Z-2 Suit Support Stand

Introduction

NASA’s next generation spacesuits are the Z-series suits, made for a range of possible exploration missions in the near future. The prototype Z-1 suit has been developed and assembled to incorporate new technologies that has never been utilized before in the Apollo suits and the Extravehicular Mobility Unit (EMU). NASA engineers tested the Z-1 suit extensively in order to develop design requirements for the new Z-2 suit.

At the end of 2014, NASA will be receiving the new Z-2 suit to perform more testing and to further develop the new technologies of the suit. In order to do so, a suit support stand will be designed and fabricated to support the Z-2 suit during maintenance, sizing, and structural leakage testing. The Z-2 Suit Support Stand (ZSSS) will be utilized for these purposes in the early testing stages of the Z-2 suit.

Design Parameters

Using Creo Parametric, the support stand is designed and fabricated using 80/20 Inc. t-slot profiles as the main support structure. T-slot framing is more versatile, efficient, and economical than welding. In addition, t-slotted frames are easily modified and disassembled to tailor to the user’s needs. The design requirements of the Z-2 suit support stand are as follows:

- Support 2x the total weight of the Z-2 suit (340 lbs)
- No interference with umbilical routing
- Ability to attach & detach casters for transport and testing
- Accessibility to Z-2 suit components for test technicians
- Other features that will facilitate test technicians such as tool holders, push handles, etc.

Stress Analysis

One part of the ZSSS is the latch mechanism interface between the suit and the stand. The mechanism consists of the latch mount and the suit latch. The suit “sits” on the latch and is locked in place with pins. It is important to consider the stress and displacement produced by the weight of the suit. The latch mechanism interface is designed by Mr. Charles Alton for the Z-2 donning stand.

Results

Stress analysis shows that the stand interface will be able to support the weight of the suit. Deflection analysis of the column supports that will maintain the weight of suit shows that the beams will deflect 0.014 in. with a moment of 680 lbs-in. It is desirable to enforce the column support as much as possible, while minimizing the footprint of the inside corner support. To do so, the column supports are reinforced by installing joining plates with the 60/30 support and installing the collapsible gate support. This is done so that the technicians can have space to modify the suit legs and boots.

MKIII Suit Center of Gravity Test

Introduction

It is important to consider the center of gravity (CG) of a spacesuit when developing design requirements for the next generation of spacesuits. The closer the CG of the suit is to the CG of the crew member, the easier it will be for the crew member to balance when performing Extravehicular Activities (EVA). This in turn will conserve more energy that the crew member can use for other mission tasks or perform longer EVA’s.

Currently, the process for obtaining the CG location for space suits is done through CAD models, which is not always accurate. The SSA Development team is exploring other types of physical testing to determine the location of the CG of the prototype MKIII suit. This research and testing will serve as a precursor to determine the best procedures for conducting CG testing on the Z-1 suit, Z-2 suit, the Portable Life Support System (PLSS), and other suit components.

Center of Gravity Board & Software

Another method for calculating CG location of the suit is by designing and constructing a center of gravity board. The CG board consists of four load cells at each corner, a CG acquisition software, and a non-flexing platform. The suit is placed on the platform, and then the load cells will measure the force that the suit exerts on each one and sends the data to a DAQ computer for calculations. The CG software takes into account the location of the load cells, the size and weight of the platform, and a reference point for the X, Y, and Z. CG locations change with the configuration of the suit. Therefore, it is crucial to keep the suit in the same posture at all times. This can be achieved by a fixture or other methods of tying down the suit legs and boots.

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“We came all this way to explore the moon, and the most important thing is that we discovered the Earth.” - William A. Anders

Figure 1: Creo 3D model of ZSSS

Figure 3: force diagram of CG hang test concept

Figure 4: set up of CG board & software