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Harald Von Beckh, Pioneer of Microgravity Medical Research

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HARALD VON BECKH, PIONEER OF MICROGRAVITY MEDICAL RESEARCH

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Abstract

Harald von Beckh was born in Vienna, Austria, on November 17, 1917. He graduated as a Doctor of Medicine from the Vienna University School of Medicine in 1940. He began working at the Academy of Aviation Medicine in Berlin where he helped in the development of the concept of the Keplerian trajectory to obtain periods of microgravity while collaborating with Dr. Heinz von Diringshofen. In 1941 he was appointed as a faculty member at the Academy of Medicine of the Luftwaffe.

At the end of the war, without any possibility to continue his research in Germany, von Beckh contacted the Embassy of Argentina in Genoa and was offered a job in Buenos Aires. Once there he became a member of the Sociedad Argentina Interplanetaria [Argentine Interplanetary Society] and actively worked to popularize the new field of space medicine. He wrote a number of articles for the national magazine of aeronautics and gave a number of talks on the subject, some of them in collaboration with Dr. von Diringshofen who also immigrated to Argentina.

Working for Argentina's National Institute of Aeronautical Medicine, he performed the first microgravity flights in the country where he tested the inner ear response on turtles and other animals. Von Beckh developed a test to understand the effects of reduced gravity on the psychomotor system, which was performed in Argentine Air Force and civilian planes.

He also formulated the bases for the understanding of eye-hand coordination in microgravity, which was essential years later with the advent of manned spacecraft. Several of his protégés from the Air Force were later in charge of biomedical experiments conducted during Argentine suborbital rocket flights carrying animals for experimentation such as the BIO-1 and BIO-2 tests.

In 1955 von Beckh published the book, *Fisiología del Vuelo* [Physiology of Flight]. It was the first book written in Argentina on the subject and was an invaluable contribution to aerospace medicine for Latin American flight surgeons.

In 1956 von Beckh accepted an offer from the American company Glen L. Martin Co. and went to work for the Aeromedical Research Laboratory in New Mexico as Chief Scientist (1964-1970). Years later he became the Director

of Medical Research for the Naval Air Development Center in Pennsylvania where he would remain until his retirement after a life dedicated to the advancement of aerospace medicine.

1. Beginnings

Harald von Beckh, whose full name was Harald Johann Albrecht Theodor Georg von Beckh Widmanstetter, was born November 17, 1917, in Vienna, Austria[1]. His parents, who were both doctors, instilled their love for medicine in the young Harald. In 1935 von Beckh entered the Medical School of the University of Vienna.

Many years later, on the occasion of the 60th birthday of von Beckh, his childhood friend and university colleague, Dr. Richard Polacsek, gave the following speech about his friend's university years.

> He often made very unorthodox decisions which retrospectively always proved to be right. For instance he insisted that one cannot understand the anatomy or histology of an organ system without first knowing its physiological function. So he made the unusual decision in the first year of medical school to enlist in a course which was taught in the third year and which had the only purpose to prepare the student for the final exam in physiology. This course was extremely demanding and involved many hours of daily work because the examiner, Prof. Arnold Durig was dreaded for his rigorous examination standards.[2] His failure rate averaged 70% of the candidates. After the completion of this course, Harald was looked upon by his classmates as a walking handbook of physiology. . . There came the opportunity for a smallish physiology examination which was not mandatory, but of course with all that knowledge in his head, Harald took it. . . I will never forget the expression of infinite amazement on the face of Prof. Durig when Harald displayed his knowledge. . . at the end of the exam Prof. Durig invited Harald to work in his institute, a great privilege bestowed only upon very few.
>
> . . . Professor Durig, a passionate mountain climber, had already before the turn of the century conducted several research expeditions on the Monte Rosa. . . he was an internationally recognized authority in altitude physiology and hypoxia. Harald, a flight enthusiast and glider pilot at the age of sixteen, saw the opportunity to do research with Prof. Durig's altitude chamber which was then the only one in the country. But aviation medicine was not a recognized specialization then and everybody thought he would become a surgeon like his father or an internist like his mother. Harald however had made his decision. Although the work in altitude physiology was extremely time consuming, he was still the first of our class to complete the preclinical phase summa cum laude in all five subjects, and raced through the clinical phase with

[1] When becoming a US citizen in 1963 his name was shortened to Harald J. von Beckh.

