

Grand Canyon Alternative Motor Project

University of Utah

Advisors:

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Motor Team

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Overview

- Problem Statement and Motivation
- Motor Selection
- Motor Mounting & Problems
- Geometry Simplification & CFP
- U of U Drive and Mounting Solution(s)
- Throttle Control
- Cooling System
- Schedule/Budget
- Goals
- Conclusion



Problem Statement

- Focus on the Year I deficiencies of insufficient motor performance and excessive heat buildup.
- Collaborate with the outboard “Lower Unit” teams from both Northern Arizona University and Arizona State University.



Motor Selection

- Benchmarking for 30 hp (22.4 kW)

Manufacturer	Part Number	Nominal Voltage	Nominal Speed (RPM)	Rated Current (A)	Rated Power (kW)	Efficiency	Weight (lb)	Cost
Current Gas Motor	-----	-----	6000	N/A	22.4	~30%	184	-----
Danaher Motion	B-806-B	230	3000				n/a	??
Electricvehicle esusa.com	ADC #FB1-4001 9.1"	72-144	n/a		14.43		143	\$1,773.36
D&D motor sys	ES-31B	72-144	n/a		13.3		83	\$1,149.00
PMG	PMG132	72	10800	110	11.1	88%	25	\$985.00
Baldor Motor	D5020P	150/300	1750		14.8		286	\$6,410.00
LEMCO	LEM-200- D127	72	3600	200	12.56	90%	24	~\$1,500.00

Last Year's Motor

Lynch LEM200-D135

- Underpowered
 - River Guide said it “felt” underpowered
 - More like the old 20 hp outboards
 - 72 Volts at 200 Amps = 19.5 hp
- Overheated
 - 72 Volts at 300 Amps for 2 minutes = 29 hp
 - Heat built in enclosed space
 - Melted solder => Destroyed motor
 - Not reusable or testable => Recyclable!
 - Shaft, Bearing and Casing



Motor Selection

- Lynch vs. Agni
 - Same Inventor & Same Design



Lynch LEM-200

- Efficiency = 90%
- Voltage = 24 to 84 V
- Rated Torque* = 33 NM
- RPM* = 3600
- Weight = 11 kg

Agni 143

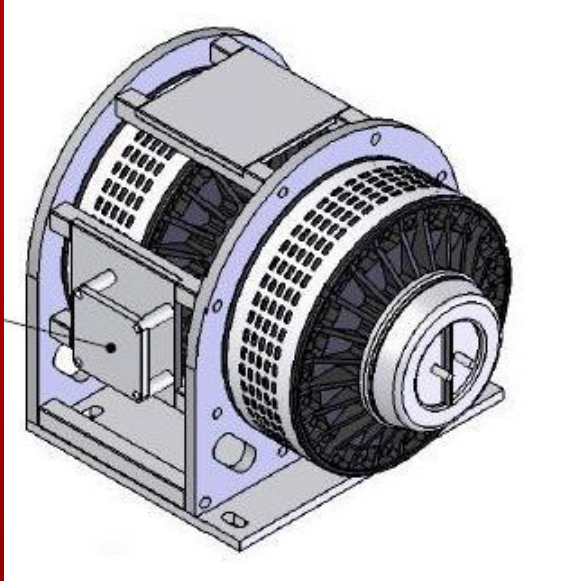
- Efficiency = 93%
- Voltage = 24 to 84 V
- Rated Torque* = 39 NM
- RPM* = 3200
- Weight = 11 kg

* At 72 V and 200 Amps



Motor Selection

- Total Power Needed = 30 hp
 - Two motors required => Mounting?
 - LEM-2x2 vs. Agni



LEM-D135-2x2
www.lemcoltd.com



Two Agni 143 motors in one pulley
Courtesy of Cedric Lynch

Motor Mounting

- Needs:
 - Connect to current lower unit
 - Establish interface with NAU & ASU lower units
 - Use provided Lynch motor bracket
 - Simplicity
- Use current Lower Cowling vs. Redesign
 - Chris Parks
 - Three problems with Lower Cowling
 - Simplicity?
 - Multiple drive configurations



Problem 1

- Sealing
 - Fuel Line holes etc.
 - Electrical Leads
 - New holes
- Solution
 - Start From Scratch

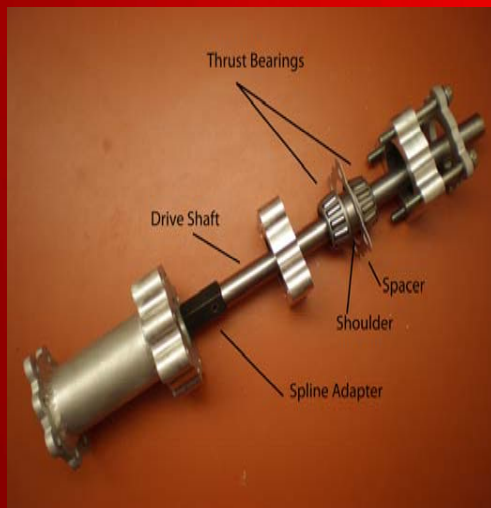
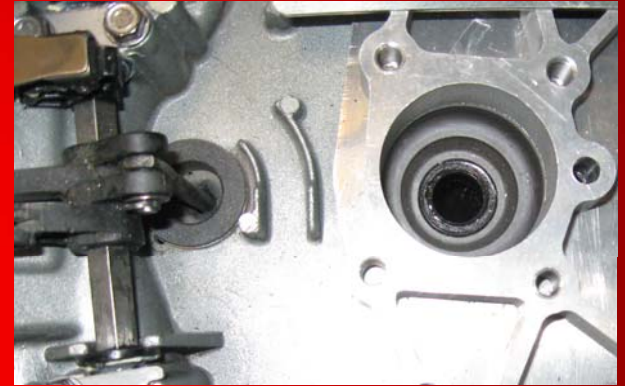


