



Presentation 3



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Review: Scope and Objectives

Northrop Grumman Corporation (NGC)

- Requested team design of functional handling arm
- Able to hold avionics
 - To prevent dropping expensive components
- Articulating/maneuverable
- Soldering/other necessary activities
- Used during system integration and testing

CAD Package

- ★ Whole system meets size of components engineering requirements

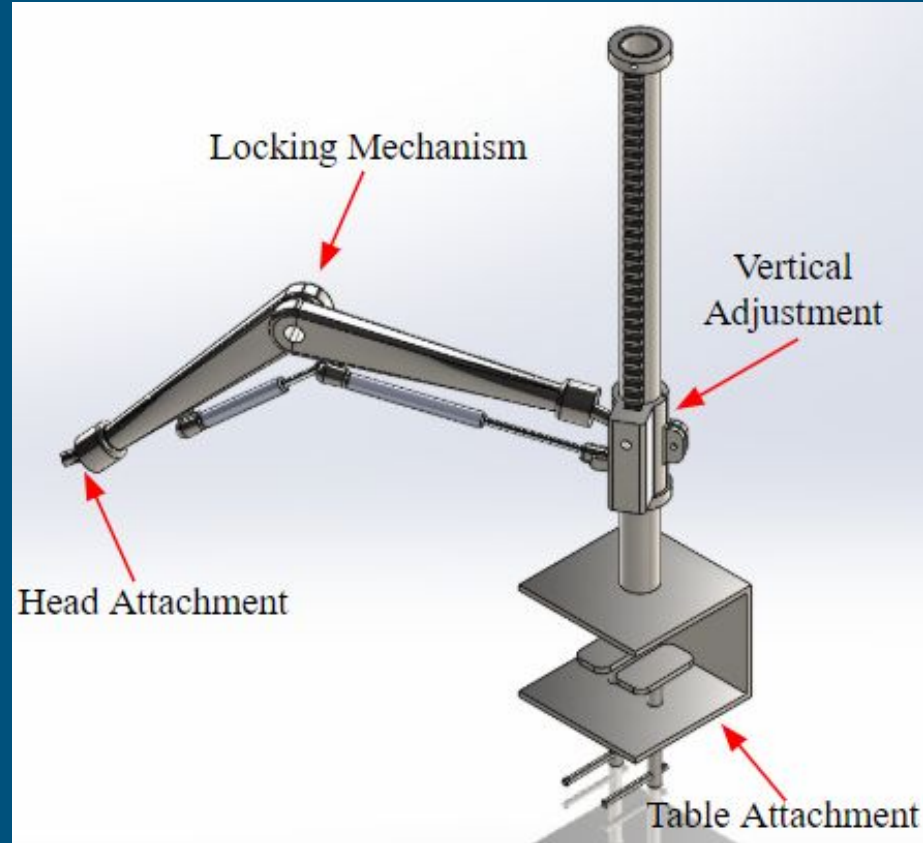


Figure 1. Complete CAD assembly

Subsystems - Table Attachment

- C-Clamp with two screws
- 6"x 4"x 3/8" thick
- 1/2" diameter screws
- 2"x 4" oval plates
- ★ Satisfies compatible with table engineering requirement