[2] Prof. Arnold During was remembered by his early research of subjects exposed to high altitude. It is possible that this is where von Beckh got interested in hypoxia, high altitude medical research, and aviation medicine.

supersonic speed. He obtained special permission to enter the final examination period in January 1940, half a year before the rest of the class, and he received his M. D. degree one month later. At that time he was 22 years and three months old--the youngest physician graduated ever on any Austrian or German university.

After graduating on February 3, 1940, von Beckh became a flight surgeon for the German Luftwaffe. In April 1941 he was assigned to the teaching staff of the Academy of Aviation Medicine in Berlin where he lectured to student flight surgeons. He worked closely with Prof. Hubertus Strughold and Prof. Heinz von Diringshofen, the leading experts of aviation medicine at that time. With the latter, von Beckh perfected his ideas on Keplerian trajectories to reach periods of weightlessness. By the end of the war, von Beckh had over five years of experience in aviation medicine.

2. Argentina

After the Second World War ended, it was clear to von Beckh that he would need to pursue his research in aviation medicine outside of Germany. At that time, Argentina was actively recruiting engineers and scientists from Germany, Italy, Poland, and other countries. Von Beckh, who used to spend his summers in the south of France and Italy, had a taste for the Latin customs, so he decided to apply for residency in Argentina at the Argentine Consulate in Genoa, Italy. Later von Diringshofen followed him there.

Dr. von Beckh arrived in Buenos Aires in May 1948. Once in Argentina, his activities in the country were many including becoming an Argentine citizen. Von Beckh revalidated his M.D. degree and began working as an onboard doctor on the Atlantic-route passenger ships for the FANU, Argentine Overseas Navigation Fleet. He contacted the local astronautical community and Teófilo Tabanera, the current president of the Sociedad Argentina Interplanetaria [SAI, Argentine Interplanetary Society, an International Astronautical Federation founding member]. Von Beckh became member number 141 of the society and began actively popularizing space medicine by giving talks on the subject (Figures1 and 2).

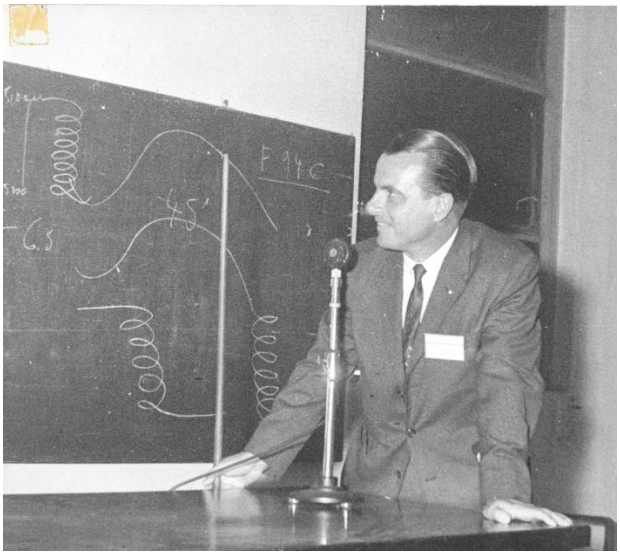

Figure 1. Dr. von Beckh during one of his talks in *Argentina.*
Courtesy von Beckh Widmanstetter family.

In May 1952, von Beckh, together with von Diringshofen, gave a joint lecture on the "Medical Aspects of Astronautics" in the halls of Transradio Internacional, generating an overflowing interest in the public and the press at the time.

Figure 2. Dr. von Beckh (First from the right), Teófilo Tabanera (second from the right) and two unidentified members during the 11th International Astronautical Congress in Stockholm in 1960. Courtesy von Beckh Widmanstetter family.

That same year, von Beckh began to write articles about his specialty for the *Revista Nacional de Aeronáutica* [*National Aeronautics Magazine*] and, at times, he collaborated with von Diringshofen. In these articles, the authors present some of the research they had done in Germany, such as those experiments carried out with parabolic trajectories while taking X-Rays on-board to see a body and its internal organ shifting during weightless periods. Research on the medical effects of a nuclear war on the population, the effects of speed and acceleration during high-altitude flights and other topics of interest were revealed to the readers of the *Revista Nacional de Aeronáutica* in these articles which informed the Argentine public about these little-known issues for the times.[3] Von Beckh demonstrated through these articles that he was at the forefront of the latest advances in his specialty.

