PROJECT 3 - FAN FLYER

- **Team Members**

- Faisal Almutairi (Project Manager)
  Ali Almari (Client Contact)
  Khaled Alazemi (The Document Manger)
  Christian Riggs (Budget Liaison)

2 PROJECT DESCRIPTION

- Design and prototype a pitch control actuator for the fan blades.
- Sponsor: Jim Corning
- Why it is important?

3 BACKGROUND & BENCHMARKING

- Helicopter
- Wind Turbine

4 RESEARCH FOR YOUR DESIGN SPACE

- **Books**

- Oates, G. (2007). *Aerothermodynamics of aircraft engine components*. Norwich, NY: Knovel.

(CHAPTER 3. AXIALFLOW COMPRESSOR AERODYNAMICS & CHAPTER 7. ENGINE NOISE)

- Seddon, J. and Newman, S. (2013). *Basic helicopter aerodynamics*. Hoboken, N.J.: Wiley.
- Budynas, R. and Nisbett, J. (2015). *Shigley's mechanical engineering design*. New York, NY: McGraw-Hill Education. (Chapters 12 to 15 Gears and Tables in the back of the Book)

5 RESEARCH FOR YOUR DESIGN SPACE

- **Articles**

- Dostal, J. and Kuzel, J. (2015). ANALYTICAL METHODS FOR CALCULATING FAN AERODYNAMICS. *Acta Polytechnica*, 55(6), p.373.
- Prasad, A. and Prasad, D. (2005). Unsteady Aerodynamics and Aeroacoustics of a High-Bypass Ratio Fan Stage. *Journal of Turbomachinery*, 127(1), p.64.
- Imiela, M. (2012). High-fidelity optimization framework for helicopter rotors. *Aerospace Science and Technology*, 23(1), pp.2-16.

6 RESEARCH FOR YOUR DESIGN SPACE

- **BOOK**:
- 1-BOXER, E., & UNITED STATES. (1951). INFLUENCE OF WALL BOUNDARY LAYER UPON THE PERFORMANCE OF AN AXIAL-FLOW FAN ROTOR. NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. HTTPS://BABEL.HATHITRUST.ORG/CGI/PT?ID=MDP.39015086495093
- 2-HITCHENS, F. (N.D.). PROPELLOR AERODYNAMICS.

7 RESEARCH FOR YOUR DESIGN SPACE

- **Articles**:
- 1-Bianchi, S., Corsini, A., Mazzucco, L., Monteleone, L. and Sheard, A. (2019). Stall Inception, Evolution and Control in a Low Speed Axial Fan With Variable Pitch in Motion.
- 2-Ieeexplore.ieee.org. (2019). Individual pitch control based on the fixed coordinate system shaft load - IEEE Conference Publication. [online] Available at: https://ieeexplore.ieee.org/document/7554716 [Accessed 1 Feb. 2019].
- 3-Pradelle, B., Triquenaux, N., Beyler, J. and Jalby, W. (2019). Energy-centric dynamic fan control.

8 RESEARCH FOR YOUR DESIGN SPACE

- **Books**
- [1] A. R. S. Bramwell, G. T. S. Done, D. Balmford, and A. R. S. Bramwell, *Bramwells helicopter dynamics*. Oxford: Butterworth-Heinemann, 2001.
- [2] Aging Mechanisms and Control. Symposium Part A - Developments in Computational Aero- and Hydro-Acoustics. Symposium Part B - Monitoring and Management of Gas Turbine Fleets for Extended Life and Reduced Costs (Les mecanismes vieillissants et le controle) (Symposium Partie A - Developpements dans
  le domaine de laeroacoustique et lhydroacoustique numeriques) (Symposium Partie B - Le suivi et la gestion des turbomoteurs en vue du prolongement de l. United States: Nato research and technology organization neuilly-sur-seine (france), 2003.

9 RESEARCH FOR YOUR DESIGN SPACE

- **Articles:**

- [1] M. Zhang, F. Lyu, S. Fu, X. Cai, K. Zong, and M. Wu, "Study on the pitch angle control of a robotized hydraulic drive roadheader using different control methods," *Journal of Mechanical Science and Technology*, vol. 32, no. 10, pp. 4893–4901, 2018.
- [2] Y. Liu and M. Sun, "Wing kinematics measurement and aerodynamics of hovering droneflies," *Journal of Experimental Biology*, vol. 211, no. 13, pp. 2014–2025, 2008.
- [3[K. S. Yakovlev, D. A. Makarov, and E. S. Baskin, "Automatic path planning for an unmanned drone with constrained flight dynamics," *Scientific and Technical Information Processing*, vol. 42, no. 5, pp. 347–358, 2015.