Courtesy of GCAMP 08-09



Problem 2

- Drive Location and Height
 - Old 4-Stroke
 - Last year -> Extend the shaft



- Solutions
 - Extend the shaft again
 - Reduce thickness of lower cowling

Photos Courtesy of GCAMP 08-09



Problem 3

- Geometry and Unneeded Components
 - Old 4-Stroke
 - Oil, Water, Fuel, Exhaust, Vibration, Reverse, Throttle
 - Bolt Pattern
 - Old vs. New
 - Adaptor Plate = Rectangular Pattern
- Solution
 - Get rid of undesirables
 - Start with fresh bolt pattern



Courtesy of GCAMP 08-09

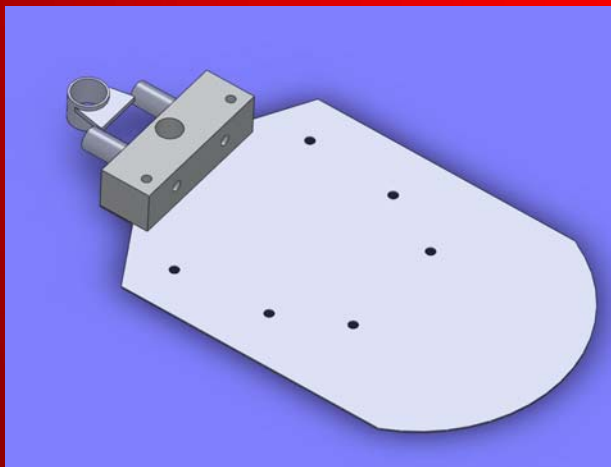


CFP

Critical Function Prototype

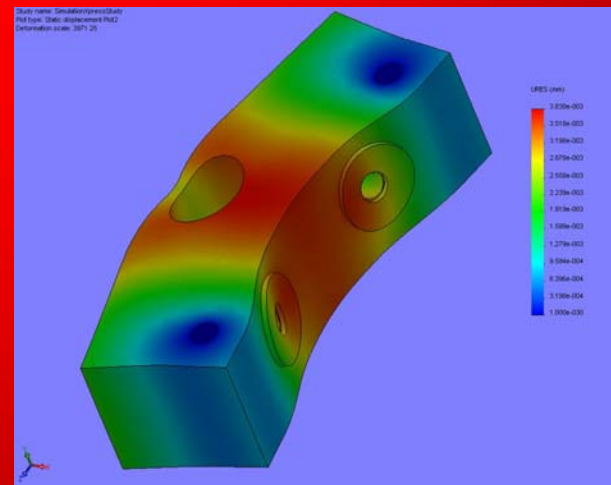
Motivations:

- Reduce GCROA's reliance on OEM parts (Honda and Tohatsu)
- Simplify and Establish Base Geometry
- Provide basis for multi-team collaboration



Planning:

- Basic Geometry with easy to use materials
- Computational testing
- Geometry Testing

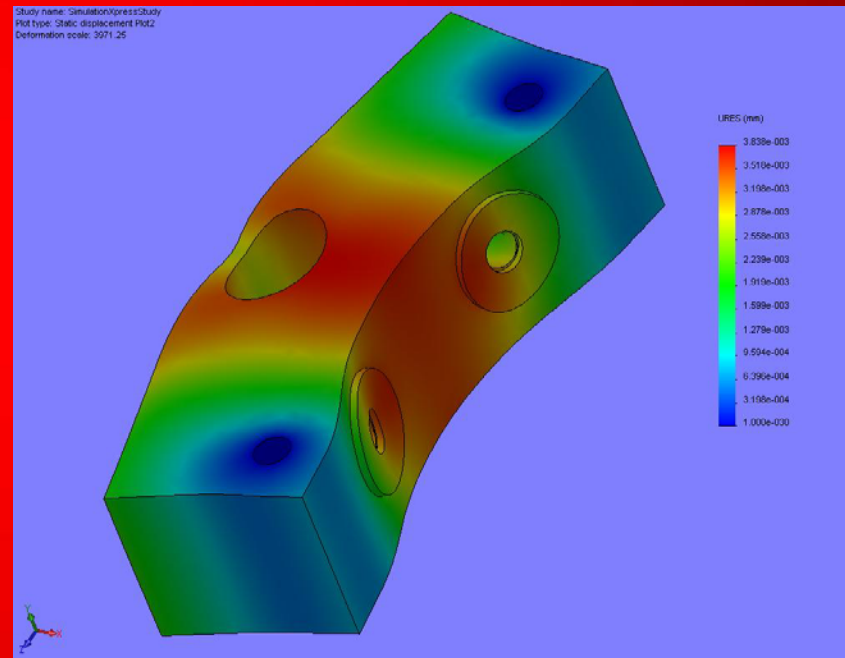


Both courtesy of N. Miller



CFP Testing/Results

- Testing:
 - To ensure design feasibility of bolts and block
 - Tensile Stress in bolts?
 - FEA
 - To find stresses in complex planes of block
- Results:
 - Safety Factor = 2.8
 - Aluminum 1060 Alloy
 - Possible redesign for weight reduction
 - Deflection < 4×10^{-3} mm
 - Grade 2 bolts okay

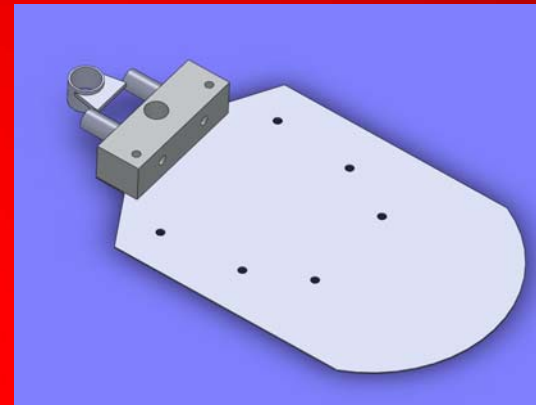


Courtesy of N. Miller



Geometry Results

- Testing:
 - Correct alignment with existing (and future) components
- Results:
 - Correct drive shaft alignment
 - Slight gap between block and plate
 - Acceptable basis for future modeling



