1/Test Proposal

Test Title	Carbon Fiber Pushrod Insert Testing
Project Car	KS7-X
Subgroup	Composites
Engineer	Keegan Jordan
Responsible Lead	Grayson Legg
Date Submitted	10/18/2023
Date Presented	10/19/2023

1. Test Variables

- *List and describe all variables to be measured by this test*
    - Tensile Strength of the assembly.
    - Shear strength of the attachment between the carbon fiber rod and the insert.
    - Etching method
    - Pinned method
    - Sanding method
    - Capped method

2. Sensors

- *List and describe the type of sensors that will be needed to collect data*
    - MTS Machine

3. Data Table

- *Create a table of the data that will be collected*

Test Sample #0: Steel pushrod

Test Method	Control Variables	Shear Strength of bond Measured (psi) Trial 1	Shear Strength of bond Measured (psi) Trial 2	Shear Strength of bond Measured (psi) Trial 3	Notes
The Steel pushrod currently used on car will be tested	-Steel Rod -Measuring device				Comparative test to Carbon Fiber alternatives.

Test Sample #1: Sanded insert bonded w/ Hysol EA-e60hp and glass beads.

Test Method	Control Variables	Shear Strength of bond Measured (psi) Trial 1	Shear Strength of bond Measured (psi) Trial 2	Shear Strength of bond Measured (psi) Trial 3	Notes
A sanded aluminum insert bonded to the carbon fiber tube using adhesive and glass beads.	-Carbon Fiber Rod -Adhesive -Glass beads -Measuring device				This test will be used as a base model test.

Test Sample #2: Etched insert bonded w/ Hysol EA-e60hp and glass beads

Test Method	Control Variables	Shear Strength of bond Measured (psi) Trial 1	Shear Strength of bond Measured (psi) Trail 2	Shear Strength of bond Measured (psi) Trial 3	Notes
An etched aluminum insert bonded to the carbon fiber tube using adhesive and glass beads.	-Carbon Fiber Rod -Adhesive -Glass beads -Measuring device				

Test Sample #3: Pinned-locked insert bonded w/ Hysol EA-e60hp and glass beads.

Test Method	Control Variables	Shear Strength of bond Measured (psi) Trial 1	Shear Strength of bond Measured (psi) Trial 2	Shear Strength of bond Measured (psi) Trial 3	Notes
A hole is to be drilled through carbon fiber rod into insert and two metal pins will be placed on either side. Pins will be used to help support the bond between the rod and the insert. Adhesive and glass beads will also be used to bond the insert and rod.	-Carbon Fiber Rod -Adhesive -Glass beads -Measuring device				

Test Sample #4: CF cap on a sanded insert bonded w/ EA-e60hp and glass beads.

Test Method	Control Variables	Shear Strength of bond Measured (psi) Trial 1	Shear Strength of bond Measured (psi) Trial 2	Shear Strength of bond Measured (psi) Trial 3	Notes
A sanded insert will be bonded to the rod using adhesive and glass beads. Then a Carbon Fiber Cap will then also be cured to the outside of the rod.	-Carbon Fiber Rod -Adhesive -Glass beads -measuring device -Resin				

Test Sample #5: A grooved insert bonded w/ Hysol EA-e60hp and glass beads.

Test Method	Control Variables	Shear Strength of bond Measured (psi) Trial 1	Shear Strength of bond Measured (psi) Trial 2	Shear Strength of bond Measured (psi) Trial 3	Notes
A grooved insert will be bonded to the rod using Hysol Adhesive and glass beads.	-Carbon Fiber Rod -Adhesive -Glass beads -measuring device				

4. Test Goals

- *What are the expectations of the results?*

	EVENT:	1G ACCEL	1.5G ACCEL	2.8G ACCEL	SS 1G SKIDPAD RH	SS 1.5G SKIDPAD RH	1G SKID+ 1G ACCEL RH	5G BUMP	Max Tension	Max Compression
RR	TR	-109.62	-122.82	-157.16	-109.95	-91.19	-169.35	0.0164	-91.19	-169.35
	LCAF	-618.71	-693.26	-887.07	-281.83	-184.85	-434.09	37.1512	-184.85	-887.07
	LCAR	525.12	588.39	752.88	372.00	286.20	572.97	-7.1710	752.88	-7.17
	UCAF	199.24	223.25	285.66	87.34	56.20	134.52	-253.7522	285.66	-253.75
	UCAR	-550.32	-616.63	-789.02	-435.12	-344.01	-670.19	-1596.2191	-344.01	-1596.22
	PR	464.80	520.80	666.40	236.51	163.00	364.28	1967.5014	666.40	163.00

- *666.40lbs of force in tensile.*
- *163lb of stress in compression*
    - We expect that the insert will be able to resist pulling out of the rod at 666.40lbs of force in tensile.
- *What factors would define a successful test vs an inconclusive test? Why?*
    - A successful test will show a maximum force experienced when the bond fails.
    - An inconclusive test would be the result of error in setting up MTS.
- *What constitutes a valid result?*
    - A valid result would be a method of bonding an aluminum insert to a carbon fiber rod that could withstand up to minimum of 666.40lbs of force in tensile and 163lbs in compression without failure.

5. Feedback

Include any feedback, commentary, or notes from the presentation session here.

Add test variables for independent variables.

Add test of steel pushrod

Calculate the expected max load of the steel pushrod

2/Test Validation

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6. Test Set-Up

Independent Variables:

- List the independent variables and how they will be manipulated
    - Insert bonding method: Observe differences in the forces experienced between the different methods of securing the insert to the rod.

Experimental Variables:

- List the experimental variables and how they will be measured
    - Applied load in tension: measured with an MTS machine. The load will be measured as a maximum at fracture.

Control Variables:

- List the control variables, how they will be measured, and how they will be kept consistent throughout multiple trials
    - The carbon fiber rod: same rod stock will be used for each test.
    - Adhesive: the same amount and type of adhesive will be used for each test (Hysol EA-e60hp)
    - Glass beads: the same amount and type of glass beads will be used for each test.

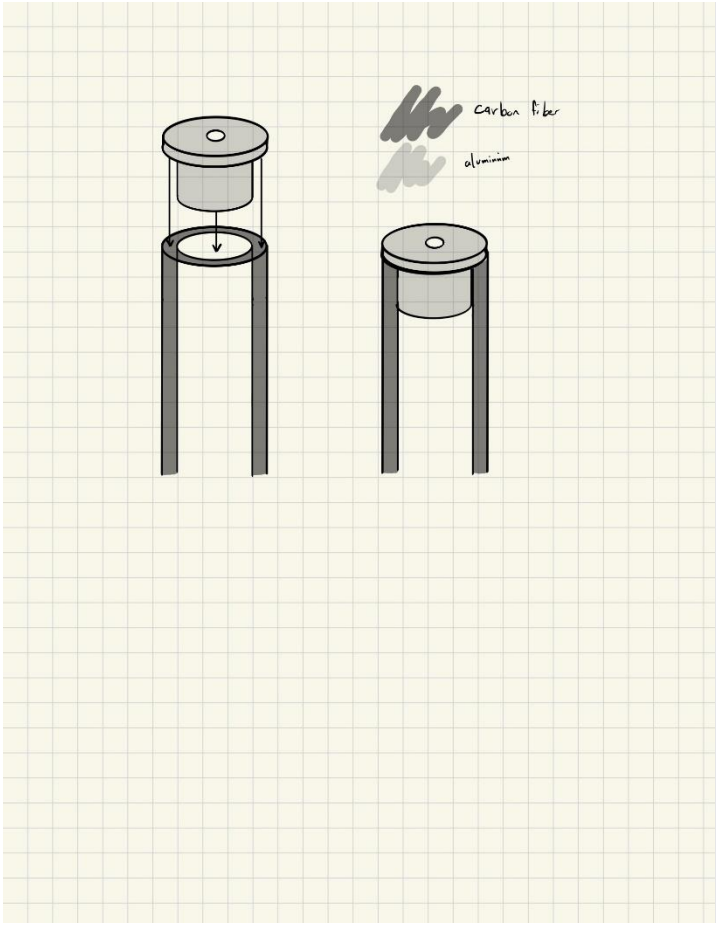
7. Data Output Sheet

- *Create an excel sheet that will be used to collect the data received from the test*
- *Include: Measured results, control variables, a notes column*
    - See excel sheet (Carbon Fiber pushrod insert testing data output)