10 RESEARCH - CHRIS

- **Articles and Patents**
- McCullum, J., Bruchal, B. and Gerwing, M. (2000). *Variable Pitch Fan*. 6113351.
- Rampal, E. and Garcin, S. (2001). *Swash Plates System for Control of the Pitch of Rotor Blades with Rotating PLate Driver*. 6280141.
- Arnold, U. and Fuerst, D. (2006). *Development of an Integrated Electrical Swash-plateless Primary and Individual Blade Control System*. 32nd ed. [ebook] The Netherlands. Available at: https://dspace-erf.nlr.nl/xmlui/bitstream/handle/20.500.11881/1109/FM08.pdf [Accessed 1 Feb. 2019].

11 RESEARCH - CHRIS (CONT.)

- **Books**

- Allan, A. (2011). *Basic sensors*. Sebastopol, CA: O'Reilly.
- Piarulli, V., United States, Langley Research Center, & Rochester Applied Sciences Associates. (1971). The effects of nonuniform swash-plate stiffness on coupled blade-control system dynamics and stability: Part 1. Analysis and application. National Aeronautics and Space Administration.

12 CUSTOMER AND ENGINEERING REQUIREMENTS

- CR's
- Reliability
- Durability
- Easy to control
- Size
- Safety
- Weight
- Efficiency
- Speed
- Travel rate
- Actuator force
- Elec. Power

13 CUSTOMER AND ENGINEERING REQUIREMENTS

- ER's
- Stability(center of gravity)
- Toughness(in.lbf.n-3)
- Friction(lb)
- Dimension(in)
- Current(A)
- Mass(lb)
- Duty cycle(100%)
- Velocity(in/sec)
- RPM
- Force(lbs)
- Volt(V)

14 SCHEDULE

- Gantt Chart
- Points out the key projects
- Due dates and duration of each
- Full chart is in appendix A

PROJECT TITLE	Fan Flyer
PROJECT TEAM LEAD	Faisal

WBS NUMBER	TASK TITLE	START DATE	DUE DATE	DURATION	PCT OF TASK COMPLETE
1	**Project Steps**				
1	Meet The TA	1/22/19	1/31/19	9	100%
1	Presentation 1	1/31/19	2/5/19	5	100%
1	Team Staff meeting 2	2/14/19	2/21/19	7	0%
1	Team/ Staff meeting 3	2/21/19	2/28/19	7	0%
1	Preliminary Design Report	2/12/19	2/28/19	16	0%
1	Website Check 1	2/28/19	3/8/19	8	0%
1	Presentaion 2	2/21/19	3/8/19	17	0%
1	Analysis Memo	3/5/19	3/14/19	9	0%
1	Staff Meeting 4	3/14/19	3/28/19	14	0%
1	Website Check 2	3/14/19	3/28/19	14	0%
1	Analytical Reports	3/26/19	4/4/19	8	0%
1	Staff Meeting 5	3/26/19	4/5/19	4	0%
1	Peer Eval 2	4/2/19	4/11/19	3	0%
1	Team/ Staff meeting 6	4/3/19	4/12/19	0	0%
1	Team/Staff Meeting 7	4/16/19	4/25/19	0	0%
1	Final Report	4/17/19	4/26/19	0	0%
1	Website 3 Check	5/1/19	5/2/19	0	0%
1	Bill of Materials	5/1/19	5/2/19	0	0%
1	CAD Model	5/1/19	5/2/19	0	0%

15 BUDGET

- The client wants a low cost for the material
- Client is not specific on the budget
  - Using a percentage in the mean time
- Budget is a rough estimate

Project Budget Reporting

PROJECT TITLE	Fan Flyer		**CLIENT**	Jim Corning
PROJECT TEAM LEAD	Faisal		**DATE**	2/2/19
Total Budget :	**100%**			
*NOTE THIS BUDGET PLAN IS A ROUGH ESTIMATE				
Expenses	**Plan (%)**	**Actual (%)**	**Date Recorded**	
Arduino Mega	5%			
Accelerometers	5%			
Manufactured parts	5%			
Aluminum Blocks	5%			
Various Parts	5%			
Total For parts	**25%**			
Labor	25%			
Total for Labor	**25%**			
Total unused	**50%**			

