Large Tool Ergonomics

Suzi Creveling, Jacob Mellberg, Sam Nelson, Nathan Reimann, & Peter Vroom
Advisor: Kenneth D'Entremont, PhD

Department of MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

ALBANY Engineered Composites

Motivation

Figure 1: Sikorsky CH-53K King Stallion, with sponson labeled

Albany Engineered Composites (AEC) designs, develops, and manufactures advanced composite components for aircraft. Many of them and their parts are made from manual labor layup processes using multiple layers of carbon fiber plies. The sponson, located on the side of the helicopter, has a particular problem with the current layup process. Due to its size, it is difficult for technicians to reach parts of the mold and often puts them in unsafe positions.

The goal of this project is to eliminate the need for technicians to be placed in unsafe positions and allow access to a larger range of technicians.

Design

Figure 2: 3D model of the topside creeper with all modifications added made using SOLIDWORKS.

Modifying an Existing Topside Creeper

- Provide support to technicians in extended positions.
- Allow access to diverse workforce population.
- Eliminate hazardous positions for technicians.
- Side-step supports allow for greater access without needing to move entire setup
- Modified existing topside creeper increase accessibility

Figure 3: Finished build of the topside creeper.

Conclusion

The topside creeper eliminates the unsafe positions used by the technicians without the tool and increases accessibility for a greater proportion of the workforce, allowing the 25th percentile female to complete the layup process. This tool can be adjusted to fit areas with varying access and can be adjusted by a single technician. The topside creeper also lowers the low back compressive force to 622 pounds, complying with the NIOSH maximum limit of 730 pounds.

Technicians will use the topside creeper during the next round of manufacturing at AEC.

Experimental Analysis

Ergonomic Analysis - 3D SSPP

Figure 4: (Above) Modeled problem area of manufacturing, provided by AEC.

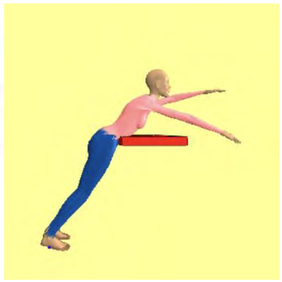

Figure 5: (Right) 3D SSPP model for 25th percentile female simulated reach using the Topside Creeper.

Assumptions:

- 25th percentile female height and weight: 61.3 in, 138.3 lbs.
- The interior dimensions of the tool are 44 inches wide and 39.5 inches high
- The axis is on the mid foot, which will offset the measurements about 3 inches.

Ergonomic Prototype Results:

Upon running the simulation through 3D SSPP we found the following to be true:

- Hands can reach across with ease (47 to 48 in.)
- Low back compression (LBC) force is below 730 lbs.
- Pad will provide extra stability and decrease LBC more
- The most important part is the 25th percentile female can reach a 20 in. square on the back side wall

FEA - Abaqus

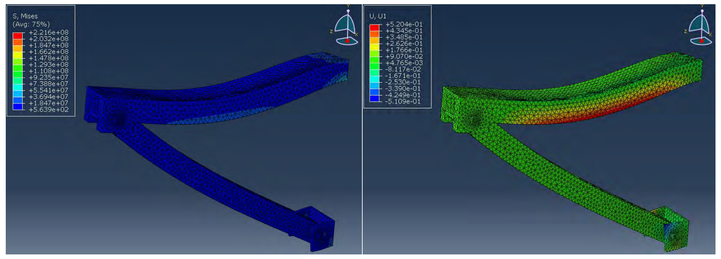

Figure 6: (Left) Von Mises stress of the modeled side-step showing a maximum force of 5-7 kPsi.
Figure 7: (Right) Maximum deformation of the side-step showing a maximum of 0.43-0.5 in.

A SOLIDWORKS model of the side-step was imported into Abaqus to simulate an 800-pound distributed load on the part. The side-step was modeled using ASTM A36 steel, with a yield strength of 45.687 kPsi for the 3x4.1 channel from American Standard Steel.

The simulation results show that using a safety factor of 2*, there will be negligible deformation, and the maximum stress will be within the published rating of the steel.

*The side-step had an applied force double that of the existing rating of the topside creeper.