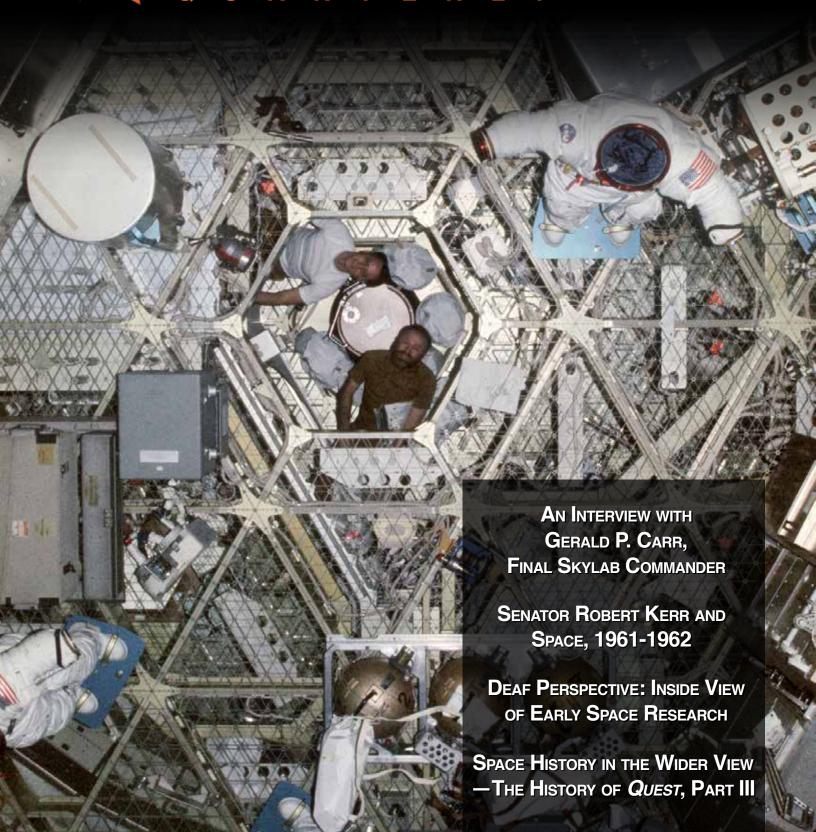


2018 - Volume 25 - No. 1 spacehistory101.com



### THE HISTORY OF SPACEFLIGHT Q U A R T E R L Y





# **Contents**

#### **Volume 25 • Number 1 2018**

www.spacehistory101.com

#### QUEST AT 25

3 Space History in the Wider View: The History of Quest, Part III

By David Christopher Arnold

9 Why I Fell in Love with Quest: The Publisher's Perspective

By Scott Sacknoff

#### **FEATURES**

12 Deaf Perspective: Inside View of Early Space Research

By Jean Lindquist Bergey

29 Snapshot of a Shifting Senate: Senator Robert Kerr and Space, 1961-1962

By Wendy N. Whitman Cobb

#### **ORAL HISTORY**

41 An Interview with Gerald P. Carr, Final Skylab Commander

Interview by Kevin M. Rusnak

#### **BOOK REVIEWS**

64 The New Gold Rush: The Riches of Space Beckons!

Book by Joseph Pelton Review by Scott Sacknoff

65 Breaking the Chains of Gravity: The Story of Spaceflight before NASA

Book by Amy Shira Teitel Review by Paul E. Ceruzzi

66 Spaceflight in the Shuttle Era and Beyond: Redefining Humanity's Purpose in Space

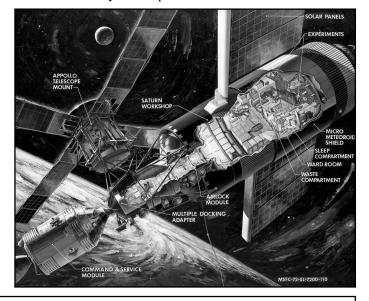
Book by Valerie Neal Review by John Sislin

67 Satellite: Innovation in Orbit

Book by Doug Millard Review by Scott Sacknoff

68 The Canadian Space Program: From Black Brant to the International Space Station

Book by Andrew B. Godefroy Review by Christopher Gainor



#### **FRONT COVER CAPTION**

Photograph taken from the hatch into the airlock module looking the length of the Skylab Orbital Workshop. Gibson and Carr look up the passageway with trash bags around them.

Credit: NASA

#### ISSN 1065-7738

The editorial office of Quest: The History of Spaceflight Quarterly (ISSN 1065-7738) is located at the ISBC, 6615 Hillandale Road, Chevy Chase, MD 20815-6424. E-mail quest@spacehistory101.com for information regarding submission of articles or letters to the editor.

Quest is published quarterly, four times per year by the International Space Business Council LLC, 6615 Hillandale Road, Chevy Chase, MD 20815-6424 USA. Periodical postage paid at Bethesda, Maryland, and additional offices.

Postmaster: Send all inquiries, letters, and changes of address to Quest: The History of Spaceflight Quarterly, P.O. Box 5752, Bethesda, MD 20824-5752 USA.

©2018 International Space Business Council LLC, All Rights Reserved. Reproduction in whole or in part without permission is prohibited. Printed in the United States of America.

# Dea

## **Deaf Perspective: Inside View of Early Space Research**

By Jean Lindquist Bergey

In the mid-1950s the United States Naval School of Aviation Medicine (NSAM) in Pensacola, Florida, conducted tests on motion sickness with at least two deaf people, Pauline (Polly) Hicks and (Bob) Greenmun. Robert Information on Hicks' time as a test subject is scant, but Greenmun remained involved in studies on motion sickness, equilibrium, and weightlessness for more than a decade. In the 1960s, 11 more deaf people signed on to serve as test subjects in studies for which they were uniquely qualified.

Greenmun provided a record of this research through vivid letters about his experience. As a deaf person, calling home to tell his family what he experienced was not an option. Communication at that time had to be in writing. Through descriptive correspondence Greenmun painted an insider's picture of early studies on the physical effects of space travel from the perspective of a human test sub-Greenmun's letters, photographs, and movies have been donated to Gallaudet University for exhibition use by the Drs. John S. and Betty J. Schuchman Deaf Documentary Center and preservation in Gallaudet University's Deaf Collections and Archives.

Greenmun (1913-1970) became deaf at the age of 12.<sup>1</sup> Graduating from Gallaudet College (now University) in 1936, he went on to teach at the Ohio School for the Deaf in Columbus, the New York

School for the Deaf in Rome, and the Florida School for the Deaf in St. Augustine. A prolific letter writer, Greenmun performed extensive duties as secretary-treasurer for the National Association of the Deaf for 18 years.<sup>2</sup>

Directing the motion sickness research was Captain Ashton Graybiel, MC, USN, (1902-1995), a noted cardiologist who led studies for the NSAM and the National Aeronautics and Administration (NASA) on how spaceflight impacts the human body. From 1936 to 1943, Graybiel worked at Harvard University's Fatigue Laboratory developing methods for measuring cardiovascular performance. His coauthored "Electrocardiography Practice" served as a text for medical students and doctors from the 1940s to the 1960s. He authored or coauthored hundreds of publications.<sup>3</sup> The Ashton Graybiel Spatial Orientation Laboratory at Brandeis University in Waltham, Massachusetts, is named in his honor.

Preventing motion sickness that could threaten spaceflight became an area of study that brought Graybiel into contact with Greenmun. Graybiel described the research as "designed to demonstrate difference between persons with and without organs of equilibrium." It is exactly the lack of functioning organs of equilibrium—the semicircular canals and the otolith organs—that made Greenmun so valuable to the studies. He could endure tests that made most subjects

sick.

Visual, vestibular, and somatosensory systems impact spatial disorientation and motion sickness. What we see, combined with how our inner ear organs interpret motion, equilibrium, and spatial orientation, along with what is sensed in terms of pressure, pain, or warmth/cold throughout the body (as opposed to a specific organ) all are connected to motion sickness. A Naval Aerospace Medical Research Laboratory report explained:

"The vestibular system is the only sensory system devoted exclusively to the detection of acceleration. Secondary information is supplied by vision and somatosensory information from skin, muscle, and joint. The pivotal role played by the vestibular system is evidenced by the absolute immunity to motion sickness in individuals with nonfunctioning vestibular end organs. All other individuals are susceptible to motion sickness."5

Greenmun had this "absolute immunity" and participated in extensive studies on motion sickness and how it could physically and cognitively impact astronauts during space travel.