16 CONCLUSION

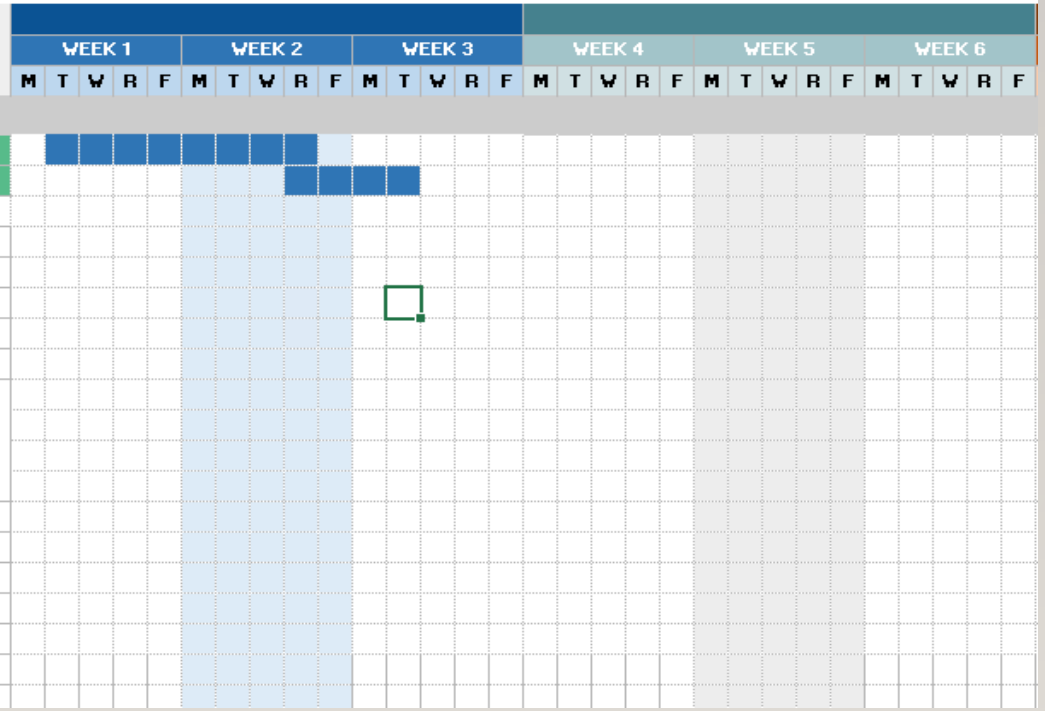
- Building a pitch actuator for the Fan Flyer
- Lightweight Materials to keep the mass low
- Designing to create a system that can control the pitch in each rotor

17 QUESTIONS?

18 APPENDIX A - GANTT CHART

PROJECT TITLE	Fan Flyer	COMPANY NAME	Jim Corning
PROJECT TEAM LEAD	Faisal	DATE	2/2/19

VBS NUMBER	TASK TITLE	START DATE	DUE DATE	DURATION	PCT OF TASK COMPLETE
1	**Project Steps**				
1	Meet The TA	1/22/19	1/31/19	9	100%
1	Presentation 1	1/31/19	2/5/19	5	100%
1	Team Staff meeting 2	2/14/19	2/21/19	7	0%
1	Team/ Staff meeting 3	2/21/19	2/28/19	7	0%
1	Preliminary Design Report	2/12/19	2/28/19	16	0%
1	Website Check 1	2/28/19	3/8/19	8	0%
1	Presentaion 2	2/21/19	3/8/19	17	0%
1	Analysis Memo	3/5/19	3/14/19	9	0%
1	Staff Meeting 4	3/14/19	3/28/19	14	0%
1	Website Check 2	3/14/19	3/28/19	14	0%
1	Analytical Reports	3/26/19	4/4/19	8	0%
1	Staff Meeting 5	3/26/19	4/5/19	4	0%
1	Peer Eval 2	4/2/19	4/11/19	3	0%
1	Team/ Staff meeting 6	4/3/19	4/12/19	0	0%
1	Team/Staff Meeting 7	4/16/19	4/25/19	0	0%
1	Final Report	4/17/19	4/26/19	0	0%
1	Website 3 Check	5/1/19	5/2/19	0	0%
1	Bill of Materials	5/1/19	5/2/19	0	0%
1	CAD Model	5/1/19	5/2/19	0	0%



19 APPENDIX B - HOUSE OF QUALITY (HOQ)

House of Quality (HoQ)

Customer Requirement	Weight	Engineering Requirement	stability (center of gravity)	toughness(in. lbf. in-3)	Friction(lb)	deminsion(in)	Current(A)	mass(lb)	duty cycle	velocity(in/sec)	RPM	Force (lbs)	Volt(v)
Reliability	9		9		6				9			3	
Durability	9			9					9			3	
easy to contro	6		6		9				9				
size	3					9		3					
safety	9		3				9						3
weight	3					3		9					
Efficiency	9						6		3				3
speed	3								3	9	6		
travel rate	6									6	9		
actuator force	6		3								3	9	6
Elec.Power	6						6				3	9	9
Absolute Technical Impo			21	9	15	12	21	12	24	15	21	21	21
Relative Technical Impor			162	81	108	36	171	36	171	63	108	135	144
Target ER values			±0.1	50	0.5	4".4".12'	2	2	100%	1	5500	25	12