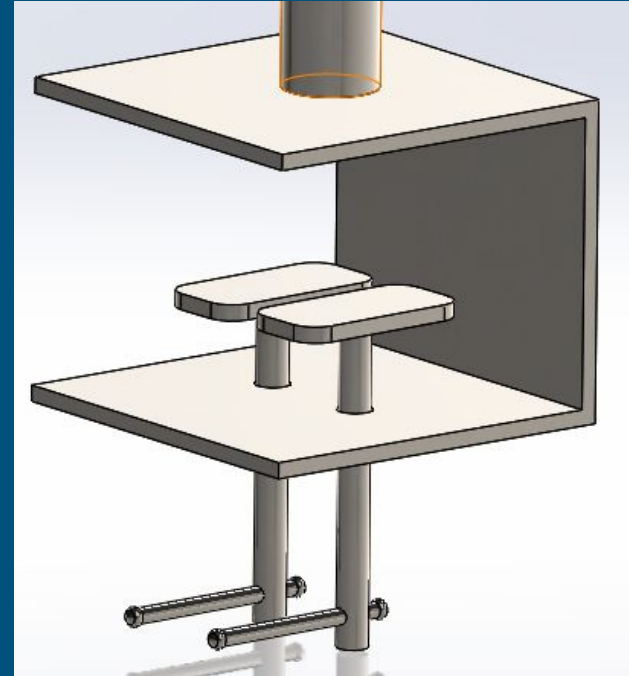


Figure 2. C-Clamp assembly

Subsystems - Vertical Height Adjustment

- Rack and pinion with crank
 - C45 Steel
- Allows for rotational movement
- Allows for vertical adjustment
- ★ Satisfies with degrees of freedom engineering requirement

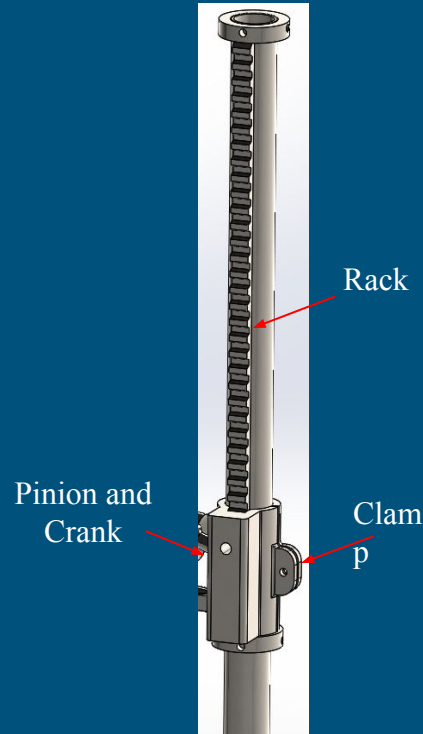


Figure 3. Rack and Pinion Assembly

Subsystems - Locking Mechanism

- Modeled after Titan arm
- Center pivot 2" diameter
- T-handle knob for lock
- ★ Compatible with torque requirement

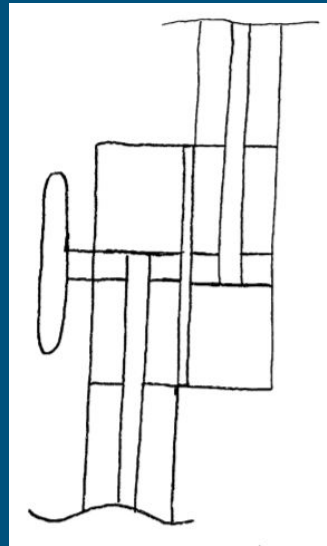


Figure 4. Titan Arm schematic

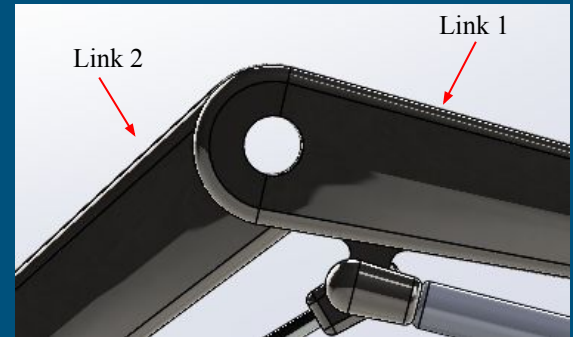


Figure 5. Complete locking arm assembly

Subsystems - Head Attachments

- Cotter pin used to attach heads
- Crescent wrench clamp
- Flexible finger head
 - Influenced by camera tripods
- Bolt-pattern
- ★ Compatible with size requirement