Both courtesy of N. Miller



Our Drive System

- Use current drive shaft
- Helical bevel gears
 - Open or enclosed?
 - Problems with ratio and RPMs
- Reuse belt from last year
 - Same reduction ratios
 - Output at prop
 - Mounted below motors



www.lltrans.com

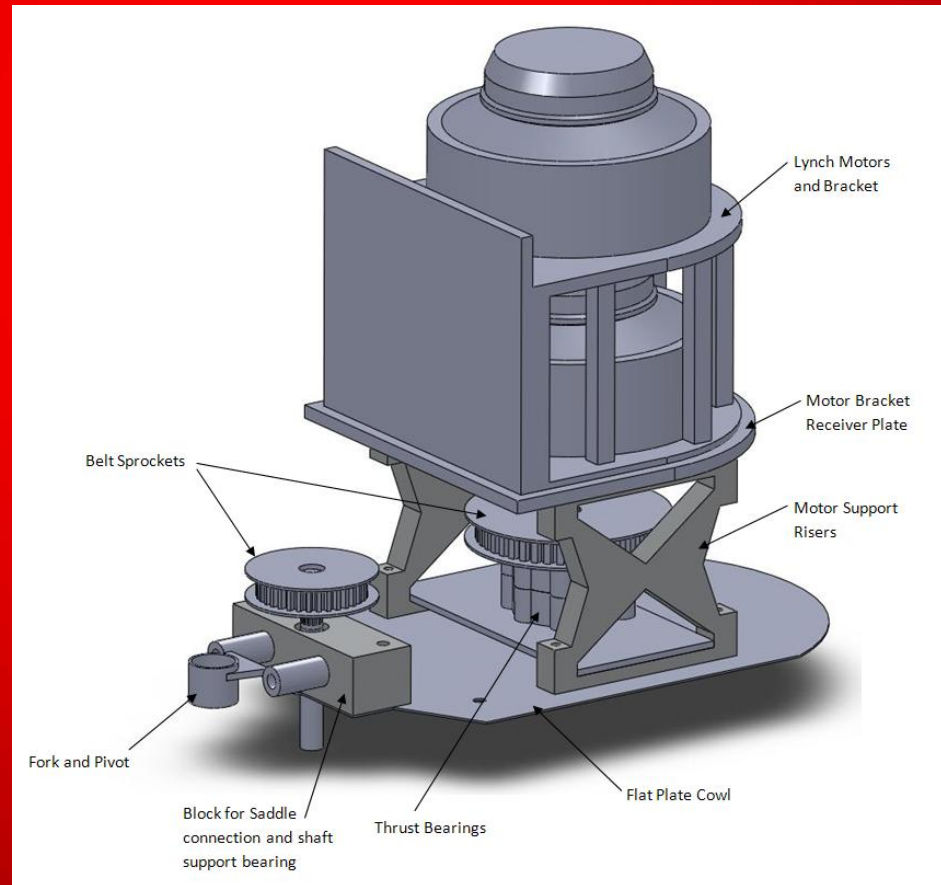


Courtesy of GCAMP 08-09

Our Motor Mounting

- Easy Changeout of Motors
 - Motors Above Belt Drive
 - Risers

Note: Motor will have opposite direction of spin from last year for forward movement of boat