https://kennesawedu.sharepoint.com/:x:/r/sites/Team-KS6-C/Shared%20Documents/Design%20Review/Proposal%20System/Test%20Proposals/Test%20Proposal%201/Composites/Carbon%20Fiber%20Pushrod%20Insert%20Testing/Carbon%20Fiber%20Pushrod%20Insert%20Testing%20Data%20output%20sheet.xlsx?d=we3d8b6ba7de94861bbf0378eced5093c&csf=1&web=1&e=PN081m&nav=MTVfe0YzNUE4NEJCLTBBRTgtNDkxNS05NkEyLTk2QTZEQTgxMjk5MH0

8. Test Set-Up Sheet

- *Create a step-by-step guide explaining how to set up the test so that any reasonably competent member could follow it and complete the test*
    - Test Sample #1: Sanded insert bonded w/ Hysol EA-e60hp and glass beads.



Surface Preparation:

- Lightly sand the inside of the carbon fiber tube with a high grit sandpaper to create a scouring that the adhesive can attach to.
- Sand the aluminum insert where it will make contact with the carbon fiber tube to create a scouring that the adhesive can attach to.

Manufacturing

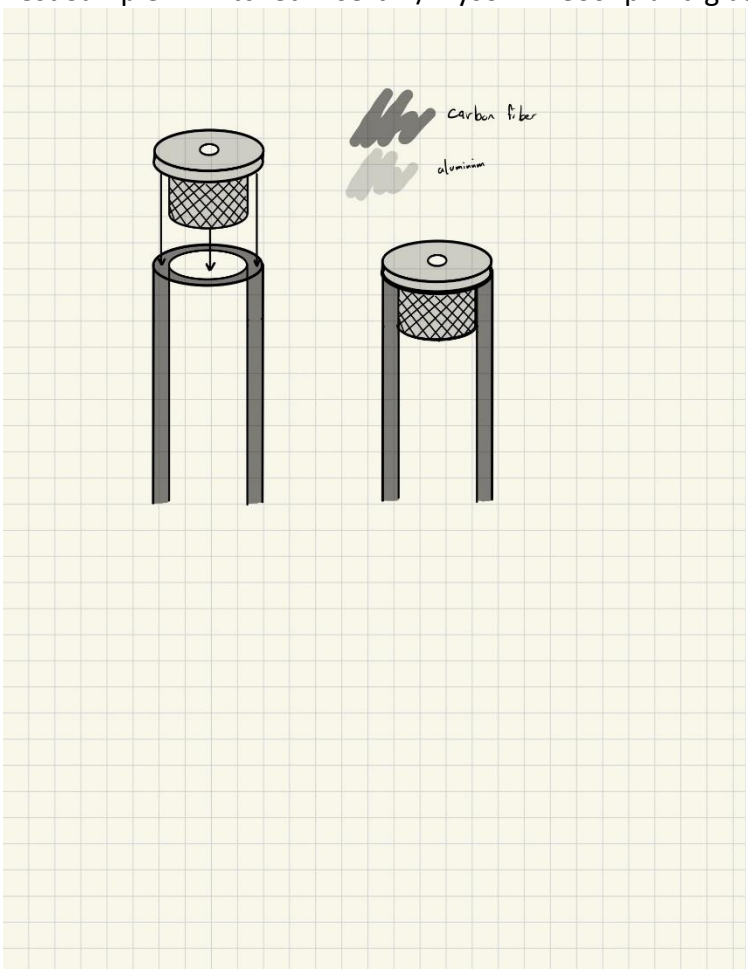
- Fabrication of aluminum insert: Aluminum stock cut on a lathe. Then drilled into the top surface for the threaded mounting hole.
- Using a mixture of adhesive and glass beads, coat the areas of contact between the rod and the insert.
- Combine insert and rod. Use a clamp to keep constant pressure while the adhesive hardens.

Testing

- Secure assembly to MTS

    - Thread jig into the pushrod insert.
    - Attach jig onto MTS machine.
- Apply tension until failure.
- Measure forces at failure.

- Test Sample #2: Etched insert w/ Hysol EA-e60hp and glass beads



Surface Preparation:

- Lightly sand the inside of the carbon fiber tube with a high grit sand paper to create a scouring that the adhesive can attach to.
- Dip the aluminum insert in an etching solution.

Manufacturing

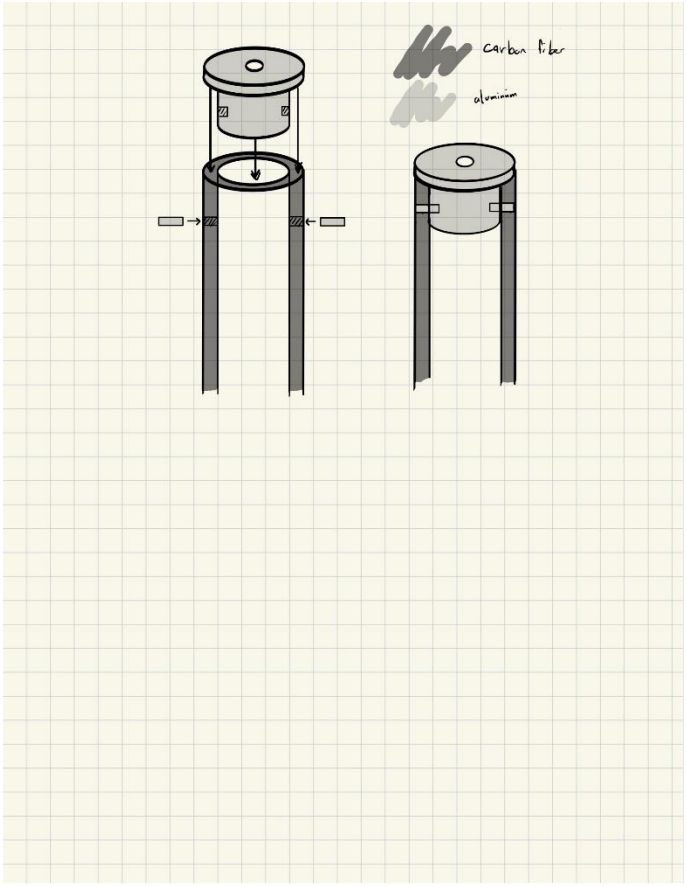
- Using a mixture of adhesive and glass beads, coat the areas of contact between the rod and the insert.
- Combine insert and rod. Use a clamp to keep constant pressure while the adhesive hardens.

Testing

- Secure assembly to MTS
    - Thread jig into the pushrod insert.

    - Attach jig onto MTS machine according to MTS procedures.
- Apply tension until failure.
- Measure forces at failure.