What follows are text selections from Greenmun's and Graybiel's letters. Each section addresses a new topic, study, or issue. Text, taken mostly from typed letters, is chronological within each topic. Brackets indicate a note for clarity.

#### The Slow Rotation Room (SRR)

On 27 July 1959, Greenmun wrote to Polly Hicks, and copied the letter to his family. He describes a Slow Rotation Room (SRR) that could turn at constant velocities of up to 20 RPM.

\* \* \*

Dear Pol, Since you are the original Pensacola Guinea Pig, and are no doubt biting your nails with impatience to know whatall is going on up here that they didn't let you in on, I am addressing this to you...This will be mostly concerned with your ex-job as [at] a Naval Experimental Station...I'll tell you how I'm going to be a Navy Big Wheel...

There is a working model of the HDD [Human Disorientation Device—test equipment that can simultaneously tip riders vertically and horizontally] in the hall by Capt. Graybiel's office, and it is an awesome thing.

Now for the wheel. Remember the human centrifuge? It's been modified, and how! They've built a roughly circular room on the center of the platform... full of more gadgets than I can possibly enumerate in this letter... That room is to be my home away from home for some time to come, sometimes for two or three days at a time. They are still fixing up the hydraulic and electronic controls, so I don't think that we will begin wheeling in earnest for some days yet, but we had a trial run this morning, and started learning the various routine we will undergo this afternoon.

I don't get the complete pic-

ture, but I think it has to do with physical control under conditions of constant rotation. The centrifuge rotates rather slowly but fast enough to keep you a bit unsteady on your feet. Captain Graybiel told me that it made most people quite uncomfortable, but that he didn't think it would bother me.

Well, while we were in the room, Dr. Brant Clark, who is running this project, locked us in! Captain Graybiel told me that while it was rotating we should seek support when moving about. At the time he was sitting down holding an overhead crossbar and gritting his teeth for dear life, and looking very uncomfortable, and it suddenly dawned on me that we had been in motion even while he was talking. Darned if we hadn't! I never even realized it, and had been walking all over the room inspecting it.

I'll try to describe the room, but I lack Polly's gift for making the humdrum exciting, and the painful experiences gleeful episodes so enjoyable that everyone who hears about them is wild to have his eyeballs stitched or his insides swirled around, or to stand on his head and whistle Yankee Doodle. As I said, it is full of gadgets. One is a seat with hydraulic controls—you lie flat and suddenly it lifts you into a sitting position. Another is a dart board complete with darts. There are ten tennis balls and a waste basket to throw them into. There are ten heavy padlocks. There is a pack of cards. There is a gadget to test your steadiness of hand. There is a floor to stand on, with both feet, or with



Robert Greenmun in a centrifuge chair.

Photo courtesy of James Greenmun.

either foot and your eyes closed. There is a tiny sink. There is a place where you can go when you have to go. There is an intercom, dials, lights, fuse boxes, various controls that looks like something out of Rube Goldberg.

\* \* :

Greenmun mentioned the "stitching of eyeballs" in a few letters. While a complete picture of the procedure is unclear, it seems that threads attached to the eyes enabled researchers to more closely watch for any nystagmus or movement of the eyes during tests of motion.

In nine paragraphs of description Greenmun detailed tests conducted in the Slow Rotation Room. The first is the "old standby" balance exam where "I go down like tenpins..." Second is a card game. Third is combination padlocks "very complicated and there are ten

of them.... It takes brute force to open the thing... Remember you are a little unsteady on your feet, and a tiny slip and you have to start it all over again." Fourth is a steadiness test involving "a series of 10 holes, the largest hole an inch across and the smallest about the size of the lead in a lead pencil. 15 seconds for each hole. You try to hold the stylus in it without touching the edge. Every time you touch it is counted by a mechanical counter." Fifth is a dart board where you "see how high a score you can make with five darts. Trouble is that while you rotate the board moves around to where it wasn't when you tossed the darts. Good practice for trapshooting, or for golfing on a very windy day." Sixth is basketball toss across room— "same comment as for dart game." Seventh is walking, "Take five steps, toe to heel, from outer perimeter to center of room. Repeat, from center to outer perimeter. Time and steadiness count." Eighth is more walking but taking normal strides along the side of the room and back. The ninth test involved dials. "You set them in order, from one to five, each one with a different number that is given orally, and you have four seconds per dial. In my case they give me a card and I memorize the sequence of numbers. And boy, you ought to see the contortions that little game puts you into."

There are a couple of other test[s] that we haven't tried yet, but the idea seems to be to familiarize us with them until we can do them all quickly before they start rotating us. It is going to get darned monotonous, believe you me. When they start to rotate us, they will

lock us in. I gained the idea that there will be about four of us, and that we will give the tests to each other, or that I will be in charge of giving the test myself to different subjects. They will keep us locked in for various lengths of time. Probably a few hours at first, but Dr. Graybiel told me this morning they will go for as long as two days or more at a time. So, if you don't hear from me in what may seem reasonable lengths of time, just reconcile yourself to the fact that those who go around in circles are called big wheels, and that I have become a big wheel in Uncle Sammy's Navy.

\* \* \*

The next day, 28 July 1959, Greenmun wrote:

I understand there will be four of us. Two are regular subjects. I am the "control"—I don't have trouble with getting dizzy or motion sickness. The fourth will be a medical officer. We will give the test to each other, and it is my impression that in further experiments with different subjects I will be along for the ride and to administer tests.

Spent this morning and again this afternoon running the tests over and over. I don't know if you understood the dial test. The five dials must be set to certain numbers in a regular sequence, and to reach each dial you have to really strain. The idea is that moving one's head up and down or from side to side while undergoing rotation is to most people uncomfortable, leads to vertigo and

various illusions. This test is actually given from the outside, and the dials we have set have their counterpart in the control room of the centrifuge. You have to stretch for each one of them – back to the left, forward to the right, down to the left, directly overhead, and twist around so you can see the one that is directly behind the seat. Their position makes it necessary to really contort your head and neck muscles. It is a real strain, and they take your blood pressure after every five series. They follow that up with a steadiness test.

...Dr. Graybiel was in for awhile. Funny what appeal our projects always have for the Director of Research, when there are so many other vital projects going on, and he is one of the leading world authorities on space medicine and cardiology. And what a good, considerate, and thoughtful man to work with. All of us love him.

\* \* \*

On Sunday, 2 August 1959 Greenmun wrote home detailing his first run in the SRR, complete with description of the repeated dexterity, cognitive, strength, blood and heart tests that filled each day, as well as meals and sleeping arrangements.

Our tests usually consumed all of the morning, and until about 4:30 in the afternoon, so there wasn't much time to get bored. The evenings went quite quickly, too. We were in bed by 10:00 the first night, and before 9:00 the second. We slept on foam rubber pallets on the floor. Had sheets, pillows

and pillow cases, and two Navy blankets apiece. The pallets were only 5 feet long, so we had our choice of having our heads or our feet hang over the edge. Not too comfortable, but we all slept quite well. There was room for only 3 pallets, but one of us was supposed to be on watch at all times, so only 3 could sleep at once, so that was all right. I didn't have to stand watch. They had to report to the control room via the intercom, so that left me out. However, I usually got up during the night and sat and smoked for awhile with whomever was on watch.

...We gave the tests to each other, with the exception of the dial test which, as I have noted, was given from "outside". When I took it, the numbers to which I was to set the dials were given to me on a card, for example 9-2-7-4-3, and Lt. Nelmley [Medical Officer who stayed in the room] would tap

me on the knee with a pencil for the start, and for each four second interval, as succeeding numbers were read over the intercom.

...Well folks, the first stage of this project is over. We will just have to wait until Tuesday to see what comes next. If you don't hear from me for some time to come, you will know I've gone off on another trip somewhere.