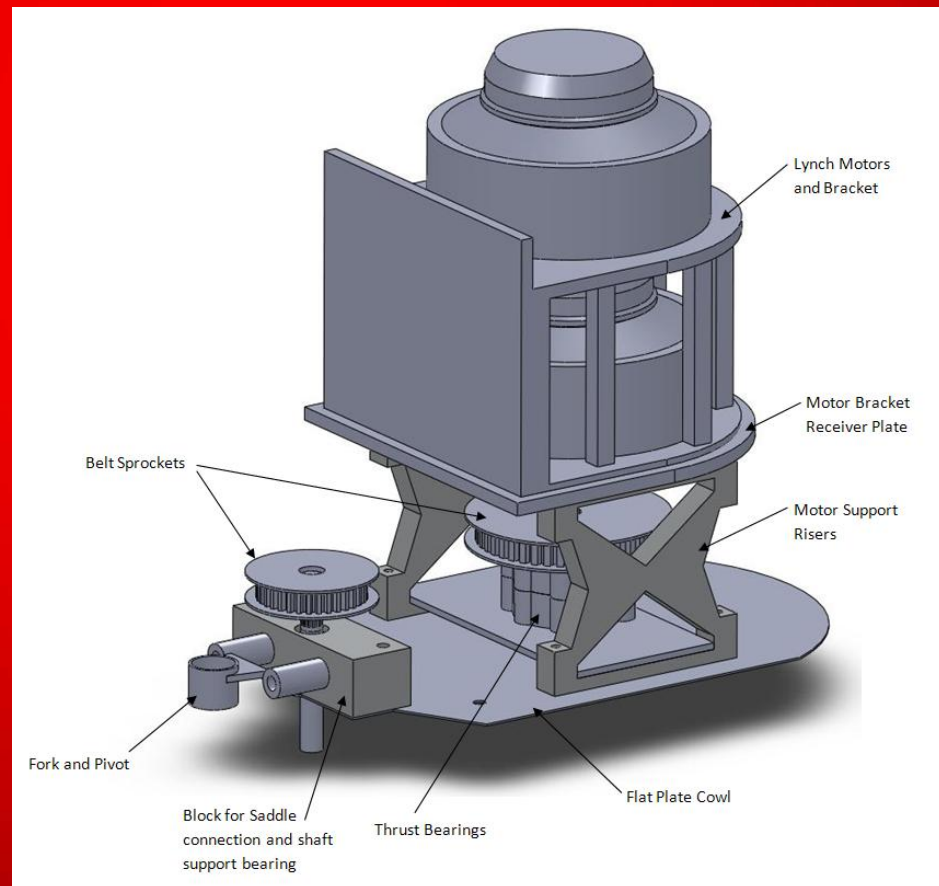


Courtesy of N. Miller



Our Motor Mounting

- Easy Changeout of Motors
 - Receiver Plate to Mate with Lynch Bracket

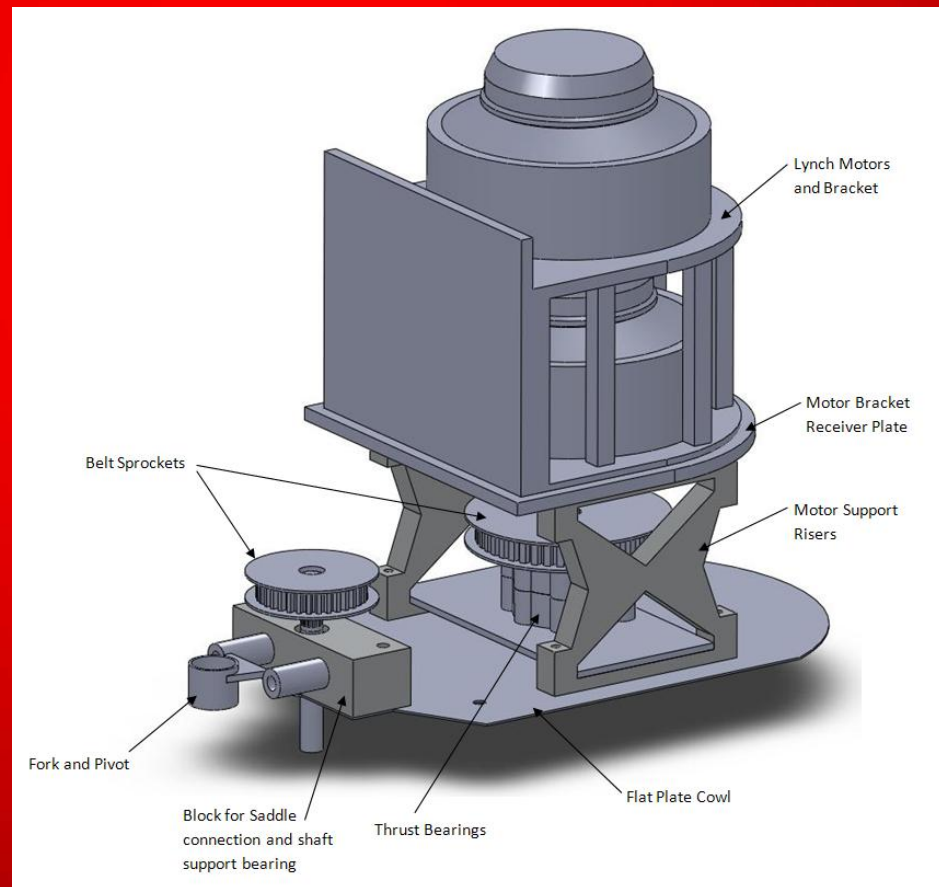


Courtesy of N. Miller



Our Motor Mounting

- Easy Changeout of Motors
 - Pulleys independently supported and tensioned

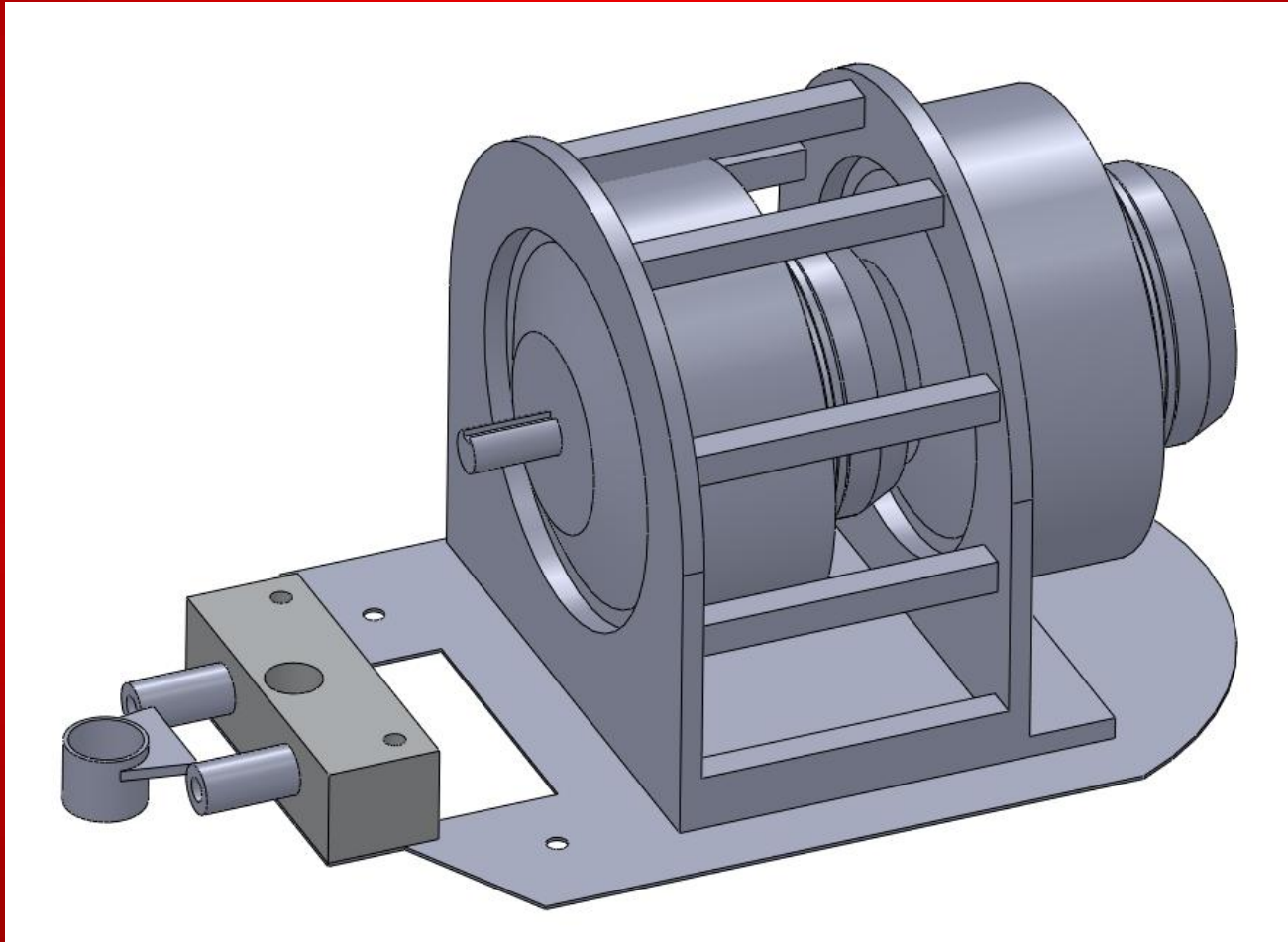


Note: Also easier for belt changes

Courtesy of N. Miller



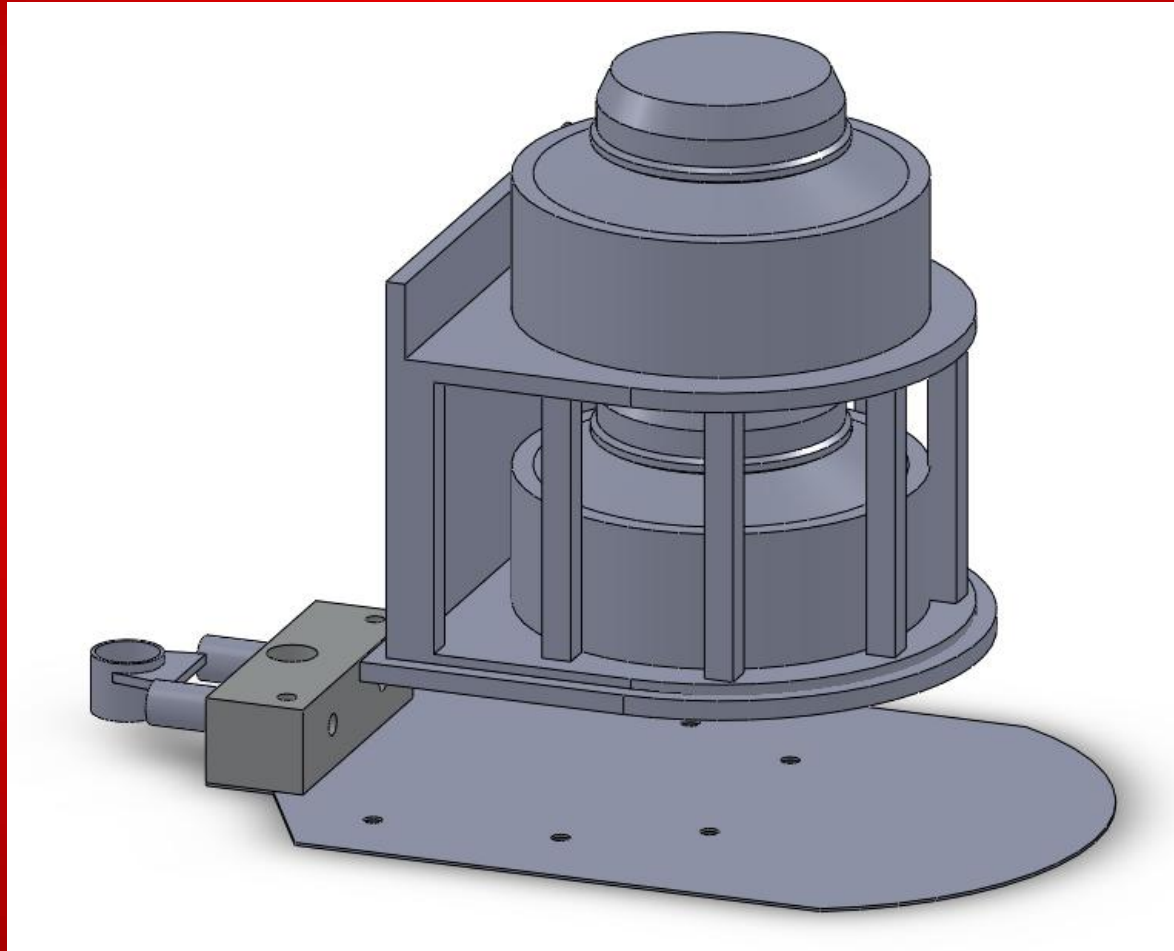
Alternate Mounting 1



Courtesy of N. Miller



Alternate Mounting 2



Courtesy of N. Miller



Throttle Control

- Replace current cable system with electronic
 - Last year
 - Linkage to Potentiometer



Photo courtesy of GCAMP 08-09



www.vishay.com

- This year
 - Connect Handle Directly to Position Sensor
 - Vishay 981 HE



Cooling System

- Definitely Needed
 - Last year got to 330° F
 - Motors fine in open air but not in enclosed space
 - No windings => create own air cooling
- Still in Preliminary Stages of Design
 - Open vs. Closed Loop
 - River water vs. Coolant & Exchanger
 - Tubes in Upper Cowling
 - Thermocouple Controlled Pump



Schedule & Budget

Date	Task	Completed
11/1/09	Motors Selected, Mounting Design Decided	+*
11/13/09	CFP Complete	+
12/25/09	Have Motors	+
1/15/09	Throttle Control Assembled	+/-
2/14/10	Final Rev of Motor Mounts and Lower Cowl	-
4/4/10	Upper Cowl, Cooling System	-
4/20/10	Total Assembly for Design Day	-

Items	Spent
Motors & Shipping (x2)	\$2717.67
Hardware & Machining	\$34.15
Pulleys, Straighten Shaft	\$125
Throttle Assembly	\$35