Test Sample #3: Pin-locked insert w/ Hysol EA-e60hp and glass beads



Surface Preparation:

- Lightly sand the inside of the carbon fiber tube with a high grit sand paper to create a scouring that the adhesive can attach to.
- Sand the aluminum insert where it will make contact with the carbon fiber tube to create a scouring that the adhesive can attach to.

Manufacturing

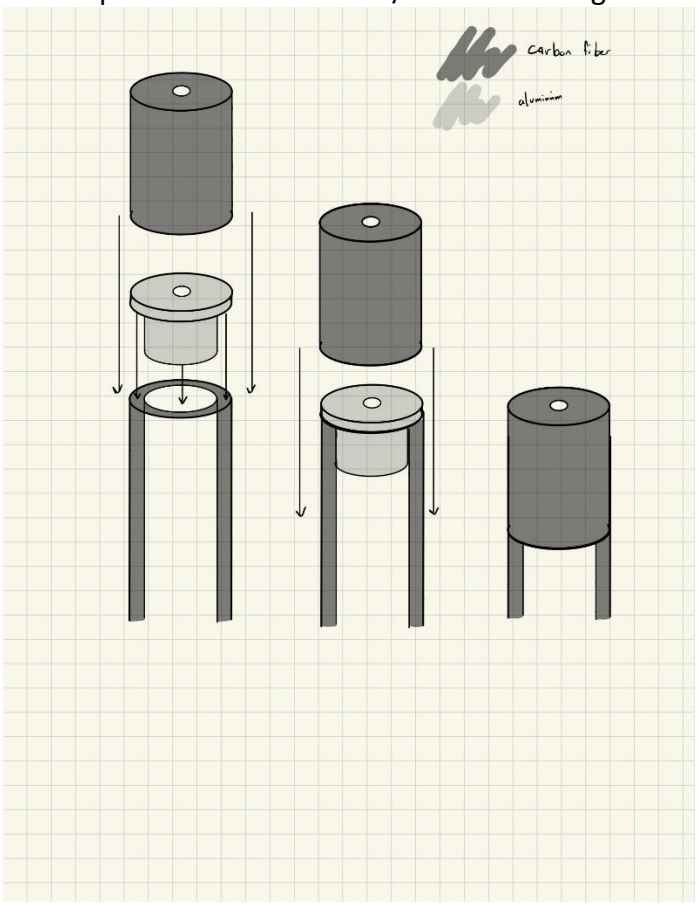
- Fabrication of aluminum insert: Aluminum stock cut on a lathe. Then drilled into the top surface for the threaded mounting hole.
- Fabrication of aluminum pins. Aluminum stock cut on a lathe. Or bought from supplier.
- Using a mixture of adhesive and glass beads, coat the areas of contact between the rod and the insert.
- Combine insert and rod. Use a clamp to keep constant pressure while the adhesive hardens.
- Use a $1/8^{th}$ in drill bit to drill a hole on either side of the tube into the aluminum insert.

- Insert pins into drilled holes and secure with adhesive.

Testing

- Secure assembly to MTS
    - Thread jig into the pushrod insert.
    - Attach jig onto MTS machine according to MTS procedures.
- Apply tension until failure.
- Measure forces at failure.

Test Sample #4: CF cap on a sanded insert w/ adhesive and glass beads.



Surface Preparation:

- Lightly sand the inside of the carbon fiber tube with a high grit sandpaper to create a scouring that the adhesive can attach to.
- Sand the aluminum insert where it will make contact with the carbon fiber tube to create a scouring that the adhesive can attach to.
- Lightly sand outside of carbon fiber rod where cap and rod will make contact to create scouring that the cap can be layered on top of.

Manufacturing

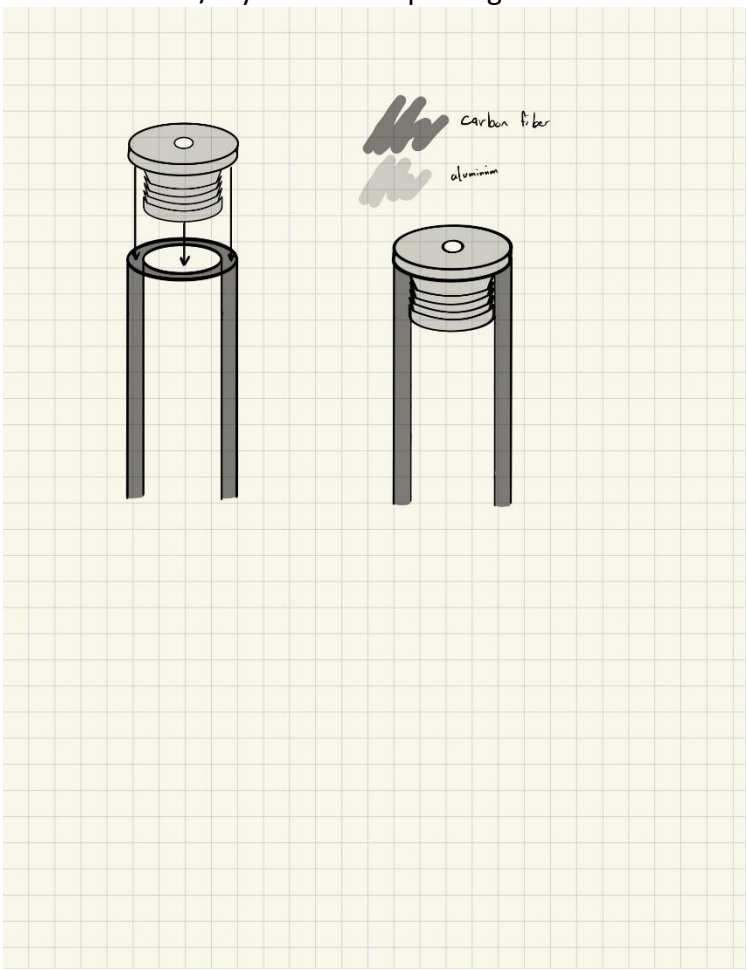
- Using a mixture of adhesive and glass beads, coat the areas of contact between the rod and the insert.

- Combine insert and rod. Use a clamp to keep constant pressure while the adhesive hardens.
- Layup carbon fiber material onto rod/insert assembly to form a cap.
- Bag assembly and cure.

Testing

- Secure assembly to MTS
    - Thread jig into the pushrod insert.
    - Attach jig onto MTS machine according to MTS procedures.
- Apply tension until failure.
- Measure forces at failure.

Test Sample #5: Grooved insert w/ Hysol EA-e60hp and glass beads.



- **Surface Preparation**:
- Lightly sand the inside of the carbon fiber tube with a high grit sand paper to create a scouring that the adhesive can attach to.
- Sand the aluminum insert where it will make contact with the carbon fiber tube to create a scouring that the adhesive can attach to.

Manufacturing

- Using a mixture of adhesive and glass beads, coat the areas of contact between the rod and the insert.
- Combine insert and rod. Use a clamp to keep constant pressure while the adhesive hardens.

Testing

- Secure assembly to MTS
    - Thread jig into the pushrod insert.
    - Attach jig onto MTS machine according to MTS procedures.
- Apply tension until failure.
- Measure forces at failure.

9. Feedback

Include any feedback, commentary, or notes from the presentation session here.