Love to all, Pop

\* \* \*

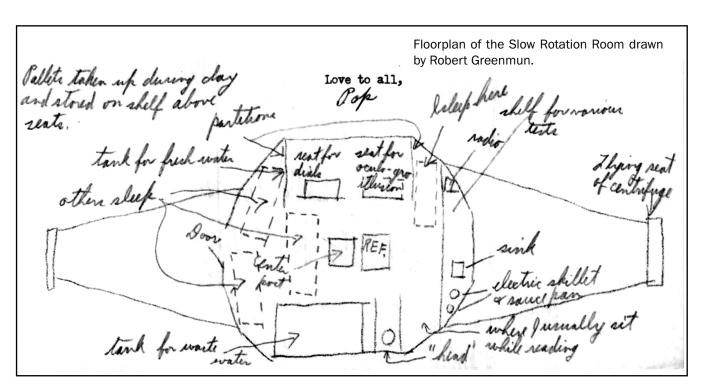
In a 6 August letter Greenmun described his post-SRR run hours as drowsy with a headache that kept him in his hotel room for most of a day. Two days later he was back in the SRR. This run added a new "oculo-gyro" rotation of the eyeball test involving opening padlocks at high speed which tore the skin off his palm resulting in a 20-pound loss in grip strength. While administering electrocardiograms one of the new test subjects referred to him

as "Doctor Greenmun" about which he commented "Far be it from me to disillusion the young." The routine was similar to previous runs, with the added padlock task.

On 12 August 1959, Greenmun referenced another person, Virginia Ates, who was "one of our Pensacola gang of guinea pigs" though it is not clear if she participated in any studies or was simply considered a potential deaf test subject. In the letter Greenmun lists the RPM of the runs in the SRR:

We made two runs at 2.4 rpm, two at 3.8, two at 5.4, and one at 10.0. I made all except the second 5.4 run. There were 25 persons concerned with each run—engineers, flight surgeons, subjects, observers, supply men, etc. etc., and the schedule as originally laid out was rigidly adhered to.

There is literally never a dull moment out there at the base, and while you may imagine this sort of thing might get



pretty monotonous, I did not find it so. I was continually in competition with myself and the others trying to better previous scores on the tests, and those tests really kept us busy throughout the day.

\* \* \*

Writing home on 16 August 1959, Greenmun described another multi-day SRR run:

#### Dear folks:

This last run was really something!...Last Thursday we started off at 5.4. I did not know the speed had been stepped up, and I was rather amused at what I took to be exaggerated efforts on the part of the others to compensate for the centrifugal force—until I stood up and started walking myself. Then I realized that we were really going faster.

As always, first order of the day was taking the electro-cardiograms. Then the others took the test for oculo-gyro illusion. I haven't described this test before. Pol [Polly Hicks] will remember that we had it in the Link Trainer—there is a box mounted at an angle with little holes bored around all of the edges that can be seen from where you are sitting. In total darkness it seems to zoom off in various directions as your state is changed from static to rapid rotation, or when you are quickly accelerated and decelerated. As this test is given in total darkness, and reactions reported over the intercom to the control room, there was no point in having me take it. We have two auto seats mounted on an 18" high platform. Underneath is the tank for our water—we have an electronic pump to draw it up to the tap at the sink. The left hand seat is the one from which we manipulate the dials. The right one is for the oculo-gyro illusion test. It has an arrangement so that it can be raised from prone to erect almost instantly by means of compressed air. In front of it is a mirror, which reflects the box described above, and the subject watches it in the mirror as he is shot into an upright position, and describes over the intercom what he thinks he sees.

Well, before we started that one, Endicott and Every [Naval personnel] were already making use of the wax-lined paper bags that we use for motion sickness. The poor guys could hardly drag themselves around. Price (the medical officer) was feeling pretty miserable, too, and kept his head stiffly erect, not venturing to turn it. By the time that test

was over Every's and Endicott's bags were rapidly filling up, and Price, while he kept the contents of his stomach intact, was looking pretty green around the gills. We started on the Romberg test, the one where you stand on both feet, then one foot, with the eyes closed. Every made it, but Endicott just gave up, and collapsed on the floor. Dr. Clark, over the intercom, cancelled all of the morning's tests except the dials, and ordered a rest period. Endicott and Every promptly went to sleep. Price found a place as close as he could to the center pole, where you do not feel the centrifugal force so much, and settled down with a magazine. Me? I was having a ball! Felt perfectly normal and, after the first 15 minutes didn't even feel the rotation and moved around as easily as on any of the previous runs.

\* \* \*

Greenmun's last Slow Rotation Room run began on 20 August 1959:

#### Dear folks:

We start the last run tomorrow, and it should be a humdinger! We are going to spin at a merry 10 rpm. They have selected the three toughest...and warned me that I'll probably have to play nursemaid to them.

Have been having fun reading the outside log. As I told you we keep an inside log, but it is very incomplete. There is someone in the control room all the time, and nothing is done inside that is not reported over the intercom. They know what we are doing every moment of the waking hours, and it is all written down in the book. It was very interesting to follow the reactions of the group that finished their 5.4 rpm run today. Their motion sickness did not come on as quickly as that of those in our group under the same speed of rotation, but by noon all of them were pretty sick. Most of them were over it by the time we opened the room this morning, but Nelms was still pretty miserable. Some of the comment over the intercom was amusing. One fellow said that all he wanted was to "get out of here." Going back to past runs I found Price had commented "Greenmun is happy because the rest of us are sick," and the "three healthy ones are all sick, but Greenmun is feeling fine." Now I ask you, was that a compliment or an insult?

\* \* \*

Upon completion of the run, on 22 August 1959 Greenmun wrote:

This run was really a lulu. As usual, I was unable to perceive when rotation began, or when maximum speed was reached. Don't seem to feel the centrifugal force at all sitting down. But boy! After we were off and I started moving around— WOW! We had to keep our bodies at the angle of 30 degrees from the vertical when we were near the walls of the room, and it was quite a trick to walk from one side to the other, with varying strength of the centrifugal force all the way across—leaning one way when you started and the other way when you got there. Walking toe to toe from the door to the center post was like walking up a steep hill—we actually had to crouch. And pacing along the side of the room was almost impossible for all of us at first. Going across from left to right we started at the wall and were about 4 feet way from it in the middle of our promenade, and then approached it again at the end, and when we tried to stop we were literally flung against the wall. It took much longer than usual to adapt ourselves. And you should see those tennis balls curve! When I made a lucky toss and one landed in the basket, it would spin in circles around the side until it finally got to the bottom.

...When we cooked, we had to lay the handle of the frying pan down on the counter and prop up the far side so that it made an angle of approximately 35 degrees from the horizontal. Had to do the same with the saucepan. And we could fill our sink only half-full—water almost to the bottom at front and to the top at the rear. Jars of fruit juice slid out of the refrigerator whenever we opened the door.

...I only took the electrocardiograms—I didn't interpret them, but I am sure that there was considerable strain on the hearts of both [test subjects] Every and Price—could tell by the unusual gyrations of the needle that traced their heart action. Funny about these runs is how sleepy it seems to make everyone—except myself.

...At 8:00 we gave our morning report over the intercom, and then the various tests of equilibrium that they always ask for the first thing—standing against the door and observing any illusions—such as the floor slanting up or down, lack of solidity in the center post when the head is moved up and down or from side to side, etc. etc. Then the dial

test. I found during my days as an outside observer that the dial test is given by means of a sound tape. So, too are the two-minute intervals for the 30 minute math test. When we had completed the entire series, we stopped abruptly, all of us sitting braced, and the others observing the lighted box of the oculo-gyro test. I don't take this one because it requires oral response to specific questions in total darkness. Then we had to sit immovable after the lights came on and the doctors came in to examine each one of us. As the "control" I'm always the last one to be examined. The examination consists mainly of questions concerning the experience, variation in feeling during rotation and after stopping, reactions at the moment of stopping, and then the Romberg and the walking test. Of course I can feel an abrupt stop, but I never feel anything "different" until I stand up and try to walk. Then, as far as I am concerned, the room is still going around, and it is some time before I can get off my sea legs. The others, of course, have the same trouble, and I have the chance to watch them all take their first stumbling steps. There are always plenty of people at hand to catch them when they stagger badly enough to endanger themselves.

