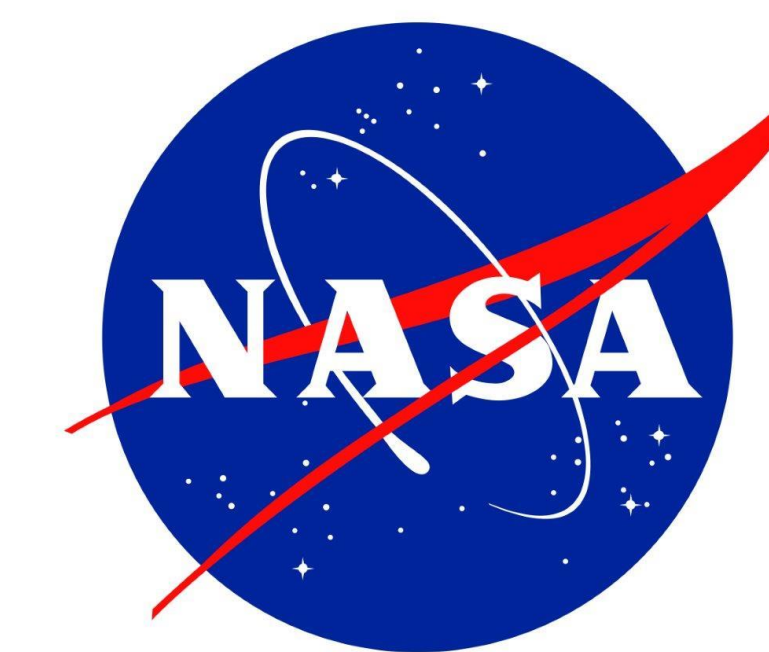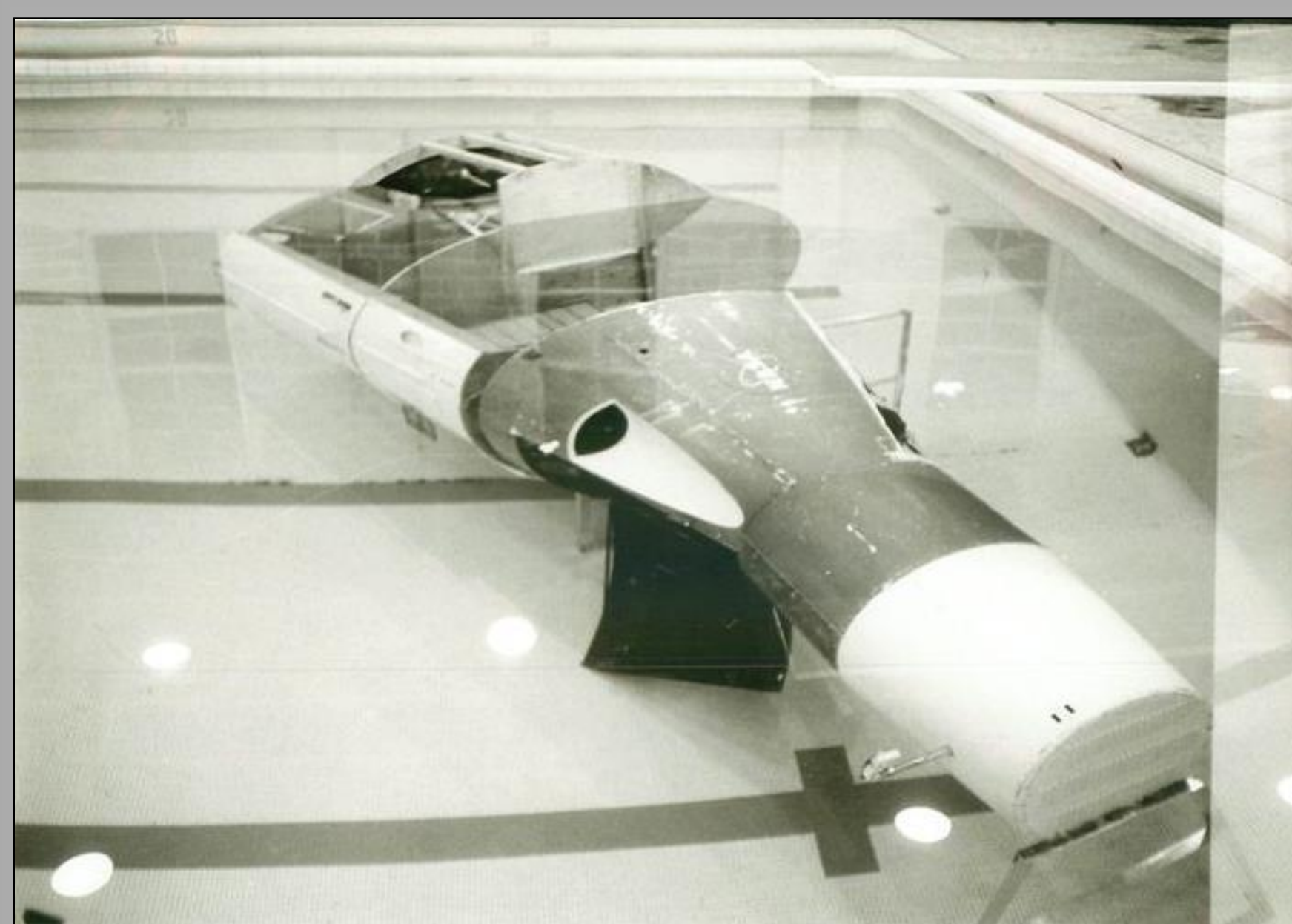# COMPILING A COMPREHENSIVE EVA TRAINING DATASET FOR NASA ASTRONAUTS