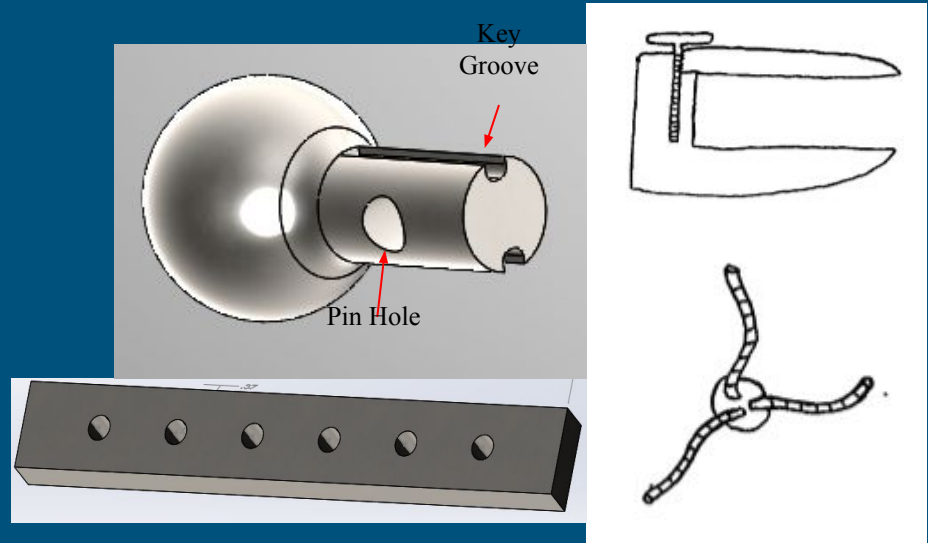


Figure 6. Complete head attachment assembly with bolt pattern and schematic of crescent wrench clamp and flexible finger head

Engineering Requirements

Table 1. Engineering Requirements

Engineering Requirement	Target	Our Design
Longevity of Components	Life Cycles	Currently doing analysis to confirm
Structural Integrity	Load tested to 125% (lbs.)	Currently doing analysis to confirm
Size of Components	Minimum: 6.0 x 2.5 x 1.125 (in.) Maximum: 6.0 x 2.5 x 12.375 (in.)	Whole System Size inc. Head Attachments
Load Capacity	Minimum: 1/2 (lbs.) Maximum: 15 (lbs.)	Currently doing analysis to confirm
Compatible with Table	Pressure (psi)	Table Attachment
ESD Compliant	0V between arm and user (V)	Add a Grounding Plug
Torque Requirements	20lbs additional force @ locked (lb-ft)	Currently doing analysis to confirm
Degrees of Freedom	Six (df)	Vertical Height Adjustment
Factor of Safety	Safety Factor: ≥ 3.0	Currently doing analysis to confirm
Device Weight	≤ 50 (lbs.)	Within range with this material
Cost	$\leq \$9,500$	\$2,845.20

