on the ISS might enjoy Japanese sushi, American candy, and European chicken turmeric with champignon mushrooms and peas (European Space Agency, 2015). Certainly space food systems have come a long way. However, still, after up to a year in space, astronauts lament the lack of fresh foods, lack of diversion and hot temperatures of cooking, and several other homelike comforts. It is these obstacles that NASA must tackle to prepare for a potentially multi-year duration trip to Mars.

Cooking Unexpected Results: Team bonding and diversion

Dr. Hunter's study was designed to quantify and compare several physiological aspects of two comparable populations. She recorded data on nasal patency, odorant identification, meal acceptability, and daily mood and health in HI-SEAS astronauts, and a simultaneous bed-rest study. These factors respectively try to identify if clogged noses, menu fatigue, or mood contribute to astronaut loss of appetite. Another aspect of the HI-SEAS study, however, had the crew eat "meals of two different types: meals containing only prepackaged, shelf-stable foods including instant backpacking foods and commercial packaged foods...and meals prepared by the crew from a pantry of shelf-stable ingredients" (Life Sciences Data Archive, 2018). Although Dr. Hunter's full report is forthcoming, preliminary results are available which show that "some subjects demonstrated significant menu fatigue coupled with diminished ratings of intensity, pleasantness, and 'interest in eating' for odors sourced from the [prepackaged] facility meals." Additionally, when asked about what lessons she learned from Mission I, Dr. Hunter stated in a 2013 interview (Saulnier, 2013) that "the crew was wildly enthusiastic about doing their own cooking. Part of it was that they liked their cooking better than backpacking foods, but I think they also appreciated the opportunity to be creative and do something for each other. Cooking and sharing food is a part of human culture [and] that's difficult to maintain when your food comes out of bags or cans, and all you do is mix it with water." This can be seen in archival content in the HI-SEAS team blog and youtube channel. Much of this content recorded information about cooking and eating on the station, including a cookbook, blog posts, and a video series entitled Meals for Mars--a cooking show about producing meals with the freeze dried and shelf stable ingredients in the HI-SEAS pantry.

It is evident from these personal records that cooking and eating home made meals were boons to the HI-SEAS crew. Sian Proctor, the crew's education outreach officer writes in one blog post "I finally got a chance to cook with Oleg. It was Yajaira's birthday giving us the perfect opportunity to celebrate with a cake...Oleg is known in the hab as the bread guy. He makes some amazing breads and Russian dishes so I was really excited to get baking with him. We had a great time...In the end, both we and the crew loved it!" (Proctor, 2013). Another crewmember (actually from Mission II) identified his favorite part of the hab as "the breadmaker... because the breads that it produces is insanely good. They fill the entire hab with the smell of freshly cooked bread and when they come out they're hot and ready to eat" (HISEAS Media, 2014). From these archival accounts we see that the social, entertaining, and comforting aspects of a homemade meal are highly important to the crew's livability and wellbeing.

Conclusion

In both theory and practice the first HI-SEAS mission has shown an elision of a new wave of relatable, outreaching, and "human-centered design" in NASA science. It is a stark contrast to the food cubes and toothpaste-tubes developed from calorie-in-calorie-out theoretical work completed at the NASA up until the most recent decade. As ISS astronaut Don Pettit describes (NASA Johnson, 2015) contrasting a device of his own invention--a microgravity drinking cup--to sucking beverages through the standard ISS retort package, "if you have a real cup, an open container, it's so ingrained in human beings--it's so ingrained in culture--it adds back the dimension of what it's like to be a human being in a civilized way." NASA's interest in

civilizing spaceflight for crew morale has elided scientific inquiry and humanities study, and when STEM subjects are humanized, STEM archives and archival materials prove to drive science forward.

Reference List

Air Force Missile Development Center. (1961). *Manhigh III: USAF Manned Balloon Flight Into the Stratosphere*.

Bourland, C. T. (Charles T., & Vogt, G. (2010). *The astronaut's cookbook : tales, recipes, and more*. New York: Springer.