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The McDonogh School's swimming pool with a Gemini mockup. Source: nasa.gov

Background

Training for a spacewalk or extravehicular activity (EVA) is considered hazardous duty for NASA astronauts. This activity places astronauts at risk for decompression sickness as well as various musculoskeletal disorders from working in the spacesuit. As a result, the operational and research communities over the years have requested access to EVA training data to supplement their studies.

Purpose

The purpose of this project is to describe the comprehensive EVA training dataset that was compiled by the Lifetime Surveillance of Astronaut Health (LSAH) epidemiologists to investigate musculoskeletal injuries among US astronauts who trained in the extravehicular mobility unit (EMU). The EVA training dataset does not contain any medical data; it only documents when EVA training was performed, by whom, and other details about the session.

The Weightless Environment Training Facility (WETF) at the Johnson Space Center. Source: nasa.gov

Methods

LSAH began the quest to acquire EVA training data in September 2010. Several datasets were reviewed, but the most complete set of Neutral Buoyancy Laboratory (NBL) training records were sent to LSAH by the NBL Training Operations Manager in January 2011. These records, which are updated periodically, contain over 12,000 Weightless Environmental Training Facility (WETF) and NBL training sessions. Although the first training session in the dataset occurred in March 1982, the majority of WETF training runs were missing. In addition, training run records were missing for astronauts with photographic evidence of EVA training as well as documented EVA experience. After making numerous contacts, 11 hand-written logbooks of WETF training sessions were located in the possession of a manager with the EVA Management Office. From February 2012 to January 2013, the manager voluntarily reviewed the logbooks, entered the training data into spreadsheets, and sent 11 files to LSAH containing over 2,000 WETF training sessions spanning from 1981 to 1996.

In an effort to compile training and injury information in a single resource, the NBL module of the Exercise Injury System (EIS) went online in March 2012. Epidemiologists can readily access prospectively collected training details that were not previously included in the training dataset. In addition to US facilities, NASA astronauts completed training sessions in Russia's Hydrolab at the Gagarin Cosmonaut Training Center. Although the Russian Orlan suit was used to complete the majority of Hydrolab training runs, some were completed using NASA's EMU. In November 2013, an EVA training manager in Russia sent LSAH records of 28 training sessions completed in the Hydrolab using the EMU and spanning from 1999 to 2006.

Records from other facilities were excluded from the dataset for a variety of reasons. There are only photographs and personal accounts to document sessions at both a Langley Air Force Base swimming pool, where techniques used to simulate EVA maneuvers in water were first demonstrated in 1964, and at the McDonogh School's swimming pool in Baltimore, Maryland, where ambitious training led to the unprecedented achievements of the 1966 Gemini 12 EVAs. Archived paper records were not pursued for training sessions performed from 1967 to 1997 at Marshall Space Flight Center's Neutral Buoyancy Simulator (NBS) in Huntsville, Alabama, because of the significant effort required to secure the records in electronic format.

EVA readiness testing and training has been conducted at other smaller US facilities over the years. The availability of these records is unknown to LSAH, and they were not pursued for inclusion in this project due to the suspected low number of training runs completed by US astronauts. In addition, records were also excluded for training sessions completed at other space agencies. Several sessions were performed using the EMU at Japan's Weightlessness Environment Test System (WETS), but they were short and considered "development" runs. Training sessions completed in ESA's Neutral Buoyancy Facility at the European Astronaut Centre were "pre-familiarization" sessions in preparation for NBL training runs and were not included in the dataset. China operates the Neutral Buoyancy Facility at the Astronaut Center of China; however, US astronauts do not use this facility.

LSAH merged records from the WETF, NBL, and Hydrolab. Extensive cleaning was required since the multiple sources frequently contained duplicate records. In addition, training records for EVA partners were used as proxies for astronauts with EVA experience but no training records.