\* \* \*

In November 1959 Associated Press xcience writer Frank Carey described the small, 15 ft. diameter, 10 ft. high Slow Rotation Room with padded walls as "a one-room house on a kind of turnstile. It looks as innocent as a merry-go-round at the county fair, but it packs a sickening wallop." Describing the response of test subjects Carey wrote,

"Coming back to a stationary floor after two days of motion, all but one of the men acted as though they had been on a drinking spree. After welcoming them back from space, scientists put them through a series of body-balancing tests, including standing on one foot. By far the steadiest member of the crew was Robert Greenmun, 45, of St. Augustine, Fla., a civilian, who is deaf. The reason for his steadiness, scientists explained, is that his particular type of deafness is due to loss of function of the inner ear. That is, his semi-circular canals and also his otolith organs do not function; hence he is comparatively immune to the dizziness and other effects of prolonged rotation."

#### **Surgery**

Becoming deaf as a youth from mastoiditis, an infection of the ear, Greenmun's sense of motion was diminished. As a young man, he had undergone two ear surgeries. In 1958 Greenmun offered to undergo additional surgery to remove his otolith organs to ensure that he had no labyrinthine-based input. Graybiel wrote in response to his offer:

\* \* \*

8 May 1959

Dear Mr. Greenmun: Someday I hope it will be possible for everyone to know both the nature and extent of your willingness to cooperate with us in carrying out what we consider to be a very important research project.

I have heard from Dr. Lindsay in Chicago, who is President of the Otological Association, and he feels it would be all right for us to go ahead and carry out the operation. I have placed all of this in the hands of Dr. Dominey and I will let you know the minute he has reached a decision in the matter.

Ashton Graybiel, Captain, MC, USN

\* \* \*

Reviews and delays ensued:16 June 1959

Dear Mr. Greenmun: We still wish to carry out the operation on your middle ear, but must test you out in very thorough fashion on all of our new gadgets before this is done. Unfortunately, the new device is still not operational, and it may be sometime before we can get the necessary test completed. If we can do it toward the end of the summer, well and good. If not, we will have to wait until your next vacation time.

Ashton Graybiel, Captain, MC, USN

\* \* \*

On 29 July 1959 while Greenmun was in Pensacola for Slow Rotation Room tests, a doctor cleaned and irrigated his ears with ice water, a test used to expose those trying to avoid the military draft by claiming to be deaf. Jets of ice water in the ears causes the eyes to move rapidly; this nystagmus does not occur in people who became deaf from infections that damage the inner ear. Greenmun described the procedure:

Capt. Graybiel wanted me to go over to the hospital to see Dr. King, their new ear surgeon...He gave my ears the most thorough cleaning they have had in years, and I knew in a moment that he is tops as an ear specialist, for he is the only doctor who has ever done that job without hurting me...After cleaning me out I had the ice water test again. Only one who has taken it knows what torture that is. Then it was the old routine of stand on both feet, then try to stand on one foot with the eyes closed something that is impossible for me. I don't know what the decision was, but you know that Capt. Graybiel wants an operation on my left ear to destroy the function of the oto-lith organs in that ear, and the results of that operation will answer a lot of questions having to do with balance, equilibrium, and vertigo for which there is no answer now.

\* \* \*

On 22 August 1959 Greenmun further described the surgery:

I don't believe I told you that last Wednesday I saw Dr. King again, and he had several other doctors in to observe me. Gave me the ice-water treatment again—longer and much less funnier than usual, this time with me reclining and with some bulbous spectacles on my eyes so that they could observe the motion and/or contraction of the eyeballs. It has been definitely decided that they are going to operate. I think that you understand that the reason a select few deaf subjects are being used here is because they are rara avis [rare birds]—they lack the oto-lith function of the middle ear, a function that is very important in balance and equilibrium. They have examined hundreds of possible subjects, and only a handful of us qualify. I am a bit unusual in that I have a remnant of the oto-lith function. In some ways I am a very unsatisfactory subject, in that my reactions seem to run the entire gamut between normal function and no function, and as a result experiments with me have cast doubts on the validity of all known tests for that function. So they are going to do just about everything that they can think of with me first-make sure that I have had all of the tests they now have or can dream up in the future, and then they are going to operate to destroy what little function there remains in my left ear, and then go through all of the tests again. It is not a particularly pleasant prospect—the operation will be much like a radical mastoidectomy with the attendant pain and risk, but under the circumstances and because the results of that operation will be so valuable to research and a real contribution to knowledge... it would be very wrong of me to shirk what I feel is a real responsibility.

\* \* \*

By 21 May 1962 the legal assistant to the General Council questioned whether the Office of the Secretary of the Navy had the authority to approve surgery on a civilian. Greenmun inquired about being inducted into the Naval Reserve and Graybiel wrote to say he would explore the possibility, but that there was little likelihood of approval.

Yet on 9 September 1962, in a long letter home after weeks in Pensacola, Greenmun told family that the surgery was yet planned.

As I understand it, if arrangements carry through, I will come to Pensacola at the close of school at Christmas time and enter the hospital here for the operation, which will be performed on both ears at the same time.

The four-year discussion on surgery seemed to come to an end in October 1962.

Dear Mr. Greenmun,

The Navy has turned us down in our request to carry out the contemplated surgery. As you may well guess, I am bitterly disappointed because it constitutes a significant set-back in our attempts to completely unravel the role of the vestibular organs. ... Please accept my very sincere and deep appreciation for your willingness to go through with the operation, even though we were prevented from consummating it.

Ashton Graybiel

\* \* \*

On 4 November Greenmun offered to undergo the surgery on his own. On 8 November 1962 Graybiel wrote on the subject one last time:

Dear Mr. Greenmun:

Thank you very much for your letter of November 4. Although I think the risk of any com-

plication is extremely small, I would not like to see you go out and have the operation on your own...

We already know that you have lost the semicircular canals, and we also think that you have lost probably all the otolith organs as well. In other words, we think that you already have been labyrinthectomized as a result of the operations you had many years ago. The reason we wanted the operation is to make dead sure everything was gone.

Ashton Graybiel

\* \* :

The offer and exploration of the never-performed surgery shows the extent to which Greenmun was willing to sacrifice in order to become an even better test subject. Surgery would remove not only his otolith organs, but also any doubt about the research data.

#### **Human Disorientation Device (HDD)**

While on summer break from his job at the Florida School for the Deaf and Blind in St. Augustine, Greenmun returned to Pensacola in 1960 to take part in studies involving the Human Disorientation Device (HDD), a research tool for studying effects of angular acceleration. The device is a seated cylindrical cab that can move simultaneously on a horizontal or vertical axis. It replicates angular accelerations such as a spinning satellite. A press release for the 15th Annual Instrumentation Conference and Exhibit in New York, New York describes the purpose of the HDD. "Research studies now under way are evaluating the responses of normal persons and those of persons who have lost their organs of equilibrium by disease or injury. Such studies will aid in assessing the importance of these organs to man's ability to orient himself in space."7 Greenmun explained that "it is the one device the doctors refuse to test personally, although they have tried out everything else we have. Dr. Ades has had his hearing permanently impaired by participation in some of the acoustic tests that we went through in the past."8

\* \* \*

On 14 July 1960 Greenmun described HDD tests for his family:

I worked most of the day in the H-D-D. So far I haven't had a head over heels ride. They've been oscillating me, that is, spinning me first one way

and then the other, in total darkness. Actually I enjoy it. Sitting strapped in that chair it is much like rocking back and forth. As they accelerate in one direction the seat seems to tip slowly forward, and then as they decelerate it seems to tip back, then they reverse direction and I rock forward again. Actually I can't tell when it starts or stops, or in which direction it is turning—just feel a gentle rocking motion. On Tuesday we worked with "after images" induced by firing a flash bulb in my eyes through a circular mask. The after image was like a doughnut and I was supposed to report on its apparent motion.

...Dr. Niven wired me with a half dozen electrodes around the eyes which were supposed to transmit eye motions to a graph. Started spinning me at 11:00, worked for an hour with faulty connections, then Dr. Niven went out for hot dogs and coffee. The electrodes are all attached to short wires with plugs in the ends to be inserted in matching plugs around my headpiece in the HDD, and I sat around at lunch time trying to keep the wires from getting tangled in my hot dogs and coffee.