- Being Rev'd as progress is made



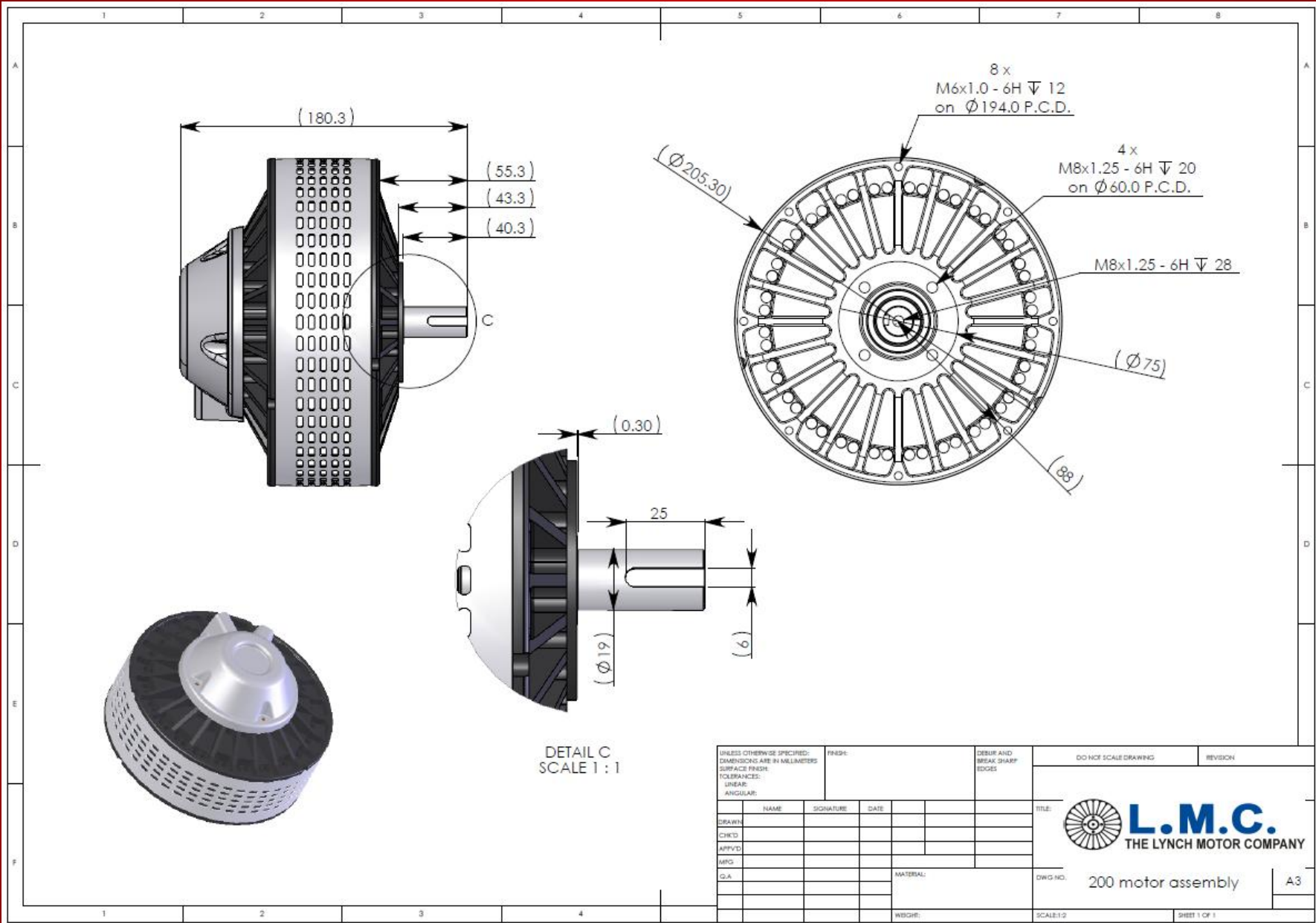
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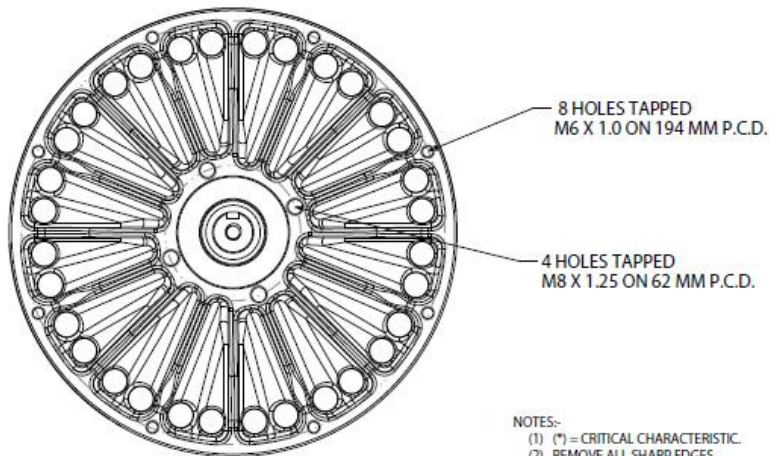
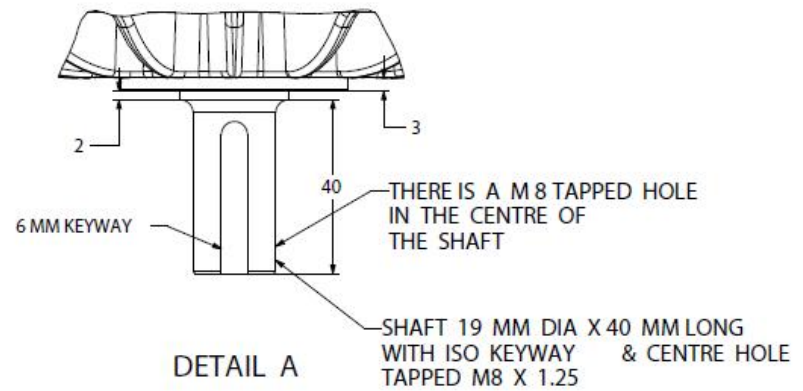
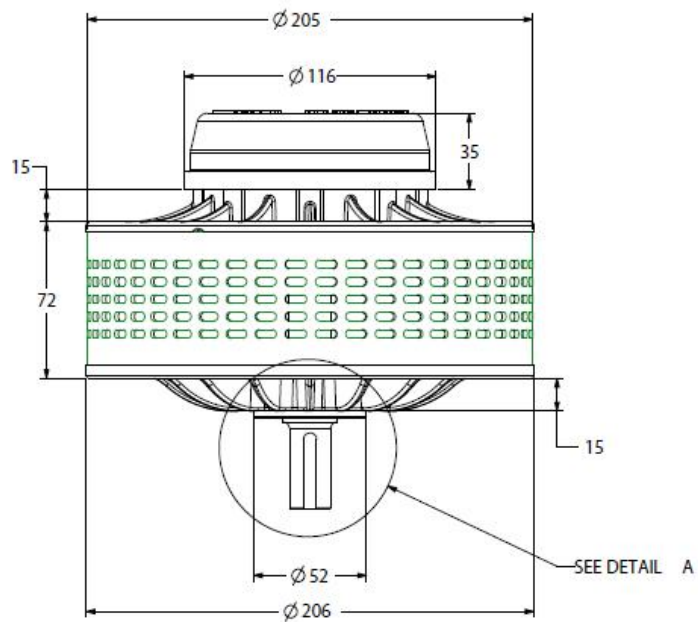


Questions?