3/Test Design Validation

KENNESAW MOTORSPORTS

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Engineer	Keegan Jordan
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Date Presented	10/26/2023

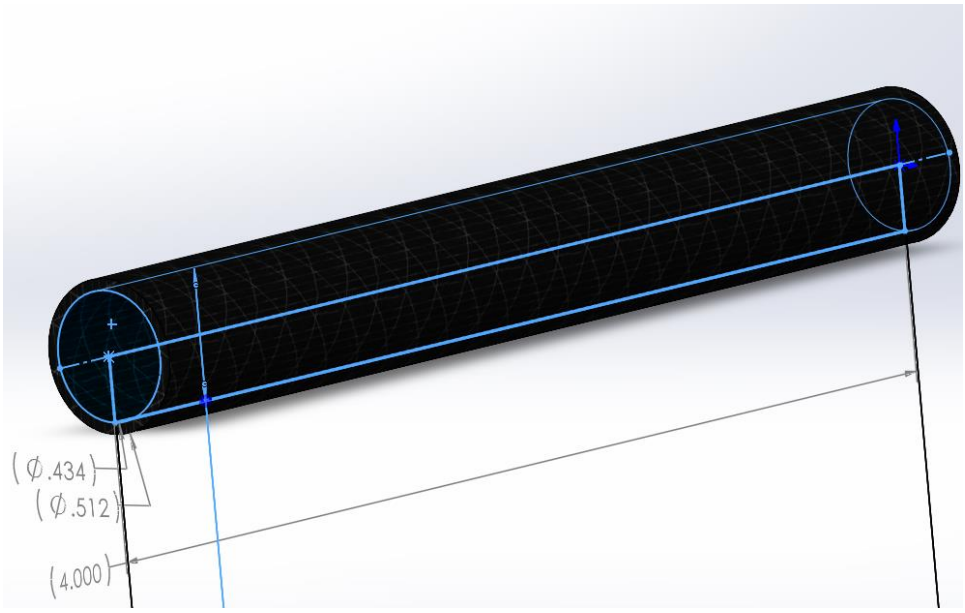
10. CAD and Components

- *Insert images of solid models and drawings of all components here. Include a bill of materials if commercial/off-the-shelf (COTS) components are used.*
- *Include fastener and sensor selection*

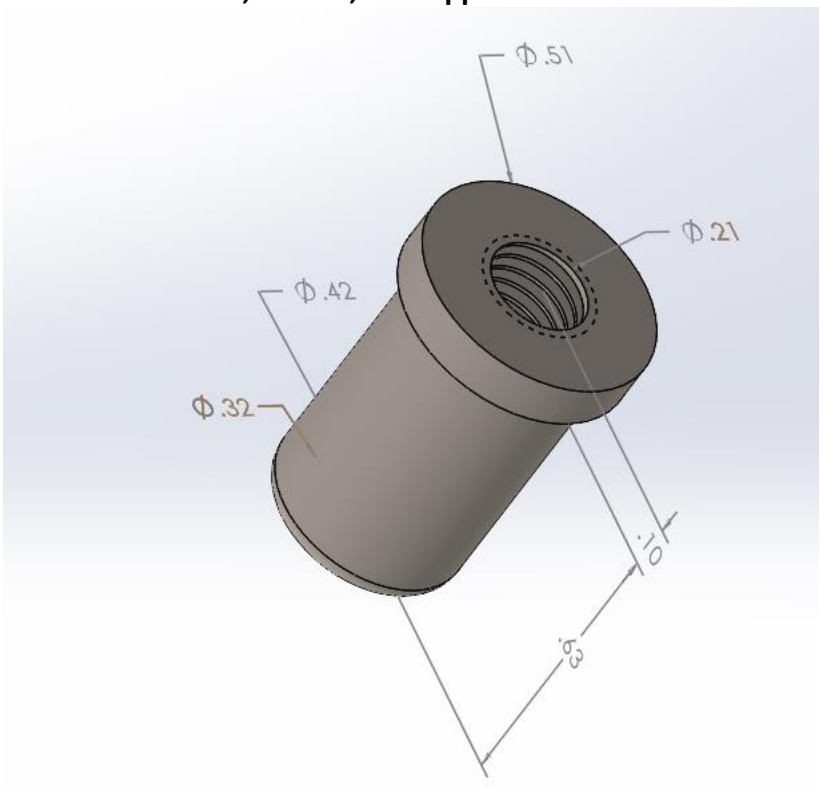
Item	Supplier	URL	Cost/unit	Units	Total
Carbon Fiber Rod .512" diameter 48" long	Carbon Envisions	https://compositeenvisions.com/product/roll-wrapped-carbon-fiber-tube-twill-weave-gloss-finish-48-long/	$23.70 per 48" rod	2	$47.40
Hysol EA e-60hp	McMaster	https://www.mcmaster.com/products/loctite-hysol/adhesives-2~/container-type~cartridge/	$22.55 per 50ml	2	$45.10
Aluminum 6061 rod stock .5"diameter 48" long	Online Metals	https://www.onlinemetals.com/en/buy/aluminum/0-5-aluminum-round-bar-6061-t6511-extruded/pid/1084	$9.08 per rod	1	$9.08
Stainless Steel 316 dowel pins	Amazon	Follow link in comments	$10.97/ pack of 25	1	$10.97
Rockwest Glass beads #1031-25	Rock West Composites	https://www.rockwestcomposites.com/1031-25	$35.99 for 25g bottle	1	$35.99
Commercial Grade Carbon Fiber Fabric 2x2 Twill 3k 6oz/203gsm 60" with Tracers	Carbon Envisions	https://compositeenvisions.com/product/commercial-grade-carbon-fiber-fabric-2x2-twill-3k-6oz-203gsm-60-with-tracers/	$17.00 for 36"x60"	1	$17.00

Resin	Fibreglast	https://www.fibreglast.com/product/System_2000_Epoxy_Resin_2000	$74.99/ per quart	1	$74.99
Resin Hardener	FibreGlast	https://www.fibreglast.com/product/System_2000_Epoxy_Resin_2000	$29.95 / ½ pint	1	$29.95
Steel Round bar stock 1" diameter	Online Metals	https://www.onlinemetals.com/en/buy/carbon-steel/1-carbon-steel-round-bar-1045-cold-finish/pid/21682?CAWELAID=12029332000020414 7&gclid=CjwKCAjw-eKpBhAbEiwAqFL0mltbIwn0ktc4ERfd4qj_O-DnYWamS2i9hekTob2Se74QJEZ77laUdRoCj7oQAvD_BwE	$11.37/ ft	1	$11.37
Aluminum Etching Solution 60-80% Phosphoric Acid, 0.01-10% Acetic Acid, and 0.01-5% Nitric Acid	Lab Alley	https://www.laballey.com/products/aluminum-metal-etchant?currency=USD&variant=39788438356123&stkn=7c72afeff1e7&gclid=CjwKCAjwnOipBhBQEiwACyGLuvjlwoc1g-48neSTpJzMEXJD723dKOFYP7iXWh-hPfsbuKvSlgfUyxoCPKsQAvD_BwE	$20.00/ 100mL bottle	1	$20.00