They have a lot of really crazy ideas they want to try out, including one that may include Polly, and sooner than she expects...Should be fun! Dr. Niven, of course, wanted to know all about the Hicks, and I told him Polly thought the people at NAS [Naval Aviation Schools] didn't like her any more, or perhaps that she had been such a big baby when they stitched her eyeballs that they were afraid to give her another try. Capt. G and Dr. N fairly bristled at the idea. Dr. Niven wrote out emphatically "NOT TRUE!!!"

Well, they are full of plans for me, but most of the plans are as yet very indefinite. All I know is that I've been the subject of numerous conferences, and that I am a badly needed "control."

Love to everybody, Bob

\* \* \*

One of the first to ride the HDD, Greenmun also assisted Dr. Niven in developing procedures and troubleshooting problems. It took two weeks to discover that Greenmun's "self-winding" watch caused erratic performance of the recorder. The HDD was also affected by a nearby ejection seat trainer.

#### **Elevator Rides in the Empire State Building**

In a letter dated 7 August, without a year but probably 1960, Greenmun described a trip with Polly Hicks to New York City for tests in the elevator of the Empire State Building. A DC 4 Navy aircraft flew them from Pensacola to Floyd Bennett Field on Barren Island, Brooklyn, New York. Along the way "Polly and I had the run of the plane, and spent quite a bit of time both ways riding up front in the cockpit with the pilots." After a few hours of subway rides, seeing the sites, and eating sandwiches at the 47th Street Automat, they arrived at the Empire State Building. Greenmun recalled the experience in a letter to his wife:

Dear Roe,

They had one of the express elevators reserved for us, with an operator, and from 8:00 until 2:00 a.m. we took turns riding between the first and the 80th floor [hand written in the margins of the page is "In total darkness"]. I won't try to tell you what we were doing, because I don't really know, but it was much the same as we have been doing in the HDD—observing after-images induced by flash bulbs set off from behind a screen with a thin one inch ring through which the flash was visible, and which left a very strong after-image, purplish in color, of a ring.

You girls did a good job of scaring Polly about those elevators, but actually after we had been riding awhile neither of us could tell whether we were going up or down. After the first trip Polly decided there was nothing to it, and there really wasn't.

#### **Expanding the Pool of Test Subjects**

In 1961 Graybiel brought a team of researchers to Gallaudet College to test more than 100 men who had become deaf from spinal meningitis, selecting 10 new test subjects to join Robert Greenmun. They became known as the "Labyrinthine Defectives" or "LDs" because their inner ear physiology made it possible to endure tests of extreme motion. Together the 11 names are listed on charts such as "Clinical Findings in Eleven Deaf Persons with Bilateral Labyrinthine Defects."

In 1965, one additional Gallaudet student, James Bischer, participated in centrifuge tests. Every test subject has a unique perspective on the experiments and their personal contributions to spaceflight history.

In various combinations, the Gallaudet test subjects participated in zero gravity flights, a multiday run in a 20-foot diameter rotating room, centrifuge spins,

Gallaudet students, faculty, and staff selected in 1961 as test subjects:
Harold Domich, class of 1940
Barron Gulak, class of 1962
Raymond Harper, class of 1964
Jerald Jordan, class of 1948
Harry Larson, class of 1961
David Myers, class of 1961
Donald Peterson, graduate degree, 1953
Raymond Piper, class of 1962
Alvin Steele, class of 1963

John Zakutney, class of 1964

balance tests, tilting, swinging and rotating studies, and an adventure on choppy North Atlantic seas. Greenmun often had a role in communicating with his fellow deaf test subjects and also in documenting results of the experiments. On weightlessness and aerobatic flights he had the responsibility of tabulating and graphing results from oculogravic illusion and eye counterrolling experiments. In August 1963 researcher Dr. Brant Clark relayed data collection instructions for flights conducted at Wright Patterson Air Force Base near Dayton, Ohio. Each sheet of data noting horizontal and tilted lines of perceived horizon was to be given to Greenmun, who then tabulated and made computations at various degrees. Dr. Clark added, "Mr. Greenmun knows what to do. He will make individual and group curves for all the data...There will be two group curves: normal and L-D."9

\* \* \*

Tests of balance varied. In August 1962 Greenmun describes a new challenge:

He [unnamed doctor] and Capt. Graybiel have worked out a devilish new test which was the first one they gave me. They have a series of rails set off from the floor about two inches, seven in all. The first one is about 3" wide and the sizes diminish down to 1/2". We start at the first one, and try to walk its length heel to toe—three tries on that, then on to the next one, ending up with the half-incher. I could get about four steps on the first one, but couldn't even get my feet together on the last. After three tries at walking we then have three tries standing for one minute heel to toe on each rail

with eyes open, then three tries on each rail with eyes closed. I couldn't even get my feet together on the last three with my eyes open. So closing them was a nobile [sic] but futile experiment. Anyhow, I tried.

Then came some tomfoolery at trying to draw lines at various angles from a point marked in the center of a sheet of paper, first with the eyes open and then with adhesive patches over the eyes. They would position your hands on the paper and on the pencil that was stuck in the dot in the center, tap you a certain number of times on either the right or the left shoulder to indicate the number of degrees (one tap for 10, 2 taps for 20, etc. up to 90) and you were supposed to draw a straight line with the pencil that number of degrees from vertical.

Then to the tilt room to be strapped in with a shoulder harness in a new version of the tilt chair. First I had to set an artificial horizon while being tilted at various degrees up to 90. Was supposed to set the horizon to a horizontal position with the floor, no matter how much I was out of the horizontal. Could feel all my insides swing back and forth. This was done with a patch over the left eye and I was supposed to keep the right eye closed until a buzzer sounded. While my eyes were closed they would move the horizon off the horizontal for about five times while I remained in the same position, and at the signal I had to open my eyes and reset it. Then they would move me to another angle and do the same thing over again.

...After lunch it was back to the tilt room, with both eyes taped, and then he would tap me a number of times on either shoulder to indicate the number of degrees he wanted me to tilt the chair to the left or the right, and I would repeat after him ("left, 60 degrees") for example, then work the controls that turned the seat until I thought I was at the right angle, and then yell "mark."

\* \* \*

With Gallaudet test subjects along for research runs, Greenmun had people with whom he could sign, making communication an easy two-way exchange. Together they enjoyed numerous weightlessness flights and a few boat rides. They also endured time in the tilt chair.

\* \* \*

#### Dear folks:

This morning I was wheeling away off in the wild blue yonder in a Navy dive bomber. Yes, we finally had that long delayed flight! Believe me, it was worth waiting for, yet I couldn't help marveling to myself, "What silly capers for a grandpa." The plane has two seats in the pilot's compartment, and two more seats facing each other under the rear canopy—the observer sits facing forward and the subject (me) facing backward.

Did all of the stunts that were on our sequence—and more. Those dive bombers can not only go straight down—they can climb straight up, and it was a queer sensation looking straight down at the tail when we were in an almost vertical climb. We did everything—loops, tight turns, dives, barrel rolls, aileron rolls, victory rolls. Even experienced momentary moments of zero G. The only discomfort was in the pullouts after steep dives when we experienced from 4 to 6 G—not enough even for a brownout, but if you tried to lift your arms they weighed a ton.

The view was beautiful. We flew mostly along the coast from Pensacola Bay to Mobile Bay. Santa Rosa Island from the air is a sight to behold! It is even more interesting when it is over and under and all around you, as is the case when you are making a loop or a roll or a tight turn.

Imagine getting paid for such a ride!

...The only new thing this week was also the most uncomfortable. We were tightly strapped into airplane seats, the first day on the tilt chair and the second day in the centrifuge. They really pack us in. But the innovation this time was a dental tray filled with soft sealing wax (hot) that we had to clamp our teeth into. A peg extended out in front of the tray and this was solidly clamped into the seat apparatus. The idea was to hold the head immobile. They also had a head band, also full of hot sealing wax, that was drawn tight and allowed to cool. They put drops in our eyes to contract the pupils to little more than tiny dark specks, set up a camera a foot from that eye, put a patch on the other, and had a flash gun with a shield that was about a half inch from the eye being photographed, through which the flash really concentrated itself. They would take pictures by remote control at various degrees of tilt and at various degrees of acceleration and rotation. We would get a signal when they were ready to take the picture and were supposed to pull the cheek down under the eye, signal back that we were ready, and then would come the flash. We'd signal back whether we thought the picture would be satisfactory or not, and then they would change position or speed and take another. They'd use up a 36 exposure roll of film, stop, and as soon as they changed the roll, start up again, for a total of 72 pictures each run.

