Bell Helicopter Tiltrotor Blade Fold Design Concept

Overview
Bell Helicopter has tasked the team with designing a manually folding tiltrotor blade fold mechanism. This manual system is intended to replace the automatic blade fold system currently in place in Bell’s tiltrotor aircraft in order to reduce weight and cost of manufacture. Finite element analysis and weight optimization was conducted to assess the feasibility of the team’s prototype and a quarter-scale model was constructed as a proof-of-concept.

Objectives
The final deliverable for this project is a fully-functional proof-of-concept for a manual blade fold system. This design must achieve a fatigue life of a minimum 10,000 flight hours and must be easily foldable by a 120 pound person.

Approach
- Customer needs were obtained through corporate contacts Kyle Cravener and Travis Jurell
- A thorough patent search of existing products was conducted to aid in initial design
- Weighted customer needs chart and Pugh matrix were used to narrow down initial designs
- Two alpha prototypes were modelled using Solidworks: one with a wide blade tang and one with a narrow blade tang
- Both alphas were rapid prototyped using the 3D printers in the Learning Factory
- A preliminary design review (PDR) was held with Bell representatives to help narrow down the best option of these two, and the narrow tang concept was decided upon
- Bell suggested that the design be changed to accommodate 120 degree blade folding (up from 90 degrees)
- Rough estimates of composite material properties were provided by Bell, limiting testing to finite element analysis only
- Further refinements (weight optimization, chamfered surfaces, addition of roller bearings) were made to the final beta prototype
- Finite element analysis (FEA) was conducted on the refined prototype in Solidworks
- The beta prototype withstood the load states provided by Bell and maintained a factor of safety above two for all cases
- Accurate fatigue analysis was unable to be conducted with the given material properties
- A quarter-scale, proof-of-concept model of the final beta was developed

Outcomes
- Our design will greatly reduce the weight and cost of Bell’s tiltrotor aircraft (the current systems cost was not provided)
- Our design allows for 120 degree blade folding in either direction relative to the hub assembly
- Preliminary FEA suggests that a 10,000 flight hour fatigue life could be possible with this design
- The roller bearings between the tangs and cuff ensure easy folding with limited force (satisfies 120 pound person requirement)