

MONTEITH PERSONAL ALL-TERRAIN VEHICLE

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OVERVIEW

- Introduction
- Initial examination of original design
- New design alternatives
- Static force analysis
- Flow analysis
- Recommendations

мрату

INTRODUCTION

- Client presented us with a new concept in personal transportation
- Highly advanced human electric hybrid hardware platform
- Issues addressed:
 - Urban congestion
 - Safety
 - Pollution
 - Cost
- Client request: construct vehicle body
- Project scope:
 - Model vehicle body
 - Analyze the feasibility of the design



INITIAL EXAMINATION OF ORIGINAL DESIGN



Figure 1: Original design provided by client

Figure 2: Pressure profile from initial investigation of original design

NEW DESIGN ALTERNATIVES

- 2 design alternatives:
 - 1. Rounded nose design
 - 2. Ventilation design



Figure 4 (bottom right): Front view (a), right view (b), and isometric view (c) of the ventilation design



STATIC FORCE ANALYSIS

- 3 static force analyses:
 - 1. Deflection the degree to which a structural element is displaced under an applied load
 - 2. Strain ratio of deformation by initial length
 - 3. Stress force applied over a cross-sectional area of an object
- 3 applied force values in analyses:
 - 1. 700 N
 - 2. 1500 N
 - 3. 2000 N

DEFLECTION: RIGHT VIEW



DEFLECTION: BOTTOM VIEW

700 N



1500 N

UPES [mm]

1.2526-302

1.147e-002

9.306 e-000

8.3456-003

T.302e-009

6.2500-003

5.215e-003

4.173e-003

3.1200-003

2.0856-003

1.043e-003

1.0000-030



2000 N



DEFLECTION: RIGHT VIEW



DEFLECTION: BOTTOM VIEW

700 N



1500 N



2000 N



DEFLECTION: RIGHT VIEW



DEFLECTION: BACK VIEW



DEFLECTION DATA [MM]

700 N

Original design:

- Maximum deflection = 0.0128
- Average deflection = 0.0124
 Rounded nose design:
- Maximum deflection = 0.00738
- Average deflection = 0.00721
 Ventilation design:
- Maximum deflection = 0.0134
- Average deflection = 0.0130

1500 N

Original design:

- Maximum deflection = 0.0274
- Average deflection = 0.0267Rounded nose design:
- Maximum deflection = 0.0158
- Average deflection = 0.0154
 Ventilation design:
- Maximum deflection = 0.0287
- Average deflection = 0.0278

2000 N

Original design:

- Maximum deflection = 0.0365
- Average deflection = 0.0356

Rounded nose design:

- Maximum deflection = 0.0211
- Average deflection = 0.0206
 Ventilation design:
- Maximum deflection = 0.0382
- Average deflection = 0.0371

STRAIN: RIGHT VIEW



STRAIN: BOTTOM VIEW



STRAIN: RIGHT VIEW



STRAIN: BOTTOM VIEW

1500 N 2000 N ESTRN ESTRN 4.208e-006 5.612e-006 3.858e-006 5.144e-006 3.507e-006 4.677e-006 3.156e-006 4.209e-006 2.806e-006 3.741e-006 2.455e-006 3.274e-006 2.104e-006 2.806e-006 1.753e-006 2.338e-006 1.403e-006 1.871e-006 1.052e-006 1.403e-006 7.014e-007 9.353e-007 3.507e-007 4.677e-007 4.945e-012 4 6.806e-012





ESTRN

1.963e 006

1.7996-005

1.636e-006

1.472e-005

1.3096-005

1.145e-006

9.815e-007

8.179e-007

6.543e-007

4.907e-007

3.272e-007

2.026e-012

STRAIN: RIGHT VIEW



STRAIN: BACK VIEW



STRAIN DATA

700 N

Original design:

- Maximum strain = 6.82E(-6)
- Average strain = 6.75E(-6)
 Rounded nose design:
- Maximum strain = 1.20E(-6)
- Average strain = 1.17E(-6)
 Ventilation design:
- Maximum strain = 5.77E(-6)
- Average strain = 5.71E(-6)

1500 N

Original design:

- Maximum strain = 8.19E(-6)
- Average strain = 8.04E(-6)
 Rounded nose design:
- Maximum strain = 2.56E(-6)
- Average strain = 2.51E(-6)Ventilation design:
- Maximum strain = 6.24E(-6)
- Average strain = 6.23E(-6)

2000 N

Original design:

- Maximum strain = 10.9E(-6)
- Average strain = 10.7E(-6)

Rounded nose design:

- Maximum strain = 3.42E(-6)
- Average strain = 3.34E(-6)

Ventilation design:

- Maximum strain = 7.65E(-6)
- Average strain = 7.63E(-6)

STRESS: RIGHT VIEW



STRESS: BOTTOM VIEW

700 N



von Mises (N/m^2) 6.700e+005 6.142e+005 5.583e+005 5.025e+005 4.467e+005 3.500e+005 3.350e+005 2.792e+005 1.675e+005 1.117e+005 5.583e+004 1.264e-001 Wield strength: 5.515e+007

1500 N



2000 N

von Mises (N/m^2)

1.4360+006

1.316e+006

1.196:+006

1.077e+006

9.571e+005

8.375e+005

7.179+005

5,982e+005

4.786e+005

3.589e+005

2.393e+005

. 1.196e+005 2.709e-001 → Yield strength: 5.515e+007



STRESS: RIGHT VIEW



STRESS: BOTTOM VIEW

700 N





1500 N



2000 N



STRESS: RIGHT VIEW



STRESS: BACK VIEW



STRESS DATA [MPA]

700 N

Original design:

• Maximum stress = 0.670

Rounded nose design:

- Maximum stress = 0.153
 Ventilation design:
- Maximum stress = 1.91

1500 N

Original design:

• Maximum stress = 1.44

Rounded nose design:

- Maximum stress = 0.327
 Ventilation design:
- Maximum stress = 4.10

2000 N

Original design:

• Maximum stress = 1.91

Rounded nose design:

• Maximum stress = 0.437

Ventilation design:

• Maximum stress = 5.47

FLOW ANALYSIS

- 2 flow analyses:
 - 1. Pressure the force applied perpendicular to the surface of an object per unit area
 - 2. Velocity the rate and direction of the change in position of an object
- 4 different flow rates:
 - 1. 30 mph
 - 2. 45 mph
 - 3. 60 mph
 - 4. 75 mph

• 30 mph



• 45 mph



• 60 mph



• 75 mph



• 30 mph

7.88e+01 ANSYS R17.2 1.78e+02 **ANSYS** 7.14e+01 1.61e+02 6.40e+01 1.44e+02 5.66e+01 1.27e+02 1.11e+02 4.92e+01 4.17e+01 9.38e+01 3.43e+01 7.70e+01 6.02e+01 2.69e+01 4.34e+01 1.95e+01 1.21e+01 2.65e+01 9.69e+00 4.70e+00 -2.71e+00 -7.14e+00 -1.01e+01 -2.40e+01 -4.08e+01 -1.75e+01 -5.76e+01 -2.49e+01 -7.44e+01 -3.24e+01 -3.98e+01 -9.13e+01 -1.08e+02 -4.72e+01 -1.25e+02 -5.46e+01 -6.20e+01 -1.42e+02 -1.59e+02 -6.94e+01 -1.75e+02 -7.68e+01 -1.92e+02 -8.42e+01 -2.09e+02 -9.16e+01 . (<u>•</u>)---> · (🗩) 🖚) -2.26e+02 -9.90e+01 -2.43e+02 -1.06e+02

• 45 mph

• 60 mph



• 75 mph

• 30 mph



• 45 mph







• 75 mph



PRESSURE DATA [KPA]