Soon he left his job at FANU and started to teach the aerospace medicine specialization to medical doctors at the Instituto Nacional de Medicina Aeronáutica [National Institute of Aeronautical Medicine], as well as teaching some human physiology courses at the University of Buenos Aires (Figure 3).

Figure 3. Dr. von Beckh (Second from the right), Dr. von Diringshofen (second from the left) with unidentified Argentine Air Force officers during a meeting at the National Institute of Aeronautical Medicine. Courtesy von Beckh Widmanstetter family.

In 1950, he started his experiments on weightlessness in Argentina by flying parabolas and dives using water turtles and himself as test subject. He studied neuromuscular coordination, orientation, and recovery from blackout in the weightless state. In human subjects he used a psychomotor "drawing test" he developed. For studying coordination he observed the water turtles' ability to strike for food. The water turtles von Beckh used belonged to the Chelonia species (i.e., the Chrysemys ornata and Hydromedusa tectifera) which are found in parts of South America. Because these species of turtles move underwater with extraordinary speed and skill in all directions in their quest for food, he found them to be the most suitable for studies of orientation behavior and muscular coordination. These turtles are extremely voracious

[3] See "Medical Aspects of Astronautics" Heinz von Diringshofen and Haraldo von Beckh. (Nov. 1952), "Nuclear Energy in a Future War" (March 1953), "Speed, Acceleration, Gravitation" (Sept. 1955), "Multidirectional Protection Against Accelerations" (Sept. 1955), all articles published in the Revista Nacional de Aeronáutica, now Revista Aeroespacio.

and under normal gravity conditions, they strike with pin-point accuracy in a snake-like manner, projecting their necks at their food (Figure 4).

Dr. von Beckh carried the turtles in water-filled jars on the plane. During the parabolic flights, the turtles were offered bits of meat either individually with pincers or by putting the bait into the jar. This last procedure proved to be the most effective because the turtles would fight to catch the bait.

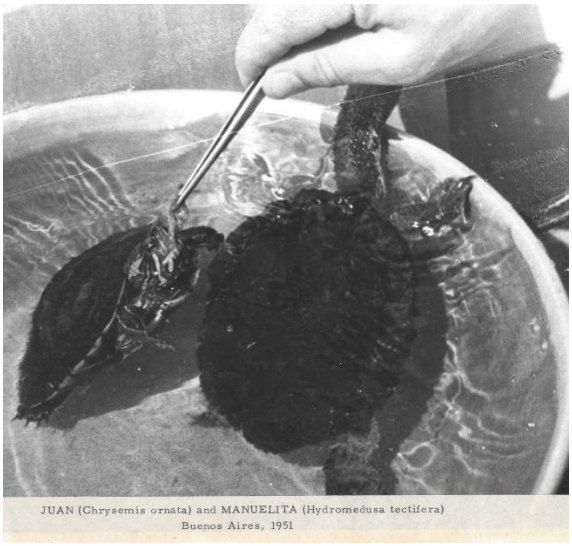

Figure 4. Juan and Manuelita, the turtles used by von Beckh during his microgravity experiments. Courtesy von Beckh Widmanstetter family.

The results of the experiments showed that the deterioration of neuromuscular coordination observed at the onset of weightlessness was of short duration because the sense of vision easily compensated for the lack of labyrinthine cues.

His first academic paper on the subject for an international congress was presented at the 4th International Astronautical Congress in Zurich in August 1953. His paper, *Untersuchungen über Schwerelosigkeit an Versuchspersonen und Tieren während des lotrechten Sturzfluges* [Research on weightlessness on human and animal subjects during vertical diving flights], was the first academic paper on the effects of weightlessness presented on an international setting.

The aircraft that von Beckh used for his first experiments were civilian and Argentine Air Force airplanes such as the Focke-Wulf 44 (LV-YZM) *Stieglitz*, a German two-seater built under license in Argentina that was used as a school plane. Subsequently, he was able to pilot the Italian FIAT G55-B, a higher performance aircraft which allowed longer times of weightlessness.