Function/Implementation

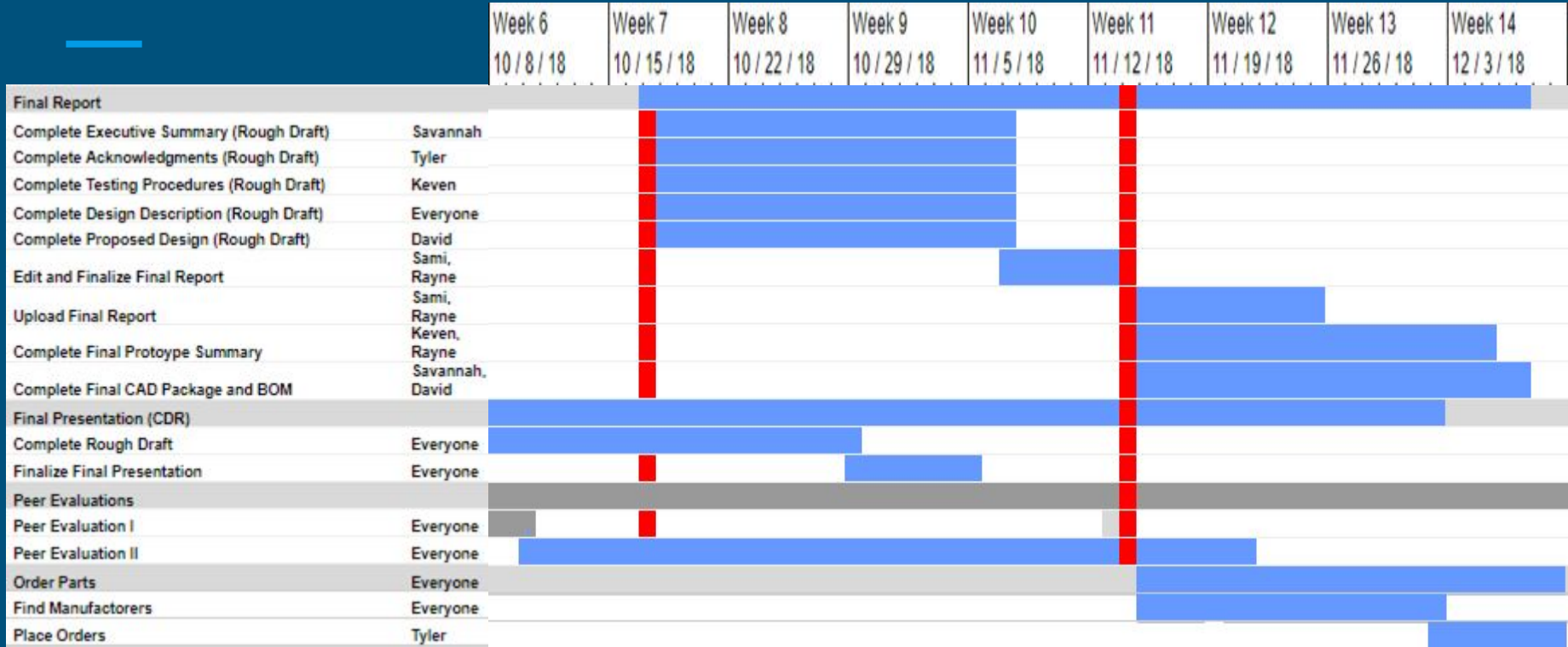
Basic Prototype

Shows function of handling arm

PVC pipe/joints

Vice jaw/clamp for table mounting component

Fall Schedule



Spring Schedule

Individual Post Mortem	Everyone	Sat 1/05/19	Mon 1/14/19	
Review Parts Ordered	Everyone	Mon 1/14/19	Sat 1/19/19	
Manufacturing	Everyone	Sun 1/20/19	Sat 2/02/19	
Progress Presentation	Everyone	Wed 1/23/19	Mon 2/04/19	
Hardware Review	Everyone	Mon 2/11/19	Mon 2/18/19	
Hardware Review 1	Everyone	Mon 2/11/19	Mon 2/18/19	
Hardware Review 2	Everyone	Mon 3/04/19	Mon 3/11/19	
Individual Analysis	Everyone	Mon 2/04/19	Mon 2/25/19	
Subsystem Construction	Everyone	Sun 2/03/19	Sat 3/09/19	
Table Attachment	Everyone	Sun 2/03/19	Sat 2/09/19	
Mechanical Joints	Everyone	Sun 2/10/19	Sat 2/16/19	
Heat Attachment	Everyone	Sun 2/17/19	Sat 2/23/19	
Locking Mechanism	Everyone	Sun 2/24/19	Sat 3/02/19	
Fail Safe	Everyone	Sun 3/03/19	Sat 3/09/19	
Midpoint Presentation	Everyone	Mon 2/25/19	Mon 3/11/19	
Spring Break	Everyone	Fri 3/15/19	Sun 3/24/19	
Unit Assembly	Everyone	Fri 3/15/19	Fri 3/29/19	
Poster and Operations Manual	Everyone	Mon 3/18/19	Mon 4/22/19	
Draft Poster and Operations Manual	Everyone	Mon 3/18/19	Wed 4/03/19	
Final Poster and Operations Manual	Everyone	Wed 4/03/19	Mon 4/22/19	
Final Product Testing	Everyone	Fri 3/29/19	Fri 4/05/19	
Final Presentation	Everyone	Mon 4/01/19	Mon 4/22/19	
Final Report	Everyone	Sat 3/30/19	Mon 4/29/19	
Final CAD Package	Everyone	Sat 3/30/19	Mon 4/29/19	
Peer Evaluations	Everyone	Mon 2/11/19	Wed 5/08/19	
Peer Evaluation 1	Everyone	Mon 2/11/19	Mon 2/18/19	
Peer Evaluation 2	Everyone	Mon 3/04/19	Mon 3/11/19	
Peer Evaluation 3	Everyone	Wed 5/01/19	Wed 5/08/19	
Website Checks	Keven	Mon 1/21/19	Wed 5/08/19	
Website Check 1	Keven	Mon 1/21/19	Mon 1/28/19	
Website Check 2	Keven	Mon 1/28/19	Mon 3/25/19	
Website Check 3	Keven	Mon 3/25/19	Wed 5/08/19	