Lynch Motor Company LEM200 Series



NOTES:-
 (1) (*) = CRITICAL CHARACTERISTIC.
 (2) REMOVE ALL SHARP EDGES.
 (3) ALL DIMENSIONS ARE IN mm.

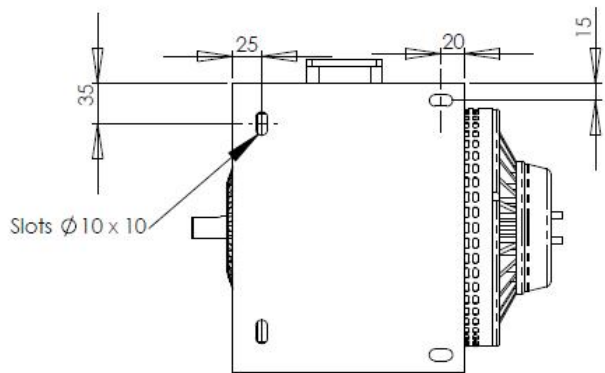
Weight: 11kg



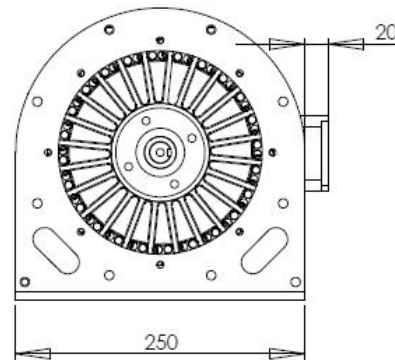
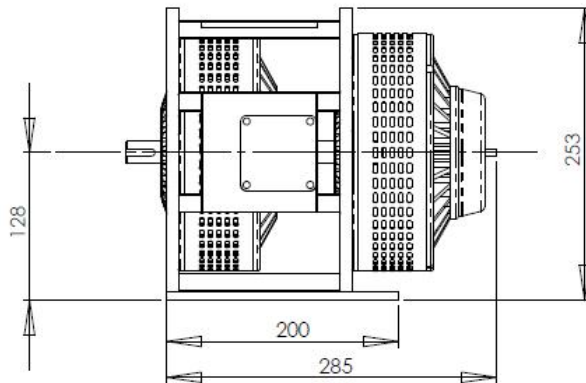
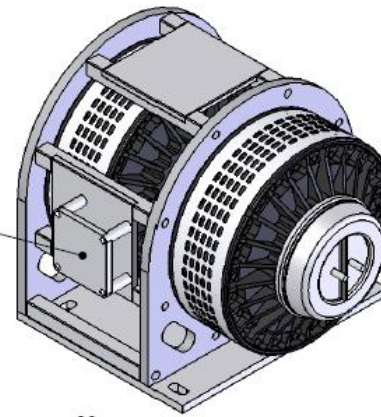
AGNI
MOTORS

www.agnimotors.com
 info@agnimotors.com
 +91 (0) 2836 253 114
 +91 (0) 9825 885 021

Agni Motors 143 Series



Terminal studs M6
under cover .
Optional mounting:
left, right or top
frame plate



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		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	First Angle Projection
		DIMENSIONS ARE IN MILLIMETRES	DRAWN	RT	10-03-06	
		TOLERANCES:	CHECKED			TITLE: LEM-2X2 installation
		HOLE CENTRES $\pm 0.2\text{mm}$	ENG APPR.			
		OTHER DIMS $\pm 0.5\text{mm}$	MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			SIZE DWG. NO. REV A LEM-2x2
		MATERIAL ALLOY 6082	COMMENTS:			
	NEXT ASSY	USED ON	FINISH			SCALE 1=5 WEIGHT: SHEET 1 OF 1
	APPLICATION		DO NOT SCALE DRAWING			