In one of his reports ("The Beginnings of Airborne Aeromedical Weightlessness Research," Report No NADC-84. . . -60) von Beckh comments on how he obtained permission to use the FIAT G55-B:

> My wish was to fly parabolas with an aircraft which was available at the airbase of Mendoza[4]. That was the FIAT G55-B which was similar to the Messerschmitt 109 with which I was familiar.
>
> On 31 August 1952 I gave a lecture at the Institute of Aviation Medicine to which Brigadier General Feliciano Zumelzu was invited. . . . He was the Commander of all units of the Argentine Air Force with exception of the flying units. . . . I described my flights with the Focke-Wulf 44 and said in my speech that it would be desirable to reach a longer time of weightlessness if I could use a higher performance aircraft like

[4] The former Los Tamarindos Air Base in Mendoza is near the Andes, and was one of the first bases of Argentina. Today is the seat of the IV Brigada Aérea (IV Aerial Brigade), and a center of training for Argentine Air Force pilots.

the FIAT G55-B. I observed the General during my speech. No movement of his face showed if he noticed my suggestion favorably. After my speech he congratulated me very kindly but said nothing about the availability of the FIAT G55-B.

How astonished I was when I received a telephone call three days later from the Base Commander of the Air Base El Palomar (near Buenos Aires) who told me that an aircraft FIAT G55-B from the base in Mendoza had landed in Palomar and was awaiting my instructions. This rapid decision in my favor was unique in the Argentine Air Force. . . . It was humoristically said that my weightlessness experiments request went through all instances so fast because it "carried no weight".

Following the FIAT G55-B experiments, von Beckh was able to extend the research of his previous paper and publish "Experiments with Animals and Human Subjects under Sub- and Zero Gravity Conditions during the Dive and Parabolic Flight" in the June 1954 issue of the *Journal of Aviation Medicine*. This paper allowed him to make contact with colleagues from the United States, especially at the Randolph and Holloman Centers of Research in Aerospace Medicine.

At a time when many medical specialists claimed that man could not survive in space and that the effects of zero gravity would be impossible to cope with (for example, that the heart would stop functioning under weightlessness), von Beckh´s research was of fundamental importance.

Between 1952 and 1953 von Beckh formulated the bases for the understanding of phenomena related to eye-hand coordination which would be essential years later with the advent of manned spacecraft. Von Beckh used sheets of paper mounted on a rigid panel. On the pages, there was a series of squares arranged in different positions. Under the effects of weightlessness, the test subjects were instructed to place crosses inside each square. The experiment was repeated with the eyes closed. As mentioned above, the military plane used was the FIAT G55-B, while the civilian school plane was piloted by César Germanó of the Aero Club Argentino. With the FIAT, von Beckh obtained up to 7 seconds of reduced gravity (Figure 5).

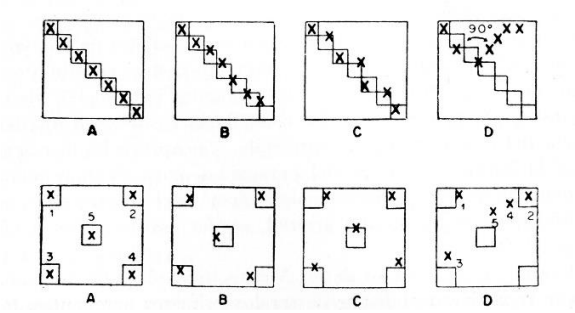

Figure 5. A chart with the results of the eye-hand coordination tests performed by Dr. von Beckh. Courtesy von Beckh Widmanstetter family.

The results of the tests showed the difficulty that test subjects had placing the crosses inside the squares while the aircraft was in reduced gravity. Later these results would be of fundamental importance in the design of cabins and control systems for spaceships.

Dr. von Beckh also noted that without an adequate harness system, that is, with the subject floating in the cabin instead of being firmly secured to the seat, the results worsened. Likewise, he was able to determine that the subjects who tried the test during several flights acquired a certain accustomedness which greatly improved the results compared with subjects without previous experience. While today accustomedness is common knowledge among

specialists in aerospace medicine, it was something totally unknown in the '50s.

His experiments with animals in microgravity were also very pioneering. One day, while preparing some turtles for experiments, he asked an assistant to disconnect the water heater after two hours. The assistant forgot and left the institute, leaving the turtles overnight at a temperature much higher than advisable. As a result, one of the animals had permanent damage to the vestibular apparatus (otoliths), which is one of the systems that regulates the functions of balance and coordination. Von Beckh continued the experiment with the injured turtle and other turtles in parabolic flights. He discovered that the animal with the damaged balance functions was better adapted to the changes of gravity and had better coordination and orientation than the normal turtles.[5]

In 1955, von Beckh published his book, *Fisiología del Vuelo* [Physiology of Flight]. It was a work on the medical aspects of aviation and space flight and was used as a textbook in Spain, Argentina, and other Latin American countries as part of the teaching curricula of aerospace medicine. Von Beckh dedicated part of his 150 pages to one of his passions: the study of gravity and acceleration and its effects on the human body. He also presented for the first time his idea of an ejection cabin which he would later perfect abroad (Figure 6).