Douglas, G. L., Cooper, M., Bermudez-Aguirre, D., Sirmons, T., & Perchonok, M. (2016). *Risk of Performance Decrement and Crew Illness Due to an Inadequate Food System*.

Retrieved from

<https://humanresearchroadmap.nasa.gov/evidence/reports/AFT.pdf?rnd=0.166503558944214>

European Space Agency, E. (2015). Cooking in space: whole red rice and turmeric chicken.

Retrieved from <https://www.youtube.com/watch?v=4exaXdPKS3Y>

Habitat Standing Review Panel. (2016). *Research Plan Review for: Deep Space Habitat: Habitability, Well-being, and Performance, Final Report*. Retrieved from

[https://humanresearchroadmap.nasa.gov/reviews/Deep Space Habitat-Livability, Wellbeing, Performance_ SRP Review \(2016\).pdf](https://humanresearchroadmap.nasa.gov/reviews/Deep%20Space%20Habitat-Livability,Wellbeing,Performance_SRP_Review%20(2016).pdf)

HISEAS Media. (2014). HI-SEAS Food. Retrieved from

<https://www.youtube.com/watch?v=hOI4xFDGzjY&t=24s&list=PLoeySDA57w5aoFar1LlCkbG3hcv5BfpFv&index=12>

Hunter, J., Halpern, B., Binsted, K., & Caldwell, B. (2014). Effects of retronasal smelling, variety and choice on appetite and satiety. Retrieved September 30, 2017, from

https://www.nssc.nasa.gov/web/guest/grantstatus?p_auth=9msf5eLv&p_p_id=GrantStatusForm_WAR_GrantStatusportlet&p_p_lifecycle=1&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1&_GrantStatusForm_WAR_GrantStatusportlet_javax.portlet.action=s

Life Sciences Data Archive, & Hunter, J. (2018). Effects of Retronasal Smelling, Variety and Choice on Appetite and Satiety (NNX11AE53G). Retrieved April 3, 2018, from <https://lsda.jsc.nasa.gov/Experiment/exper/1792#data>

National Aeronautics and Space Administration. (2006). *Evaluation of a 10-Day Menu Using a Bulk Commodity Supply Scenario Habitability and Environmental Factors Division Revision : Basic JSC 63366 Verify that this is the correct version before use .*

National Aeronautics and Space Administration. (2015). Human Research Roadmap. Retrieved April 1, 2018, from <https://humanresearchroadmap.nasa.gov/explore/>

NASA Johnson. (2014). Space Station Live: Thanksgiving Feast on Orbit. Retrieved April 1, 2018, from <https://www.youtube.com/watch?v=SA-lxPubG8k&t=189s>

Perchonok, M., & Bourland, C. (2002). NASA FOOD SYSTEMS AND ASTRONAUT EATING HABITS NASA Food Systems : Past , Present , and Future, *9007*(2), 913–920.

Proctor, S. (2013). HI-SEAS – Recipe Contest: Dark Matter Cake. Retrieved April 2, 2018, from <https://hi-seas.org/?p=1804>

Reagan, M., Janoiko, B., Johnson, J., Chappell, Ph.D., S., & Abercromby, A. (2012).

NASA's Analog Missions: Driving Exploration Through Innovative Testing. *AIAA*

SPACE 2012 Conference & Exposition, (September), 1–18.

<https://doi.org/10.2514/6.2012-5238>

Saulnier, B. B. (2013). Mission : Menu Under the Dome The view from inside. Retrieved January 4, 2018, from <http://cornellalumnimagazine.com/mission-menu/>

Simons, D. G. (1957, September). A Journey No Man Had Taken. *Life*, 1, 19–27.

Simons, D. G. (1960). *Man High*. Garden City N.Y.: Doubleday.

United States Department of State. (1998). Agreement among the Government of Canada , Governments of Member States of the European Space Agency , the Government of Japan , the Government of the Russian Federation , and the Government of the United States of America Concerning Cooperation on the Ci. Retrieved from <https://www.state.gov/documents/organization/107683.pdf>