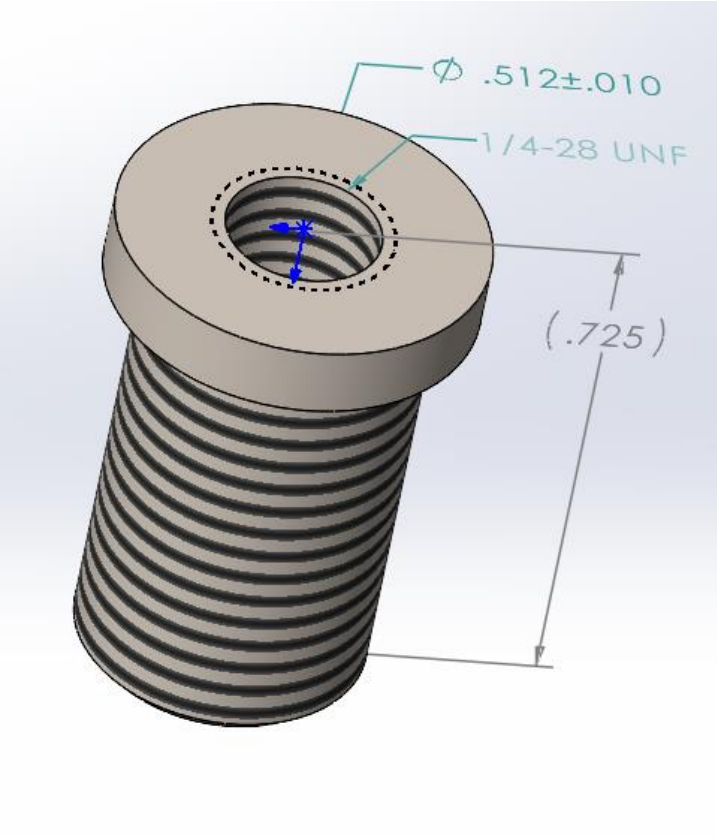
Carbon Fiber Rod Stock



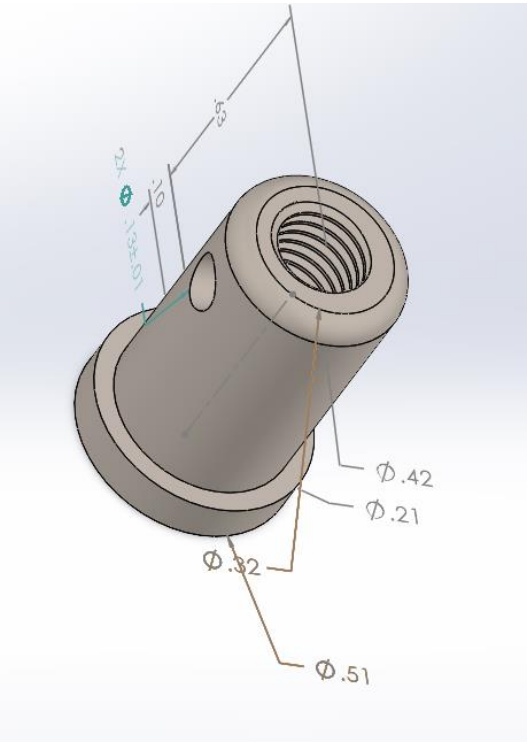
Inserts for sanded, etched,and capped assemblies.