Figure 6. Cover of the book Fisiología del Vuelo. Archive of the Author.

After the success of his first book, he began to write, almost immediately, *El Factor Humano en Vuelos de Alta Cota* [The Human Factor in High-Altitude Flights]. This work included topics almost exclusively of space physiology, such as decompression sickness, life support systems, pressurized cabins, the problem of acceleration in single and multi-stage rockets, life in a space station, and characteristics of space flight. Unfortunately, this work was never published.

[5] "The Beckh Test and its Application in the States of Sub or Zero Gravitation". Jorge W. Díaz Walker. Magazine of the Interplanetary Argentine Society. Sept. 1955.

3. Holloman Air Force Base

After almost 10 years living in Argentina, in 1957 von Beckh accepted an invitation to continue zero gravity work in the United States, first at the Glen Martin Co. and a few months later, at the USAF Aeromedical Field Laboratory in Holloman Air Force Base, New Mexico, later renamed USAF Aeromedical Research Laboratory (Figure 7). His Commander was Colonel John Paul Stapp, known for his rocket sled deceleration experiments and considered at the time to be "The Fastest Man on Earth."

Figure 7. Dr. von Beckh and his family in their house in Alamogordo.
Courtesy von Beckh Widmanstetter family.

Colonel Stapp made von Beckh responsible for the weightlessness research program. He performed experiments using the T-33, F-94C, F-100, and F-104 aircraft. In numerous flights, he was his own test subject. Von Beckh conducted 51 missions of the more than 200 trajectories investigating the alternation of weightlessness and acceleration. His aim was to duplicate what happened in space flight: the G load of the ascent and insertion into orbit, the weightless stage and the G load of reentry into Earth (Figure 8).

The results were presented in August 1958 at the 9th International Astronautical Congress in Amsterdam and later published in June 1959 in the *Journal of Aviation Medicine* with the title "Human Reactions during Flight to Acceleration Preceded by or Followed by Weightlessness."

Figure 8. Dr. von Beckh is being assisted by U.S. Air Force technicians before a test flight in a T-33.
Courtesy von Beckh Widmanstetter family.

In February 1959, von Beckh published the article "Weightlessness and Space Flight" in the journal *Astronautics*. In one of the last paragraphs, he stated: ". . . The heart, used during weightlessness to transport the blood column without the force of gravity, would need a certain time for adaptation after reentering the gravity field of the earth or another planet." He thus predicted what was later called the "Deconditioning Effect of Weightlessness" which was proven years later during the Mercury Missions when astronaut Walter “Wally” Schirra experienced orthostatic hypotension after returning to Earth from his orbital flight.

In March 1960, von Beckh attended a symposium on motion sickness with special reference to weightlessness at Wright-Patterson Air Force Base. The paper he presented was "The Incidence of Motion Sickness during Exposures to the Weightless State." He also presented this paper at the Space Medical

Symposium of the 11th International Astronautical Congress in Stockholm, Sweden in August 1960.

In his report No. NADC-84. . . -60 "The Beginnings of Airborne Aeromedical Weightlessness Research," von Beckh made the following conclusions based on his papers on weightlessness published in the decade from 1950 to 1960 (before manned space flight became a reality).

> Although the duration of weightlessness flying parabolic Keplerian trajectories was under one minute, worthwhile knowledge was gained and predictions of long duration weightlessness could be correctly made:
>
> *1)* Weightlessness does not at all provoke a "strong fall reflex" as predicted by Haber and Geratewohl.
>
> *2)* The lack of neuromuscular coordination is observed only during the first seconds of weightlessness; afterwards the control of the sense of vision allows coordinated movements.
>
> *3)* The incidence of motion sickness in the Keplerian flights with fighter aircrafts, where the subject was tied down and avoided head movements, was negligible. However in the cargo aircraft C-131, where the subject moved freely in the padded cargo department, and even made somersaults, the incidence was considerable. The astronauts of the Mercury project showed limited motion sickness. But when they moved freely…motion sickness occurred due to inertial excitation of the labyrinth (Figure 9).