Once in the tilt chair, I swallowed the wrong way and nearly choked to death! The tears would run either down my cheek or down my nose depending on which way I was tilting or whirling, and would tickle like the very dickens, and there was absolutely nothing that I could do about it but groan and bear it. Days like that I can do without.

On Wednesday finally got our boat ride. They took us out in a 63 foot aircraft rescue boat, but kept us below decks from the time we left until just before we started back. We were in a little cabin and there wasn't any air circulation. It was a HOT day, and the sun beat down on the deck just over our heads. We went out slow into the Gulf, and then just maintained steerage [to] let the boat rock and roll. The "normal" subjects, all Navy Ensigns, couldn't take much of that and one by one they went topside via the head. None of the deaf subjects were affected. Finally after one and a half hours in that black hole we were allowed to go on deck. Stayed out for another hour just enjoying the breeze and then went back in-fast. Those boats are very stable when underway, and the trip back was exhilarating.

On Friday we were scheduled to have four hours of "physiological training" for the dive bomber and weightless flights. Instead we had about 45 minutes practice in getting into and out of [a] parachute harness. Rather a waste of time, inasmuch as they had a man at the plane who strapped us in and showed us how to bail out if necessary.

Tomorrow morning we are off in a shiny new four motored prop transport for Toronto. Will be there until Thursday afternoon.

...The following week we ride a plane they are bringing down from Wright Patterson AFB for some experiments in weightlessness. They can achieve about 14 seconds of zero G each time they go over the hump, and during that time they will take photos of eye movements. I hope there are no

more dental trays. My jaw is battered and bruised, and I can eat only with difficulty.

\* \* \*

A week later, 24 August 1962, Greenmun reports on rides in the infamous "vomit comet":

Dear folks:

This was THE DAY! The thrill that comes once in a lifetime to only a few. If some one had offered me \$1,000 spot cash this morning to take my place before our flight I would have turned it down. ...Today all six of us deaf subjects went aboard a two motored (but what huge motors!) air force plane. It is something like a Convair, and is designated USAF C-131. However this particular plane has been specially built and reinforced, and is probably the only one of its kind in existence. The forward end is jampacked with electronic equipment, and the rear half is a padded tunnel with a thick foam rubber floor. We were thoroughly briefed by the Captain on bail out procedures, and wore parachute harness throughout the flight. The plane has three large emergency exists on each side. It is a big plane to stand the stress, repeated many times, of the type of flight it makes, and losing a wing is not at all beyond the realm of the possible.

...When we were up to 12,000 ft. we had our first ballistic trajectory experience. The plane dives under full power (and what power) in a 10 degree dive to about 10,000 ft. There is a 2 ½ G pullout (sometimes more) and a climb at a 35 degree angle until we are tangent to the ballistic trajectory, which is a rather flat parabola, and then for 15 seconds we experience zero G.

...Each time we climbed to 12,000 feet we would go over the trajectory twice, ending up at about 8,000, and then climb up again to repeat. Three of us alternated, and each group of 3 thus had four chances to swim around in the air for 15 seconds each time...It takes almost no force at all to spin like a ball, to cavort around upside down with your feet on the ceiling, to make like a fish or a bird...I wish very much that I had taken my movie camera... After we all had our fun, we landed, much to my own regret. I wanted more, and more, and more.

\* \* \*

Greenmun went on to recount a trip to Toronto



Robert Greenmun preparing to be tipped and rotated. The mouthpiece is to hold his head steady.

Photo courtesy of James Greenmun.

with

tests that again made none of the deaf participants sick. The most eventful part was spending time up front with the pilots each direction, with a 20 minute

ride in the pilot's seat and quite a bit of ribbing for appearing to be piloting when he was just admiring the view.

By 9 September 1962 Greenmun wrote to say that this round of experiments was over and he would soon be home. The final week involved taking ipecac which in heavy doses made all hearing test subjects and most of the deaf participants vomit. Centrifuge spins and boat rides could not alone produce the response of the ipecac. He also described the "coffin" test where test subjects drank vodka and orange juice before climbing into a suspended cage shaped something like a coffin to swing. The test attempted to determine their degree of alcoholic nystagmus.

\* \* \*

Summing up his time and studies Greenmun shared:

All this may sound frivolous, but don't for a moment doubt its' importance. One of the great mysteries is the source of motion sickness...What this proved was that motion sickness does not originate in the stomach...The causes of motion sick-

ness lie in the labyrinths of the ear and in the otolith organs, but just how this occurs and how to prevent it have been the subjects of a tremendous amount of research and millions of dollars. All of my work here for the past eight years has centered about this. Some of the answers are in sight.

... It was only three years ago that I was working over some tapes taken from the recorders in the HDD and a group of men came in and each took a brief ride in the HDD. Dr. Niven told me they were the Astronauts, and the term meant little or nothing to me—I never dreamed that anyone would actually go off in a rocket. Who knows but what in a year or two Capt. Graybiel will have a laboratory in space and I'll be there with him. This is a strange and wonderful world in which we live.

This letter puts Greenmun's start time as a test subject for the US Navy at 1954. That is the same year the Greenmun family moved to Florida and for a time stayed with Polly Hicks and her husband. It is also three years prior to the Soviet Union launch of *Sputnik 1*, the first artificial Earth satellite.

#### **North Atlantic Seas and the Miguelon**

An attempt to study residual effects of extreme motion and "bizarre stimulation" brought ten of the deaf test subjects to the North Atlantic seas. In 1964 they flew to North Sydney, Nova Scotia, and took the ferry Miquelon to the French Overseas Collectivity of Saint Pierre and Miquelon. After staying for a few days in Saint Pierre, they returned on an overnight trip.

\* \* \*

On 13 January 1964, Dr. Ashton Graybiel wrote:

Dear Mr. Greenmun

At last our plans have "jelled" for an experiment on sea sickness. I am hoping you will be able to participate, partly because we need your services and partly because it will be nice to have a little adventure together. ... The purpose of the trip, of course, is to find out if under the prevailing weather conditions you manifest any symptoms of sea sickness. To this end we will make a series of tests and observations similar to what we have done in the past; questionnaires to fill out, tests for steadiness and ataxia both before, during, and after the sea voyages, and collection of urine and blood for analysis.

Ashton Graybiel

National Geographic magazine mentioned on the trip in the September 1967 issue, "One of the researchers telephoned John Brennan, agent for the Miquelon ferry ship. 'We're studying motion sickness,' he said, 'and the Miquelon is reported to be the rollingest ship on the roughest water in the North Atlantic." Seas became so rough and the Miquelon rocked so violently that the doctors on board even though "thoroughly saturated with sea sickness drugs" could not conduct some of the tests. Deaf test subjects did not become sick.

A July 1965 Joint Report by NASA and the NSAM described the voyage conditions.

"Bizarre stimulation of the subjects' vestibular organs was provided during early February by means of a 145-foot long tug (former U. S. Army transport) travelling the 200-mile distance between St. Pierre/Michelon [Miquelon], off the coast of Newfoundland, and North Sydney, Nova Scotia, over a twenty-eight-hour period during a storm. Sea conditions ranged from moderate to severe and were characterized during the first eight hours by 40-foot waves, 40-knot winds, and 80-knot gusts. The ship endured > 40 degrees of roll, a roll rate of > 10 degrees/second, and scend [surge] of > 3G as indicated by acceleration recordings." 12

During the trip Greenmun filmed interactions with fellow test subjects and port scenes, documenting a journey that was exceptional regardless of scientific value.

#### **Counterrolling**

By May 1964 Graybiel asked Greenmun to come to Pensacola and stay through the summer to act as an assistant in measuring counterrolling movements of the eyes. Following a Washington, DC, convention of the National Association of the Deaf where he completed 18 years of service as treasurer, Greenmun arrived in Pensacola.