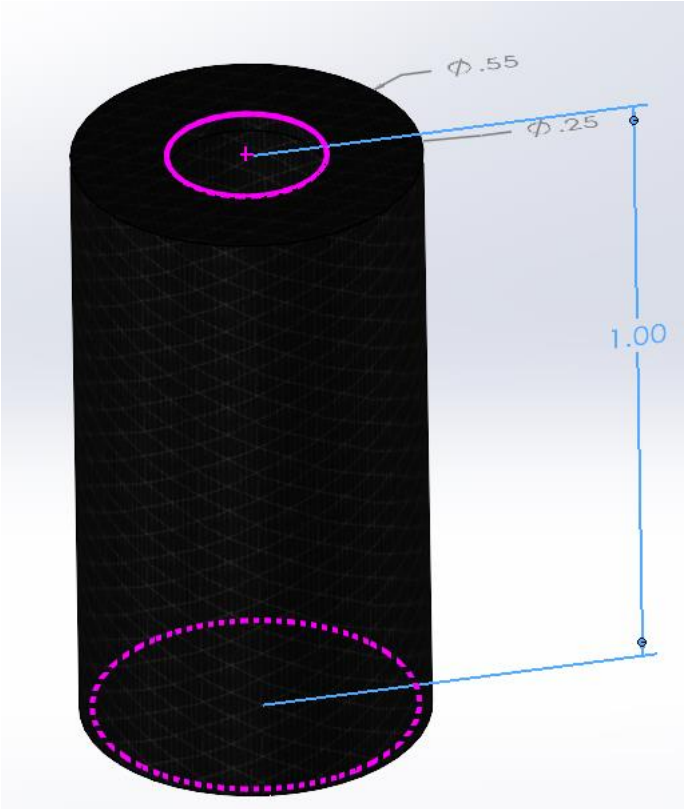
Grooved Insert



Pinned Insert

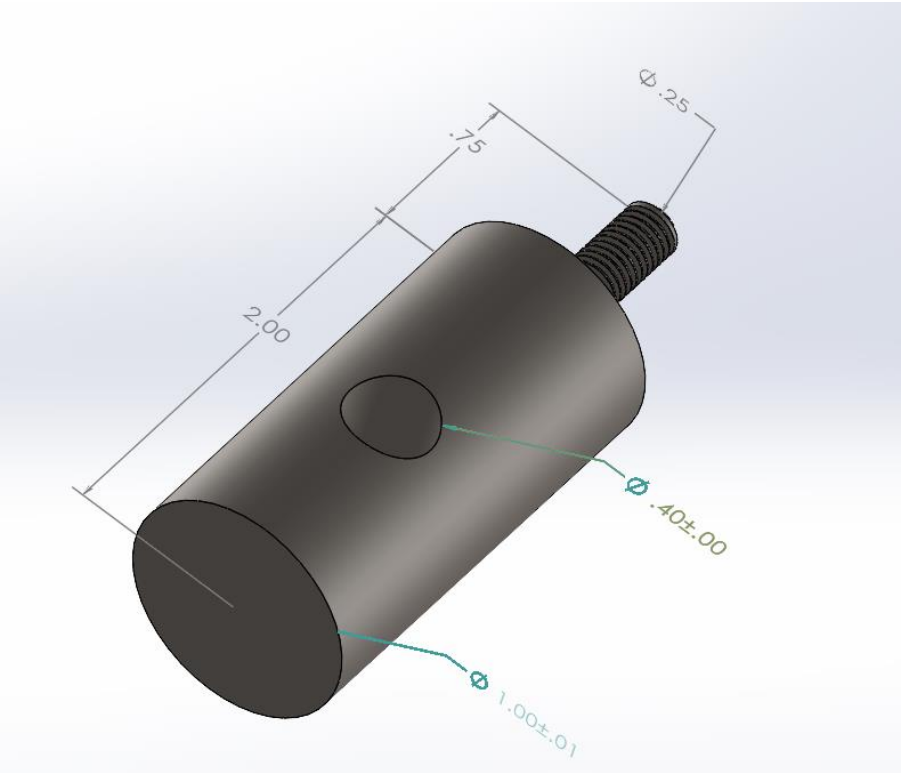


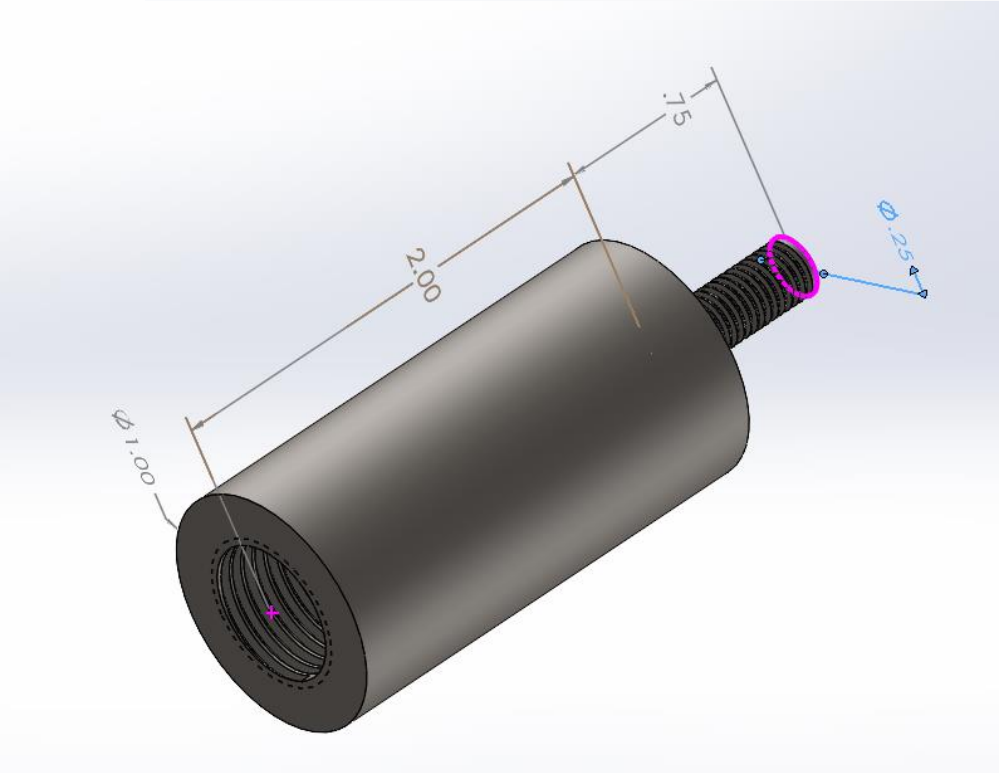
Carbon Fiber Cap (will be layed up onto rod/insert assembly)



Jig 1

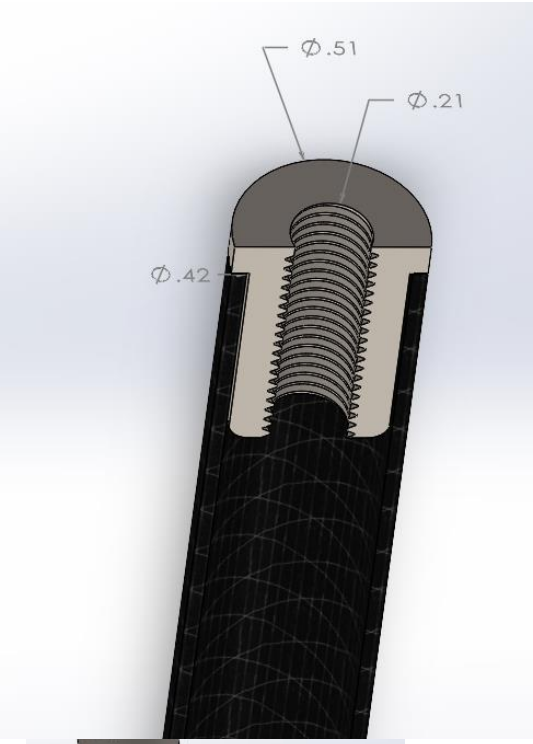
Jig 2

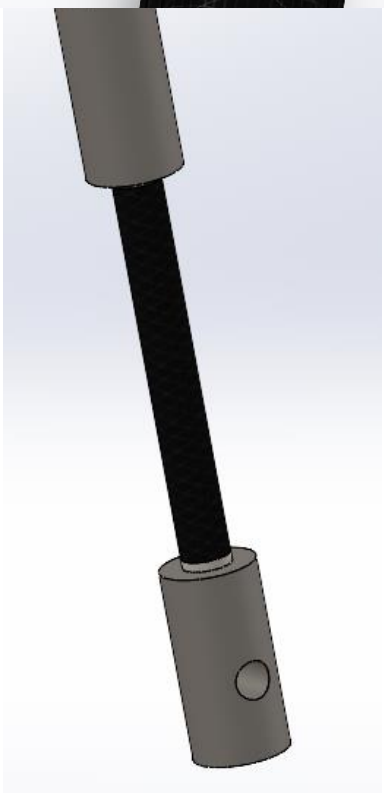




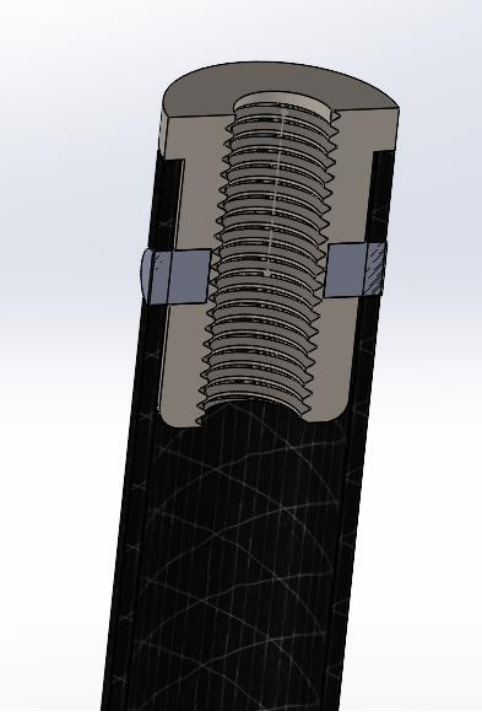
Jig Assembly

Sanded/ Etched Assembly

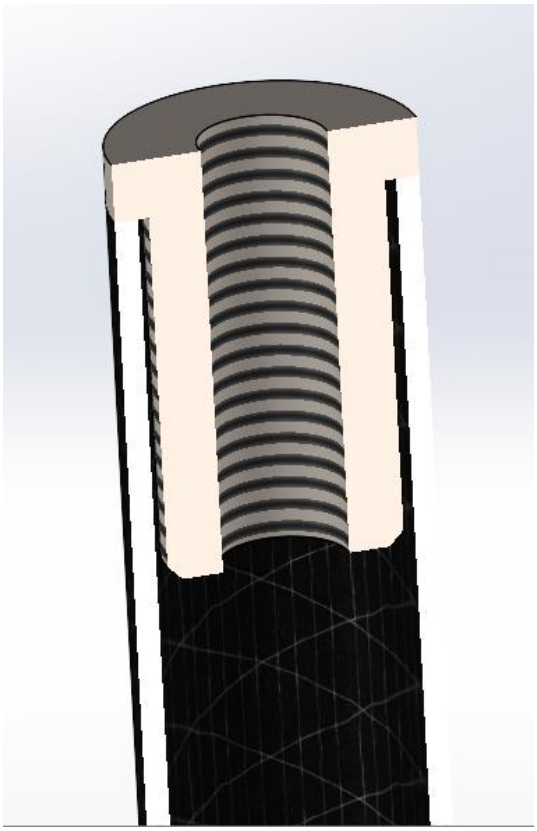




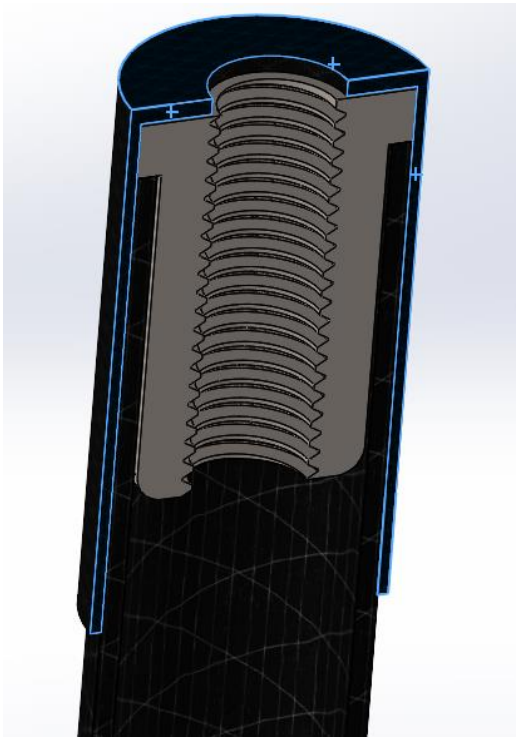
Pinned Assembly



Grooved Assembly



Capped Assembly



11. Detailed Calculations

- *Demonstrate that all COTS components are suitable for this application with calculations. Ensure that the parts are appropriate for the conditions being put through.*