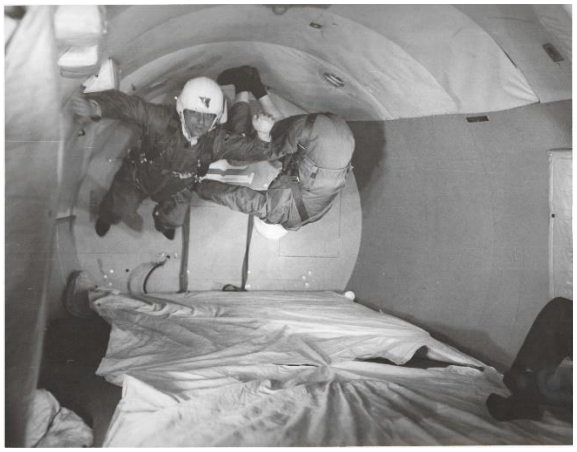

Figure 9. Dr. von Beckh during a microgravity flight at Holloman.
Courtesy von Beckh Widmanstetter family.

In 1957 at the 2nd European Congress of Aviation Medicine in Stockholm, von Beckh presented a paper which described a new principle of multi-directional G protection. Anticipating the proximity of manned spaceflight, he suggested the same principle for acceleration protection in space vehicles.

An experimental scale model of the anti-G capsule was manufactured in 1958 at the Aeromedical Research Laboratory and tested in animal experiments (mice) during supersonic (Mach 2) rocket-propelled sled runs. The results were published at the 10th International Astronautical Congress in London in 1959. Multi-directional G-protection was applied for the first time in the three M.I.A. (Mouse in Able) suborbital biological flights (Figure 10).

Between 1957 and 1958, von Beckh also participated in the ManHigh III project. These stratospheric manned balloon flights showed that man was physically and psychologically capable of traveling at space equivalent altitudes.

Figure 10. Dr. von Beckh at the rocket-propelled sled, Aeromedical Research Laboratory, Life Photo by Ralph Crane. Courtesy von Beckh Widmanstetter family.

In 1958, the responsibility for the chimpanzee flights of Project Mercury was assigned to the Aeromedical Research Laboratory at Holloman AFB. Although chimpanzees had been used previously as sled subjects in biodynamics programs, extensive physiological baseline studies—were required due to the limited biological data available for this species. At the same time, it was necessary to establish a psychological research and training program because the chimpanzees had to perform complex psychomotor tasks during the flights that would allow evaluation of their performance during the critical phases of the trajectory.[6]

The efforts culminated with the ballistic flight of chimpanzee HAM (H-A-M for Holloman Aero Med) on January 31, 1961 and the two-orbit flight of chimpanzee ENOS on November 29, 1961. HAM paved the way for the later Mercury flight (Mercury-Redstone 2) of Astronaut Alan Shepard while ENOS paved the way for the Mercury flight (Mercury-Atlas 5) of Astronaut John Glenn. During his time in Alamogordo, von Beckh also found the time to teach human physiology, in particular teaching the basis of aerospace medicine, at the Alamogordo Community College.

In an article about von Beckh and his family for the Alamogordo Daily News dated on October 4, 1959, he told the journalist that "...in 10 or 15 years, we will be able to send a few people to the moon," which was a surprisingly accurate prediction just two years after Sputnik 1.[7]

The Aeromedical Research Laboratory conducted a multitude of experiments with trained chimpanzees until its closure in 1970. The experiments covered all aspects of spaceflight and included several series of rapid decompression experiments conducted in the Laboratory's altitude chamber. The first series simulated atmospheric conditions for EVA (Extra Vehicular Activity) when the astronaut's pressure suit ruptures during extravehicular activity. A later series of experiments simulated accidental cabin decompression of Multi Mach/High Altitude Transport Aircraft.

4. The Naval Air Development Center

In 1970, von Beckh moved to Warminster, Pennsylvania to work at the Naval Air Development Center as the Director of Medical Research. There he had the opportunity to continue his experiments with a

[6] Isabel von Beckh remembers that while living in Alamogordo as a child, where they had the family home, her father used to comment on the intelligence of the chimpanzees and that they were taught on how to play tic-tac-toe.