\* \* \*

Tasks that summer included repeated tests on disorientation. On 24 July 1964 Greenmun wrote home:

Am still trying to outstare that pulsating eye from 2:00 p.m. until 10:00 p.m. (or until my eyes give out, which is usually) each day when I am not wanted on some other project. Last Wednesday

was one such day. At 7:30 a.m. I was strapped into a harness and suspended on a framework which was rotated at an angle of about 45 degrees and left hanging that way until 5:00 p.m. completely immobilized, except for my arms, which I could move about or rest in slings attached to the harness. Was lying on my right side, my left eye was covered by a patch, and I had drops to contract the pupil of my right eye. Each half hour they would take 18 pictures at the rate of one picture per second, with a strobe light aimed through the 3/4" opening of a cone about two inches from my eye. I would have my teeth securely fastened to the apparatus in front of me, and it would feel as though all of my 160 pounds was hanging from my teeth. During the picture taking my eyes would be distended by a pair of not too gentle hands, and those intense flashes were very painful. In addition there was the setting of an artificial horizon in complete darkness, and a couple of other tests of disorientation. ...During the 9 hours I was suspended six feet off the ground in that very uncomfortable and completely immobilized condition I had a urinary tube which I did not use, since I was so tightly bundled in I was not sure whether or not there was free passage through the tube and was afraid of making a complete mess of myself.

#### **Coriolis Acceleration Platform (CAP)**

In July 1964 in an effort to simulate the environment of a rotating space station, the U.S. NSAM Vestibular Laboratory first used the Coriolis Acceleration Platform (CAP). A circular room on a 40foot linear track, the CAP is a "simulator of space station acceleration environments for vestibular studies"13 that can rotate and also lift in angular motions. Designed by French civil engineer Gaspart Coriolis, the 20 foot diameter enclosed room spinning at 10 revolutions per minute can produce gravitational forces that can cause motion sickness, including nausea, disorientation, and fatigue. 14 The rate of acceleration of gravity at the outer wall is approximately 32 feet per second.<sup>15</sup> The CAP, with equipment and capabilities beyond the SRR, made it possible to create and more fully explore artificial gravity as a way to offset zero gravity and weightlessness in space.

Inside the CAP is abundant research equipment but no windows; test subjects cannot see that they are rotating, but the control room watches and listens at all times via closed circuit TV with external controls of the camera. A ball thrown straight appears to curve in flight, and when rolled across the floor takes a curvy path. Physical comforts of hot and cold running water, an electric range, a refrigerator, toilet, television, bedding, food storage, and a table with chairs is also within the circular space.

Engineers considered designs for space stations to rotate at 10 rpm, while doctors studied the effects of rotation on physical and mental activities. <sup>16</sup> In August 1964 four of the deaf test subjects—Greenmun, Harper, Larson, and Myers, started on a more than two-week run in the CAP, with three days of tests before spinning, 12 days of spinning, and then an unclear amount of time spinning in reverse direction and a few days assessing function. Letters suggest the total time was 17 days. Greenmun's footage has a text card stating the total run was 18 days.

\* \* \*

Writing to family Greenmun explained, "Will probably be able to write from the CAP, but not too often. We're gonna be busy, and if they invent any more tests they will have to discover a way to eliminate sleep."

#### On 14 August he wrote:

This will be a quickie, as I have been working hard today—7:00 a.m. to 6:00 p.m. and then Captain Graybiel invited us over to his house for drinks—then back to the hotel for supper. We are really into this CAP business to our necks now, and have gone through the entire battery of tests twice today. Tomorrow and Sunday I work in the SRR all day and as three of us will be taking turns, two of us will be in the CAP, and we are expected to run through the entire test battery twice each of those days. I don't see how it can be done, but as I have the responsibility of seeing that it is done it will be done!"

...As things stand now we will complete the CAP run September 3, and then on Sept. 4 finish those body casts that were started last Tuesday. We still don't know what they are for—it seems to be a big secret—but a number of the hearing men including some of the big shots, are also having them made, and none of them knows why for either.

\* \* \*

Fiberglass suits had been made for several deaf



Robert Greenmun shakes the hand of Commander Phoebus in front of the entrance to the Coriolis Acceleration Platform. Front row: Myers, Greenmun, Larson, Phoebus. Back row: Deware, Harper. Photo: Harry O. Larson collection, Gallaudet University Deaf Collections and Archives.

test subjects who went to a General Dynamics Lab in San Diego. Designed to keep the body immobile, casts bolted onto chairs held test subjects while immersed to the neck in a tank of water and spinning in

a large centrifuge. Greenmun was not part of the San Diego study.

The CAP run in one direction began at 8:00 a.m. August 20 and ended at 8:00 a.m. September 1. It stopped only for a few minutes morning and evening for supplies and to let Lt. Robert Kennedy, who was in charge of the daily tests, on and off. Kennedy, who could fingerspell and knew a few signs, had spent more than 2,000 hours aboard the CAP by August 1964.<sup>17</sup> Navy Ensign Deware, who Greenmun described as "good company but a lousy poker player" stayed on the CAP throughout the run. In addition to tests of dexterity and cognition performed in past studies, the CAP had significantly more electronic equipment to record responses. One apparatus called the "Rater" flashes lights in various sequences and when four lights have flashed the test subject pushes a button under the last flash. Greenmun described a math test:

We have four lamps in front of us. Each of these lamps can flash numbers from 1 to 9. They are arranged in a square, and any two may flash simultaneously. If horizontal lamps flash we subtract, and enter the remainder on an adding machine. If vertical, we add. If diagonal we multiply. The flashes are at one second intervals. They are programmed and the program is changed each day.

Footage from within the CAP shows Greenmun completing each problem with remarkable speed. While spinning, he did not appear to have any difficulty recalling which math function to perform or the calculations.

20 August—inside the CAP:

I've almost forgotten how it feels to sleep while rotating. We have more room here than in the SRR, so don't have to be pushed against the wall by the centrifugal force—we sleep with our heads to the center like the spokes of a wheel. On the other hand, we do not have the foam rubber pallets we had in the SRR and the floor is HARD! Made it the first three nights, albeit somewhat uncomfortably...I'm beginning to feel the exhaustion from a really tough day.

August 22—Greenmun reported optical illusions:

It took some time to set up this borrowed electric portable. As I am typing at a desk facing the wall, and the room is making a complete 10 revolutions per minute I not only have the sensation of typing on a table set on a steep hillside, but there is an actual optical illusion of the desk tilting down away from me. This is a very real illusion and has been the subject of much investigation.

...When you stand at the perimeter of this room you have to lean forward at an angle of about 30 degrees. When you walk straight across the room you gradually straighten up until you reach the center and then start leaning backward until you reach the other side. Walking about the circumference of the room is like walking around the inside of a steep volcanic crater. You have to keep leaning toward the center. If anyone should tip his chair backwards facing the center of the room, the results would be disastrous. Some of the boys had some pretty close shaves the first day or two. It is extremely easy to lose your balance completely if you make any sudden moves or changes of direction.

All the time I have been typing this we have

been going around and around and around. Seems rather queer that it is possible to live in such an environment, but the time is coming, perhaps sooner than we think, when people will actually be free floating through space, and then it will be necessary to rotate their vehicle to create an artificial gravity. Part of the purpose of this experiment is to see how physical well being and efficiency stand up under such conditions.

\* \* \*

Greenmun, Harper, Larson, and Myers completed the run, each of them feeling well and able to continue. After a few days they unconsciously braced themselves for walking in the CAP. Research did not stop for the weekend and Greenmun reported that they came through "in fine shape, and if there has been any physical deterioration it has not shown up on the results of our daily tests."

During the run a television showed the 1964 Democratic National Convention, though it was not captioned and therefore did not help the evening hours pass. On September 2 the counterclockwise rotation of the CAP ended. Greenmun described seeing his son as the door opened:

Dear folks: Well, we came back to the land of the living yesterday morning, right on schedule. When they opened the door, Jimmy was right in my line of sight. Of course I was sitting facing the door so that I could see him at the first opportunity. As always when we stop, we had to remain completely motionless, and I could look at him, but not turn my head. They let him on almost immediately, so he was a witness to our first awkward attempts at walking on a non-rotating platform, and I hope to tell you, they were ludicrous!! Although I expected some difficulty, I was amazed at the extent of it! None of us could walk without assistance at first the habit of combating that centrifugal force was too deeply ingrained. In about an hour, when I had the opportunity to get out and walk around a bit, I felt I was almost back to normal, but as soon as I got back in the CAP I started stumbling around again. Sort of a conditioned reflex action.