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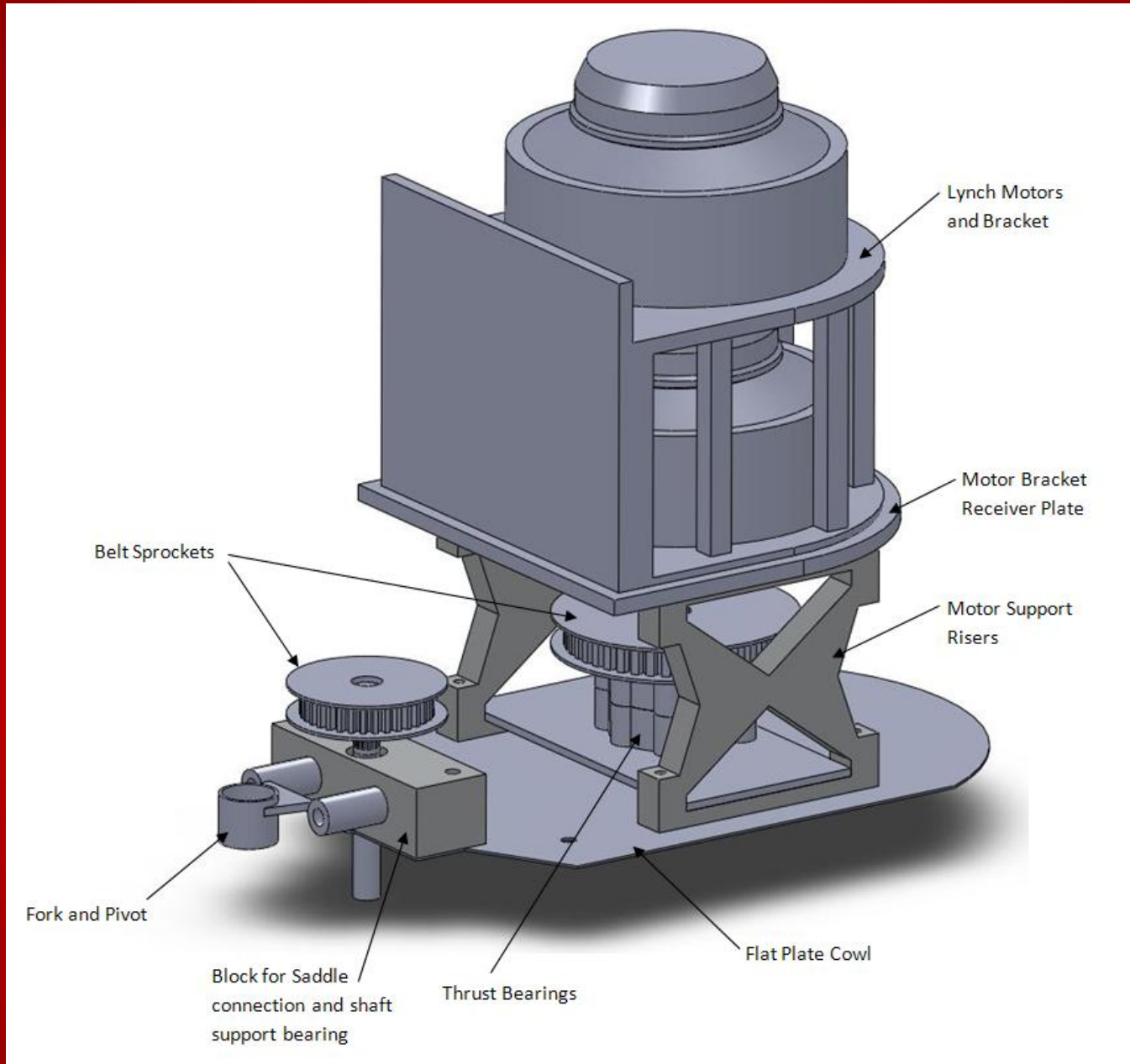
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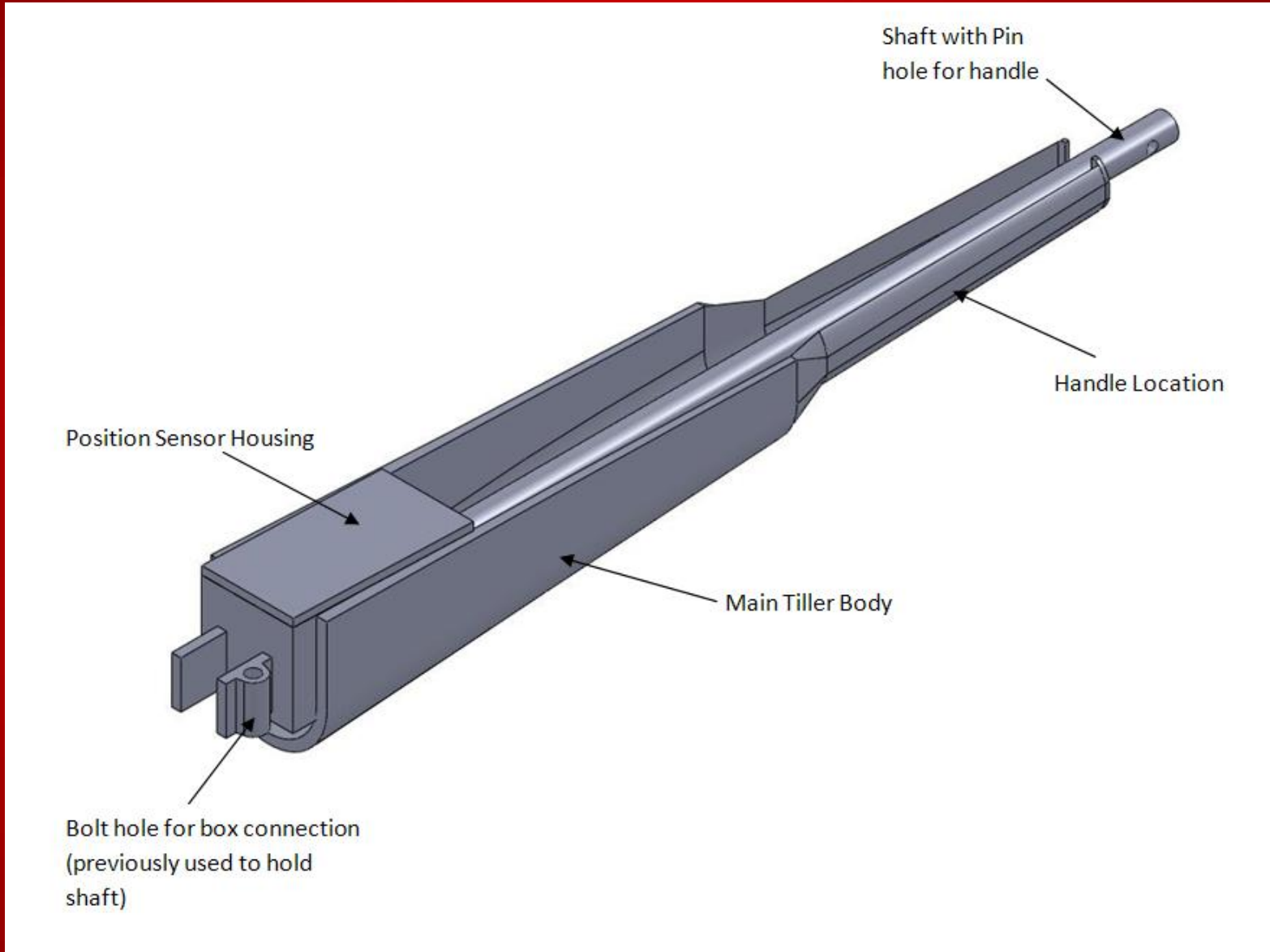
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Lynch Motor Company LEM-2x2



Total Motor & Drive Assembly

Courtesy of N. Miller



Throttle Assembly

Courtesy of N. Miller