[7] Pat Dixon, "Von Beckhs are enthused about America, love to live and work in the colorful Southwest". Alamogordo Daily News, October 4, 1959. Page 14.

50-foot radius human centrifuge. He conducted the first centrifuge experiments exposing volunteer pilots simultaneously to G-loads and to rapid decompression of the cabin environment.

On the centrifuge, he tested a supinating seat of his design which more than doubled the human tolerance to accelerations. Pilots reached 14 G for 45 seconds without PLL (Peripheral Light Loss) or any other symptom. The seat accomplished supination not by reclining the seat backward but by elevating the pelvis and legs forward-upwards keeping the head and shoulders in the same position. As a result, the vision of the pilot remains unchanged. He called it the PALE seat (Pelvis And Legs Elevating) (Figure 11).

Figure 11. Dr. von Beckh testing the PALE seat. Courtesy von Beckh Widmanstetter family.

In 1972 at the 20th International Congress of Aerospace Medicine in Nice, France, he presented his paper "G Protection by tilting aircraft seats with special consideration given to PALE pelvis and legs elevating seats."

He submitted his design to the U.S. Patent Office in October 1972 and on July 30, 1974, he was granted a patent for his "Pelvis and legs elevating G-protective seat" (U.S. Pat. 3826434, July 30, 1974).

His other U.S. patents are:

"Multi-directional anti-G device" (U.S. Pat. 2985413, May 23, 1961)

"Multi-compartment/airlock design for protection against rapid decompression in aircraft and spacecraft" (U.S. Air Force invention No. 5912, September 19, 1969)

"Life supporting pressurizable vehicles" (U.S. Pat. 3675878, July 11, 1972)

Then came a period in von Beckh's life where his work was recognized with one award after the other.

1972—Arnold D. Tuttle Award of the Aerospace Medical Association. Awarded for "original research that has made annually the most significant contribution toward the solution of a challenging problem in Aerospace Medicine."

1972—The Claude Bernard Medal of the Association of Astronautical Research, Paris, France. Awarded for "outstanding contributions to Aerospace Medicine."

1972—The M. W. Boynton Award of the American Astronautical Society, Washington D. C. Awarded for "significant research contributions to space flight safety."

1975—The Hermann Oberth Honor Ring of the Hermann Oberth Society, Bremen, Germany. Awarded for "his distinguished merits and pioneering contributions to Space Medicine and his continuous promotion of the ideas of Professor Hermann Oberth."

1976—The Hubertus Strughold Award of the Aerospace Medical Association. Awarded for "distinguished contributions to Space Medicine and Manned Space Flight."

1976—The Jeffries Medical Research Award of the American Institute of Aeronautics and Astronautics, New York. Awarded for "significant research contributions to aerospace medicine in the areas of weightlessness, acceleration protection and accidental decompression."

1980—The Scientific Achievement Award of the Department of the Navy, Naval Air Development Center, Warminster, PA. Awarded "in recognition of a significant advancement of science in the United States Navy."

1985—The Hubertus Strughold Award of the German Society for Aviation and Space Medicine [Deutsche Gesellschaft für Luft- und Raumfahrtmedizin]. Awarded for "outstanding scientific merits in research in the area of aerospace medicine."

Dr. von Beckh also received medals from the German and Austrian governments:

1979—Verdienstkreuz 1. Klasse [Officer Cross of the Order of Merit 1st class], Germany.

1981—Ehrenkreuz für Wissenschaft [Cross of Honor in Science], Austria.

He was also the president of the Space Medicine Branch of the Aerospace Medical Association (1978-1979).

Dr. von Beckh retired January 31, 1987. After he passed away on November 20, 1990, the Naval Air Development Center invited his daughters to tour the premises where he had worked, which included the human centrifuge. Isabel von Beckh remembers,

> The centrifuge was an imposing structure. The military personnel there explained to us how the centrifuge worked, and that the test pilot would be put at the end of the arm of the centrifuge and that our father would observe and give instructions from a separate control tower. They concluded by saying that Dr. von Beckh was well-known and always remembered at the Center, especially when he asked the centrifuge test pilots his famous question: "Can you take another G?

Due to his original contributions to aerospace medicine and microgravity research, Dr. Harald von Beckh deserves a special place among the pioneers of this important field (Figure 12).

Figure 12. Dr. von Beckh, pioneer of aerospace medicine and weightlessness research. Courtesy von Beckh Widmanstetter family.

5. Acknowledgments

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