PERFORMANCE OF CURED MATERIAL
Shear Strength vs Substrate
(Substrates cured for 5 days @ 22°C)

Substrate	Typical Value N/mm²	(psi)
Lapshear		
Grit-Blasted Steel	29.8	4320
Aluminum (Abraded/Acid Etched, 3 to 9 mil gap)	29.9	4340
Aluminum (Anodized)	17.9	2600
Stainless Steel	26.8	3890
Polycarbonate	12.6	1830
Nylon	1.9	270
Wood (Fir)	11.3	1640
Block Shear	N/mm²	(psi)
PVC	11.8	1710
ABS	12.8	1850
Epoxy	28.8	4030
Acrylic	1.0	150
Glass	31.7	4590

Insert surface Area:
r = 0.42 in; 0.625
from solidworks
SA = 0.826388 in²

For sanded surface:
strength in tension = 2600 psi
F = T · A
F = (2600)(0.82638)
F_{max} = 2148.59 lbs

Ground Insert
SA = 0.911538
strength in tension: 2600
F = T · A
F = (2600)(0.911538)
F_{max} = 2370 lbs

For etched surface:
strength in tension = 4340 psi
F = T · A
F = (4340)(0.82638)
F_{max} = 3586.49 lb

For pin locked:
ultimate tensile strength of SS316 = 58 ksi
shear stress = 60% of UTS
shear stress = (58000)(0.60) = 34800 psi
radius of pin = 0.0625 in
Cross-sectional Area = π(0.0625)²
= 0.01227 in²
F_{max} = T · A
F_{max} = (34800)(0.01227)
F_{max} = 427.06 lb
2_{pins} = 2(427.06 lb)
F_{max} = 854.12 lb
+ adhesive strength F = 2148.59 lbs
F_{max} = 3002.71 lbs

There is error in grooved insert calculations due to it not being a flat surface against a flat surface.

12. Readings??

- *What parameters are the specific sensors measuring?*
- *Explain and justify how the data will be measured accurately?*

- The MTS machine will be utilized to measure the max force in tensile the bond can withstand before failure for each of the trials per sample.
    - We will be collecting the data from the MTS. If there is an inconclusive test, the results of that test will be recorded and the error will be noted.

13. Computational Evaluation

- *If applicable, include FEA/CFD results and include analysis/compared to theoretical results.*

- N/A

14. Additional Verification

- *If applicable, include information such as lap sims or existing data from previous components and analyze.*

- N/A

15. Feedback

- *Include any feedback, commentary, or notes from the presentation session here.*

Drawings for inserts

4/Test Component Finalization

KENNESAW MOTORSPORTS

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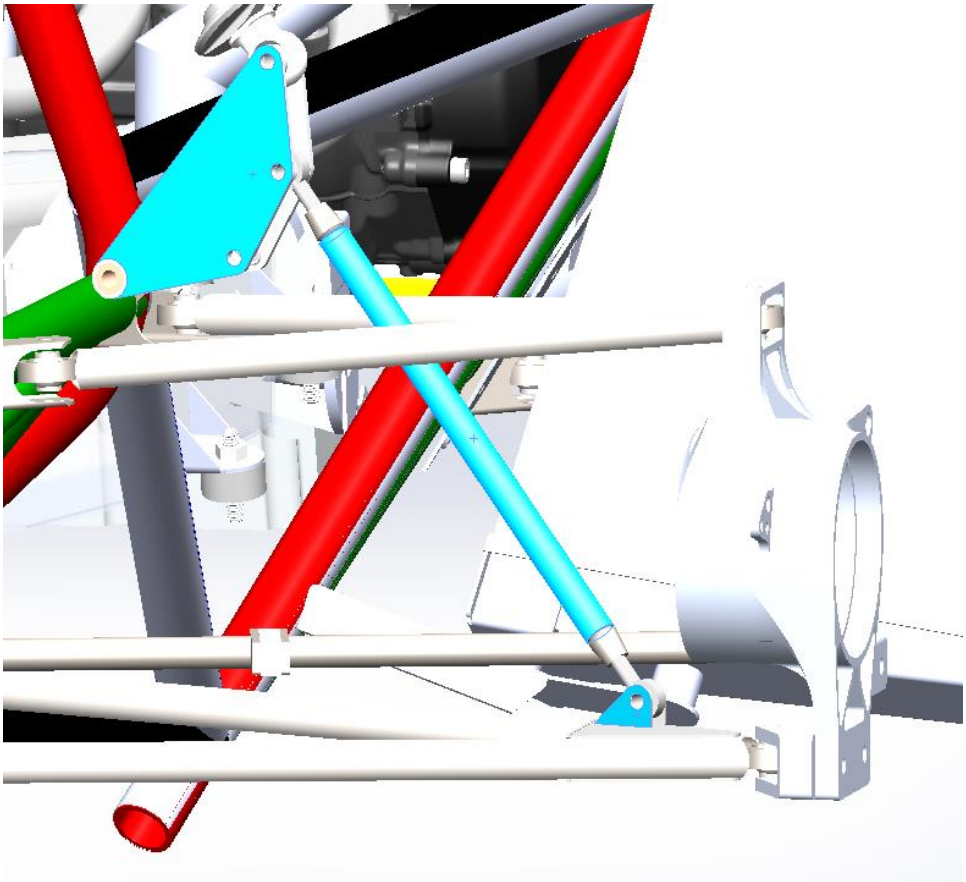
16. List of Interactions

List all interactions or conflicts with other components that are essential to conduct test. Include images of assembly CAD.

- Interaction with the bell crank.
- Interaction with the hub.



17. Manufacturing Plan

Consult manufacturing subgroup. Include necessary stock and machining operations.

Jig 1

- Manufacturing
  - Steel jig will be cut from 1in carbon steel bar stock on a lathe.
  - A 0.25x28in stud will need to be cut on one end of the jig used for threading jig into inserts
  - A m16xXXXmm thread will be cut on the other end of the jig used for threading jig onto MTS machine.

Jig 2

- Manufacturing
  - Steel jig will be cut from 1in carbon steel bar stock on a lathe.
  - A 0.25x28in stud will be cut on one end of the jig used for threading jig into inserts.
  - A 0.4in hole will be drilled through the 1in bar stock used for securing jig to MTS machine.