Results

To date, the LSAH EVA training dataset includes over 12,500 EVA training sessions performed by NASA astronauts in the EMU since 1981. The following variables are included for most records: name, sex, event date, event name, HUT type, HUT size, facility, and estimated run time. For a subset of records, the following variables are available: actual run time, time inverted, and suit components—waist bearing type, shoulder harness, shoulder pads, and Teflon™ inserts.
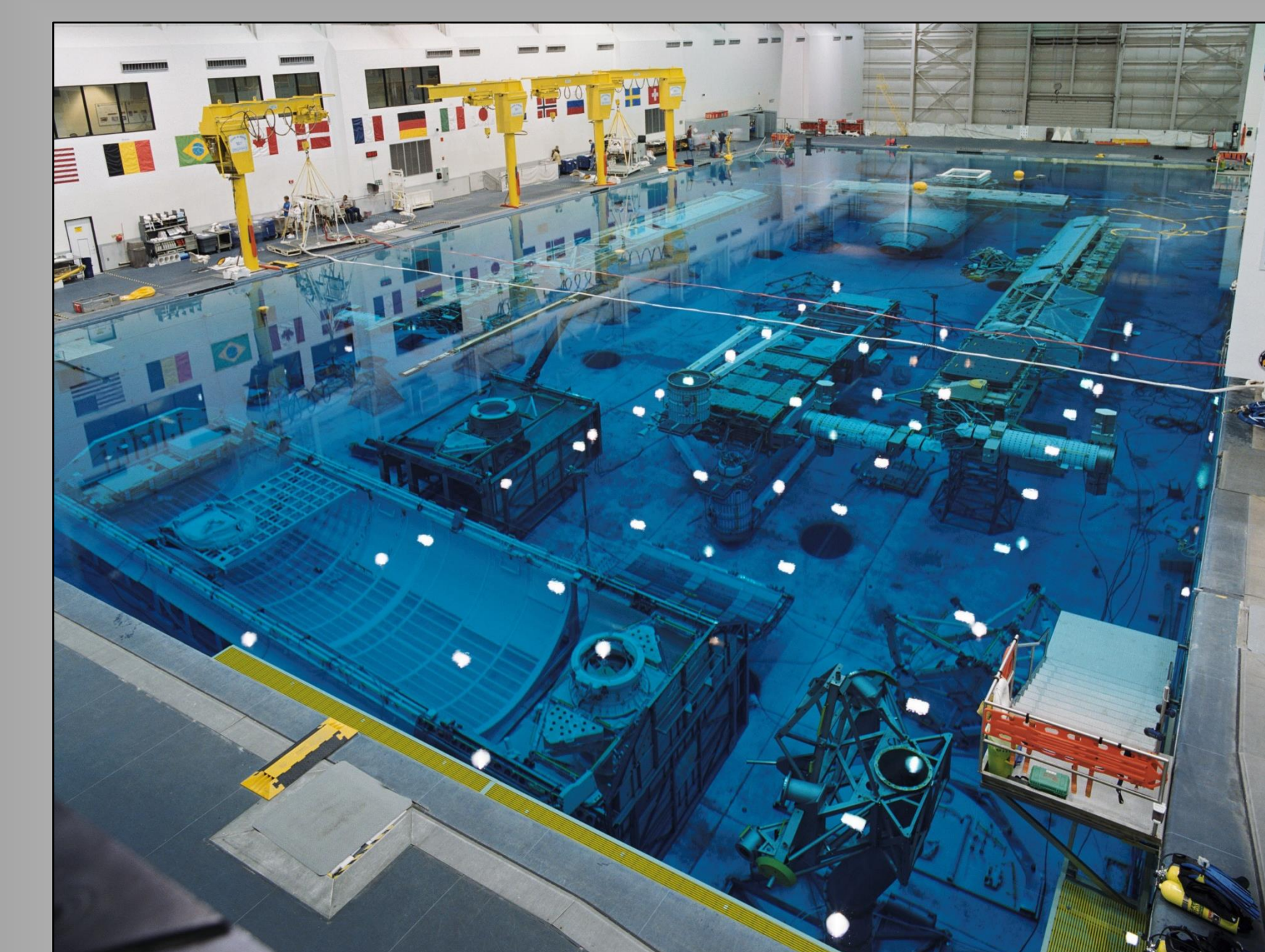

The Neutral Buoyancy Simulator (NBS) at the Marshall Space Flight Center. Source: National Park Service (nps.gov)

Conclusions

The LSAH dataset is currently the most comprehensive resource for EVA training sessions performed by NASA astronauts. However, it is not 100% complete since records from all facilities are not included. Recording of the EVA training data has changed considerably over time. Initially, the goal of early record keeping was to track the use of hardware components. The person involved was treated merely as a suited operator. This dataset has been compiled by LSAH to study the relationship between EVA training and musculoskeletal injuries, but it has many other non-medical applications. With appropriate board approvals, the dataset can be provided to other groups in order to help respond to program and research questions.

The Neutral Buoyancy Laboratory (NBL) with ISS mockups at the Johnson Space Center. Source: nasa.gov

Archived Footage!

Scan this QR code with your smart phone to view 1964 footage of underwater EVA training
Link: https://www.youtube.com/watch?v=6fzfzkyRMnE