Dummy Input Quill

Fleet Readiness Center East (NAVAIR)

Western Carolina University

PROBLEM STATEMENT

NAVAIR struggles to store V-22 nacelle components, such as the engine and gearbox, when the input quill is under maintenance. The dummy input quill eliminates the need for additional large-scale storage.

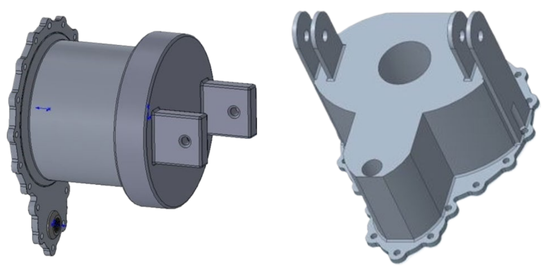
- Design and build a dummy Input Quill prototype
- Perform a strength analysis to demonstrate the prototype's load-bearing capabilities
- Produce engineering drawings of the design
- Provide instructions for the installation/removal

REQUIREMENTS

#	Description
1	The quill must be able to support a maximum load of 1000 pounds
2	The quill must feature an oil plug where oil can be changed during install
3	The quill must feature both PRGB bolt hole and gimbal ring interfaces
4	The quill must be designed with a 2:1 factor of safety in yield and a 5:1 factor of safety in ultimate
5	The gimbal ring interface must be able to rotate +/- 5 degrees to account for both the right and lefthand nacelle
6	The quill's inner pipe must be completely sealed to ensure no engine oil leakage

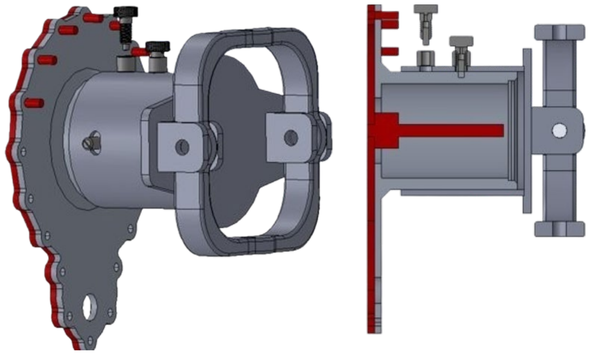
CONCEPTS

- Each team member created four solutions independently to ensure the creation of multiple unique concepts
- Original conceptual designs focused primarily around the +/- 5 degrees rotation
- Each design included the necessary mating interfaces, with a distinct geometry existing between the two
- The team applied design for manufacturing concepts to eliminate most of their concepts



FINAL DESIGN, APPROACH, PLAN

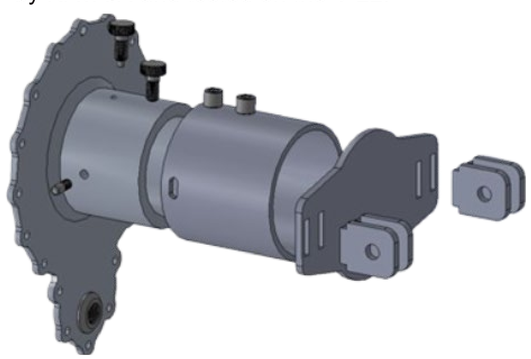
The team eventually decided upon a design which featured two concentric pipes. Vertical and horizontal degrees of freedom are restricted via dowel pins on each side of the pipes, whereas the rotational degree of freedom is controlled by two plunger-style detent pins. Altering the device for either the left or righthand V-22 nacelle is as simple as raising the engaged detent pin and rotating until the other engages.



Final design depicting assembled with both the PRGB surface and gimbal ring attachment with necessary clearances

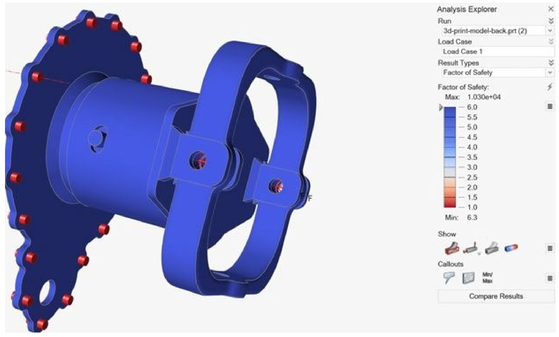
This design was selected primarily because it represents key concepts of design for manufacturing. For example, the inner and outer pipes were purchased as is, rather than having to remove material from the inside of a cylinder. All other fabricated components were designed to be waterjet cut from the same 3/8" aluminum plate. The design also features self-locating features to ensure all crucial components remain square.

Four prototypes from one-third to full scale were printed during the design process to verify key design functions. The full-scale model was printed by NAVAIR and tested on the V-22.



Exploded view of the final dummy input quill design where gimbal ring tabs, top cap, and PRGB plate can all be seen to be made from the same thickness of aluminum plate

General hand calculations and FEA verified the stability of the design within the necessary factors of safety. This was the final step necessary to give the team full confidence in their design.

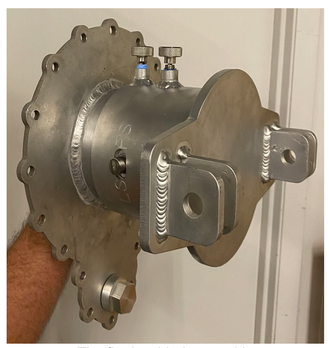


A screenshot from the final FEA iteration in Altair. The chart on the left verifies that the design is within the required factors of safety.

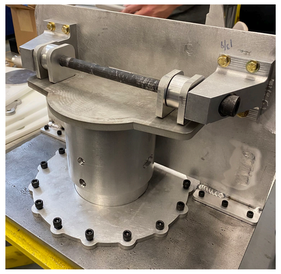
RESULTS

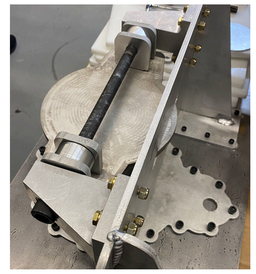
An image of the full-scale 3D-printed prototype on a V-22 gearbox

The completed aluminum design was brought to Cherry Point for one final fit check, and after a few more manufacturing operations, the quill was completed.



The final welded assembly





Pre-welded input quill assembled into welding fixturing

SUMMARY AND CONCLUSIONS

In summary, the team successfully created a design that directly met each of the sponsor's needs in an efficient, cost-effective, and safe manner. Specific tests completed to measure the designs success were:

- On-site test fit of aluminum input quill on both the left and right-hand V-22 nacelles as instructed by the install/removal document
- Took digital protractor readings to verify the rotational +/- 5 degrees offset
- Filled the inner pipe with fluid to verify the design's resistance to leakage

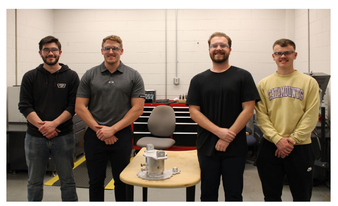
FUTURE WORK

The team delivered detailed engineering drawings to NAVAIR for future fabrication projects. In the future, the team would like to incorporate features into the design that help with fixturing during the manufacturing process. This would speed up the manufacturing process greatly.

TEAM & ACKNOWLEDGEMENTS

- Cole Holcomb – Engineering Technology
- Noah Robertson – Mechanical Engineering
- Colby O'Grady – Mechanical Engineering
- Matthew Hardison – Mechanical Engineering

- Faculty Mentor: Dr. Martin Tanaka
- Sponsor Contacts: Clara Rogers, Matthew Dietz, John Hinson



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