During the run we had become accustomed to pitching curves when we wanted to toss anything into our trash can, and one of the really amusing things was when Lt. Kennedy asked us to toss a ball to him—not one of us but threw it several feet to his left. Even though we knew we were no



Robert Greenmun preparing equipment for ocular tests.

Collection of Jerald Jordan, Gallaudet University

Deaf Collection and Archives.

longer rotating our muscles were so conditioned that try as we might we could not toss that ball directly to him.

We all were pretty good at walking and standing on the rail during rotation, but when we tried after we stopped not one of us could take more than one step without falling off. It was really amusing to watch the others, and very frustrating when my turn came.

\* \* \*

Upon completion of the counterclockwise run, they endured a test of clockwise rotation, during which is was nearly impossible to walk. The CAP experience completed, Greenmun stayed in Pensacola for a few more days to complete records.

#### **Conclusion**

Letters home after the 1964 CAP run are not in the collection. In 1968 most of the deaf test subjects, Greenmun included, received a letter asking them to participate in studies at Langley Field (Langley Air Force Base) in Hampton, Virginia. We do not have a record of the research from Greenmun.

On 11 April 1970, Robert and Roe Greenmun watched the lift off of *Apollo 13* from their living

room, then Robert went out to the store, never to return. His car was hit by a Florida East Coast Railway train and he died the following day.<sup>18</sup>

Robert M. Greenmun's letters, photographs, and films record his unique service to the nation. Through his writing Greenmun shared an intimate perspective on how research can impact the test subject, and how a test subject can impact research. His collection is a testament to the power of primary sources, one that provides evidence on a critical chapter of space science. By writing letters, Robert Greenmun wrote history.

#### **About the Author**

Jean Lindquist Bergey is the associate director of the Drs. John S. and Betty J. Schuchman Deaf Documentary Center.

Note: Gratitude goes to James Greenmun, son of Robert M. Greenmun, for donating letters referenced in this article to Gallaudet University for use by the Drs. John S. and Betty J. Schuchman Deaf Documentary Center and preservation in the Gallaudet University Deaf Collections and Archives. Profound thanks as well to Barron Gulak, Harry O. Larson, David Myers, Donald O. Peterson, and John Zakutney for providing firsthand accounts of their experience as test subjects. Thank you to historian and Schuchman Center Director Brian Greenwald, PhD, and student intern, Maggie Kopp, for insightful feedback. Finally, deep appreciation goes to the team at Gallaudet University Museum for hosting the Deaf Difference + Space Survival exhibition.

#### **Notes**

- 1 Greenmun, James. "Article Draft" Email message to author from James Greenmun, son of Robert Greenmun. 12 December 2017.
- 2 Burnes, Byron B. "Robert M. Greenmun: A Tribute." *The Deaf American* (Indianapolis, Indiana), June 1970, national edition, 3-6.
- 3 Hilchey, Tim. "Ashton Graybiel 1902-1995." New York Times (New York, New York), 3 March 1995, final edition. Accessed 12 December 2017. http://www.brandeis.edu/graybiel/about/graybiel.html.
- 4 Burnes, Byron B. "Robert M. Greenmun: A Tribute." *The Deaf American* (Indianapolis, Indiana), June 1970, national edition, 3-6.
- 5 U.S. Navy. Motion and Spatial Disorientation Systems: Special Research Capabilities. Edited by Kathleen Mayer. Report no. 93-12016. Pensacola, Florida: Naval Aerospace Medical Research Laboratory, 1993.
- 6 Carey, Frank. Associated Press Science Writer, "Navy Space Devices Test Flight Stress." *Herald-American* (Unknown), 15 November 1959, 12.
- 7 U.S. Naval School of Aviation Medicine. comp. 15th Annual Instrumentation Conference and Exhibit, New York. New York, Human Disorientation Brochure. Device Pensacola, Florida: US Naval School of Aviation Medicine, n.d.
- 8 Greenmun, Robert. Letter, 6 August 1959. Robert Greenmun Collection. Gallaudet University Library, Deaf Collections and Archives.
- 9 Clark, Brant. Memorandum to Robert Upchurch, memorandum, "Completion of the Collection of Data," 12 August 1963. Robert Greenmun Collection. Gallaudet University Library, Deaf Collections and Archives.
- 10 Grosvenor, Melville Bell. "White Mist Cruises to Wreck-haunted St. Pierre and Miquelon." *National Geographic* Vol. 132, No. 3, September 1967, 379-419.
- 11 Greenmun, Robert. Letter, 26 July 1964. Robert Greenmun Collection. Gallaudet University Library, Deaf Collections and Archives.

- Fregly, Alfred R., and Ashton Gravbiel, Residual Effects of Storm Conditions as Sea Upon the Postural Equilibrium Functioning of Vestibular Normal and Vestibular Defective Human Subjects, Research report no. MR005.13-6001. Pensacola, Florida: United States Naval School of Aviation Medicine, National Aeronautics and Space Administration Bureau of Medicine and Surgery Project, 1965. Accessed 7 December 2017. https://ntrs.nasa.gov/archive/nasa/casi. ntrs.nasa.gov/ 19650024254.pdf.
- 13 The Coriolis Acceleration Platform: A Simulator of Space Station Acceleration Environments for Vestibular Studies Designed and Developed for the U.S. School of Aviation Medicine, Pensacola, Florida. Roseland, NJ: KPT MFG Co, under the Sponsorship of the Office of Life Sciences Programs NASA, n.d.
- 14 Bascle, Michael. "Acceleration Platform Here Might Be Called Science Merry-Go-Round." *Pensacola News-Journal* (Pensacola, Florida), 26 July 1964.
- 15 Cheney, Bev, J01. "'CAP' Opens Here—First Test Underway." *U.S. Naval Air Station Gosport* (Pensacola, Florida), 7 August 1964, vol XXII, No 31 edition, 6.
- 16 Bascle, Michael. "Rotating Ensigns Leave Lab Today." *Pensacola News-Journal* (Pensacola, Florida), 9 August 1964.
- 17 Cheney, Bev, J01. "'CAP' Opens Here—First Test Underway." *U.S. Naval Air Station Gosport* (Pensacola, Florida), 7 August 1964, vol XXII, No 31 edition, 6.
- 18 Greenmun, James. "Article Draft" Email message to author from James Greenmun, son of Robert Greenmun. 12 December 2017.

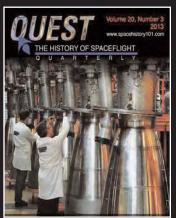


#### www.spacehistory101.com









Published since 1992, *Quest* is the *only* journal exclusively focused on preserving the history of spaceflight. Each 64-page peer-reviewed issue features the people, programs, and politics that made the journey into space possible. Written by professional and amateur historians along with people who worked in the programs, *Quest* is designed to bring you the stories and behind-the-scenes insight that will fascinate and captivate.

Preserving the history of space...

One Story at a Time<sup>™</sup>

#### **Mailing Address**

Quest P.O. Box 5752 Bethesda, MD 20824-5752 United States Tel: +1 (703) 524-2766

## quest@spacehistory101.com

**Quest on the Internet** www.spacehistory101.com

ISSN: 1065-7738

**Publisher:** Scott Sacknoff **Editor:** Dr. Chris Gainor

# Subscribe/Renew online at: www.spacehistory101.com

#### **United States**

4 issues / 1 Year: \$29.95 8 issues / 2 Years: \$50.00

#### Canada / Mexico

4 issues / 1 Year: \$34.95 8 issues / 2 Years: \$65.00

#### **Outside North America**

4 issues / 1 Year: \$44.95 8 issues / 2 Years: \$75.00

Vaal	1 1Mant to	Halm	Dragorya	460	History	of the	Cnass	Inductive
Yes!	ı vvant to	Helb	Preserve	tne	HISTORY	ot the	Space	inaustrv.

roo. I want to noip i	1000110 11	io motory or the opade madely.				
Please send me the next: 4 issues (1 year) or 8 issues (2 years) of Quest!						
Name:						
Address:						
Phone:						
E-mail:		_				
I've enclosed a check*.	Please	charge my credit card.				
Credit Card #:						
Exp Date:						
Ciamatura						