Original Design

At 30 mph:

- Maximum pressure = 80.0
- Average pressure = 79.8
 At 45 mph:
- Maximum pressure = 80.3
- Average pressure = 80.0At 60 mph:
- Maximum pressure = 80.7
- Average pressure = 80.0

At 75 mph:

- Maximum pressure = 81.2
- Average pressure = 80.3

Rounded Nose Design

At 30 mph:

- Maximum pressure = 78.8
- Average pressure = 78.5
- At 45 mph:
- Maximum pressure = 79.4
- Average pressure = 79.0

At 60 mph:

- Maximum pressure = 79.9
- Average pressure = 79.1

At 75 mph:

- Maximum pressure = 80.3
- Average pressure = 79.6

Ventilation Design

At 30 mph:

- Maximum pressure = 80.0
- Average pressure = 79.8 At 45 mph:
- Maximum pressure = 80.4
- Average pressure = 80.0 At 60 mph:
- Maximum pressure = 80.9
- Average pressure = 80.0 At 75 mph:
- Maximum pressure = 81.5
- Average pressure = 80.3

• 30 mph





• 45 mph





• 60 mph





• 75 mph





• 30 mph



41

• 45 mph



• 60 mph



• 75 mph



• 30 mph





• 45 mph





• 60 mph





• 75 mph





VELOCITY DATA [M/S]

Original Design

At 30 mph:

- Maximum velocity = 20.3
- Average velocity = 13.4 At 45 mph:
- Maximum velocity = 30.6
- Average velocity = 20.1
 At 60 mph:
- Maximum velocity = 40.6
- Average velocity = 26.8

At 75 mph:

- Maximum velocity = 50.7
- Average velocity = 33.4

Rounded Nose Design

At 30 mph:

- Maximum velocity = 17.3
- Average velocity = 10.5
- At 45 mph:
- Maximum velocity = 26.2
- Average velocity = 17.0

At 60 mph:

- Maximum velocity = 35.1
- Average velocity = 21.5

At 75 mph:

- Maximum velocity = 44.0
- Average velocity = 28.3

Ventilation Design

At 30 mph:

- Maximum velocity = 20.2
- Average velocity = 13.2 At 45 mph:
- Maximum velocity = 29.0
- Average velocity = 19.9 At 60 mph:
- Maximum velocity = 41.2
- Average velocity = 26.5 At 75 mph:
- Maximum velocity = 48.2
- Average velocity = 33.1

RECOMMENDATIONS

- Recommended additional analysis: temperature distribution
 - Temperature distribution at varying battery temperatures
 - Temperature distribution at varying battery positions
- Recommended design: rounded nose design
 - At higher velocities, concern arises over the magnitude of the lift force at the front lower section of the vehicle body
 - Winged design satisfies this consideration by lowering the lift force under the body

Figure 5: Front view (a), right view (b), and isometric view (c) of the winged design



30 mph



- Winged design:
 - Maximum pressure: 80.0
 - Average pressure: 79.8
- Rounded nose design:
 - Maximum pressure: 78.8
 - Average pressure: 78.5

Figure 6: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

45 mph





- Winged design:
 - Maximum pressure: 80.6
 - Average pressure:79.9
- Rounded nose design:
 - Maximum pressure: 79.4
 - Average pressure: 79.0

Figure 7: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

60 mph





- Winged design:
 - Maximum pressure: 81.2
 - Average pressure: 80.2
- Rounded nose design:
 - Maximum pressure: 79.9
 - Average pressure: 79.1

Figure 8: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

75 mph





- Winged design:
 - Maximum pressure: 81.5
 - Average pressure: 80.9
- Rounded nose design:
 - Maximum pressure: 80.3
 - Average pressure: 79.6

Figure 9: Pressure profile of winged design (left) compared to pressure profile of rounded nose design (right)

QUESTIONS?