BOM

Total Funds	\$9,500.00
Sum of BOM	\$2,845.20
Left Over	\$6,654.80

Table 2. Complete BOM

Part	Material	What	Length (in)	Weight (lbs)	Unit Price/quantity	Total
Tube and Link material [2]	304 Stainless Steel	1-1/2 x 0.083 x 1.334 ID	50	5.237	66.46	\$66.46
material to machine [2]	304 Stainless Steel	2" x 2"	12	13.6	197	\$197.00
material to machine [2]	304 Stainless Steel	4" x 4"	12	54.45	788.68	\$788.68
Clamp material [3]	304 Stainless Steel	6" x 4" x "3/8	12		280.02	\$280.02
Clamp screw [4]					2	\$66.70
Clamp disks [4]	304 Stainless Steel	.25"	2" x 4"		2	\$22.58
Rack and Pinion set [5]	C45 Steel				1	\$80.00
Machining Hours [6]				Hours	10	\$800.00
Welding Hours [7]				Hours	1	\$80.00
Titan Arm [8] [9]					1	\$246.00
Compression Damper [10]					2	\$160.00
screw for rack and pinion [11]	Zinc die cast/ steel	3/8" x 2"			1	\$8.90
T handle [12]	304 Cast Stainless Steel				1	10.65
Bolt pattern plate	304 Stainless Steel	13.75" x 7" x .25"			1	38.21

References

- [1] E. T. F. D. N. Staff, "Northrop Grumman Boosts Outlook as Q3 Earnings Blow Away Expectations," ETF Daily News, 26-Oct-2016. [Online]. Available: <https://etfdailynews.com/2016/10/26/northrop-grumman-boosts-outlook-as-q3-earnings-blow-away-expectations/>. [Accessed: 17-Sep-2018].
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- [4] Mscdirect.com. (2018). Clamp Spindle Assembly 78089539 - MSC. [online] Available at: <https://www.mscdirect.com/product/details/78089539> [Accessed 10 Oct. 2018].
- [5]"Rack 500mm/19" & 20T Pinion Gear Module 1.5 CNC KIT Router Plasma Laser Mill | eBay", eBay, 2018. [Online]. Available: <https://www.ebay.com/i/162590283384?chn=ps>. [Accessed: 11- Nov- 2018].
- [6] Cncmachinisttraining.com. (2013). Machine Shop Rates – What's the Average Hourly Rate | CNC Machinist Training. [online] Available at: <http://cncmachinisttraining.com/2013/08/16/machine-shop-rates-whats-the-average-hourly-rate/> [Accessed 10 Oct. 2018].
- [7]"Rack 500mm/19" & 20T Pinion Gear Module 1.5 CNC KIT Router Plasma Laser Mill | eBay", eBay, 2018. [Online]. Available: <https://www.ebay.com/i/162590283384?chn=ps>. [Accessed: 11- Nov- 2018].

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- [11]"BANSBACH EASYLIFT Dampers, Compression, Extended Length 8.27 - 6GTU7|HX1N0-001 - Grainger", Grainger.com. [Online]. Available: <https://www.grainger.com/product/BANSBACH-EASYLIFT-Dampers-6GTU7>. [Accessed: 12- Nov- 2018].
- [12] "Stainless Steel T-Knobs With Stainless Steel Screw On Morton Machine Works", Morton Machine Works. [Online]. Available:<http://workholdingcomponents.mortonmachine.com/viewitems/metal-handknobs/stainless-steel-t-knobs-with-stainless-steel-screw>. [Accessed: 12- Nov- 2018].

Questions