Test Sample #0 Steel pushrod

- Manufacturing (if no spare pushrod can be found/used)
  - Pushrod will be cut from 1in carbon steel bar stock on a lathe.
  - 0.25x28 thread will be drilled and tapped into either end of bar pushrod.
- Postproduction
  - Screw jigs into both end of assembly

Test Sample #1 Sanded Insert/CF rod assembly

- Manufacturing
  - Aluminum insert will be cut from 0.5in aluminum bar stock on a lathe. Then a 0.25 x 28 thread will be drilled and tapped through the center of each insert.
- Prep
  - All coinciding edges of inserts and carbon fiber rods will be sanded with a high grit sandpaper.
- Assembly
  - Coinciding edges of insert and carbon fiber rods will be joined together with Hysol EA e-60hp adhesive and RockWest #1031-25 glass beads.
  - Clamp will be used to hold constant pressure on assembly while adhesive cures.
- Postproduction
  - Screw jigs into both end of assembly

Test Sample #2 Etched Insert/CF rod assembly

- Manufacturing
  - Aluminum insert will be cut from 0.5in aluminum bar stock on a lathe. Then a 0.25 x 28 thread will be drilled and tapped through the center of each insert.

- Prep
    - Coinciding edges of inserts and carbon fiber rods will be sanded with a high grit sandpaper.
    - Aluminum insert will be dipped in an etching solution.
- Assembly
    - Coinciding edges of insert and carbon fiber rods will be joined together with Hysol EA e-60hp adhesive and RockWest #1031-25 glass beads.
    - Clamp will be used to hold constant pressure on assembly while adhesive cures.
- Postproduction
    - Screw jigs into both end of assembly

Test Sample #3 Pinned Insert/CF rod assembly

- Manufacturing
    - Aluminum insert will be cut from 0.5in aluminum bar stock on a lathe. Then a 0.25 x 28 thread will be drilled and tapped through the center of each insert.
- Prep
    - All coinciding edges of inserts and carbon fiber rods will be sanded with a high grit sandpaper.
    - $1/8^{th}$ in holes will be drilled into assembly to create holes where pins can be inserted.
- Assembly
    - Coinciding edges of insert and carbon fiber rods will be joined together with Hysol EA e-60hp adhesive and RockWest #1031-25 glass beads.
    - Insert $1/8^{th}$ in pins into holes. Adhere with Hysol EA e-60hp
    - Clamp will be used to hold constant pressure on assembly while adhesive cures.
- Postproduction
    - Screw jigs into both end of assembly

Test Sample #4 Capped Insert/CF rod assembly

- Manufacturing
    - Aluminum insert will be cut from 0.5in aluminum bar stock on a lathe. Then a 0.25 x 28 thread will be drilled and tapped through the center of each insert.
- Prep
    - All coinciding edges of inserts and carbon fiber rods will be sanded with a high grit sandpaper.
- Assembly
    - Coinciding edges of insert and carbon fiber rods will be joined together with Hysol EA e-60hp adhesive and RockWest #1031-25 glass beads.

        - Clamp will be used to hold constant pressure on assembly while adhesive cures.
    - Layup
        - The insert/rod assembly will have 2 plys of carbon twill weave layed on top of the insert/rod assembly.
        - Fiber will be applied with 3:1 resin-hardener mixture
    - Postproduction
        - Screw jigs into both end of assembly

Test Sample #5 Grooved Insert/CF rod assembly

- Manufacturing
    - Aluminum insert will be cut from 0.5in aluminum bar stock on a lathe. Then a 0.25 x 28 thread will be drilled and tapped through the center of each insert.
    - Grooved face will be cut on lathe.
- Prep
    - All coinciding edges of inserts and carbon fiber rods will be sanded with a high grit sandpaper.
- Assembly
    - Coinciding edges of insert and carbon fiber rods will be joined together with Hysol EA e-60hp adhesive and RockWest #1031-25 glass beads.
    - Clamp will be used to hold constant pressure on assembly while adhesive cures.
- Postproduction
    - Screw jigs into both end of assembly

18. Cost and Order List

Include all stock and COTS components, including vendors. Format according to standard order form with item name, unit cost, quantity, total cost, and any notes.

Item	Supplier	URL	Cost/unit	Units	Total
Carbon Fiber Rod .512” diameter 48” long	Carbon Envisions	https://compositeenvisions.com/product/roll-wrapped-carbon-fiber-tube-twill-weave-gloss-finish-48-long/	$23.70 per 48” rod	2	$47.40
Hysol EA e-60hp	McMaster	https://www.mcmaster.com/products/loctite-hysol/adhesives-2~/container-type~cartridge/	$22.55 per 50ml	2	$45.10

Aluminum 6061 rod stock .5”diameter 48” long	Online Metals	https://www.onlinemetals.com/en/buy/aluminum/0-5-aluminum-round-bar-6061-t6511-extruded/pid/1084	$9.08 per rod	1	$9.08
Stainless Steel 316 dowel pins	Amazon	Follow link in comments	$10.97/ pack of 25	1	$10.97
Rockwest Glass beads #1031-25	Rock West Composites	https://www.rockwestcomposites.com/1031-25	$35.99 for 25g bottle	1	$35.99
Commercial Grade Carbon Fiber Fabric 2x2 Twill 3k 6oz/203gsm 60" with Tracers	Carbon Envisions	https://compositeenvisions.com/product/commercial-grade-carbon-fiber-fabric-2x2-twill-3k-6oz-203gsm-60-with-tracers/	$17 for 36”x 60”	1	$17.00
Resin	Fibre Glast	https://www.fibreglast.com/product/System_2000_Epoxy_Resin_2000	$74.99/ per quart	1	$74.99

Resin Hardener	Fibre Glast	https://www.fibreglast.com/product/System_2000_Epoxy_Resin_2000	$29.95/½ pint	1	$29.95
Steel Round bar stock 1" diameter	Online Metals	https://www.onlinemetals.com/en/buy/carbon-steel/1-carbon-steel-round-bar-1045-cold-finish/pid/21682?CAWELAID=12029332000020414 7&gclid=CjwKCAjw-eKpBhAbEiwAqFL0mltbIwn0ktc4ERfd4qj_O-DnYWamS2i9hekTob2Se74QJEZ77laUdRoCj7oQAvD_BwE	$11.37/ft	1	$11.37
Aluminum Etching Solution	Lab Alley	https://www.laballey.com/products/aluminum-metal-etchant?currency=USD&variant=39788438356123&stkn=7c72afeff1e7&gclid=CjwKCAjwnOipBhBQEiwACyGLuvjlwoc1g-48neSTpJzMEXJD723dKOFYP7iXWh-hPfsbuKvSlgfUyxoCPKsQAvD_BwE	$20.00/100 mL bottle	1	$20.00

19. Rapid Prototyping

If this project costs over $70 or has over 3 machining ops, include a picture of a 3d printed model and its interactions with other components.

- N/A

20. Feedback

Include any feedback, commentary, or notes from the presentation session here.

Use die to cut threads on jigs, insert drawings

5/Test Analysis KENNESAW MOTORSPORTS

Project Title	Example
Project Car	KSX-E
Subgroup	Subgroup
Engineer	Name
Responsible Lead	Name
Date Submitted	mm/dd/yyyy
Date Presented	mm/dd/yyyy

21. Test Goal Justification

Demonstrate and analyze how the overall system meets its stated goals in 1/Test Proposal.

22. Test Analysis

What information was gained/learned from the test (post pictures/results/data from test)? What could have been done differently? Interpret what the data/results mean? Include a link to the excel sheet of data.

23. Feedback

Include any feedback, commentary, or notes from the presentation session here.