All-Terrain Power Chair
Team 10

BME 4910 Final Presentation
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Project for Nathan Lamb
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Introduction

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Figure 1: Computer-aided design (CAD)
Client Background

Nathan Lamb

- 11-year-old boy
- Lives in Stonington, CT
- Adventurous and playful
- Challenges:
  - Autistic
  - Cognitively and physically challenged
  - Spina bifida
    - Shunt in skull to drain fluid buildup
  - Paraplegic
  - Fidgeting

Figure 1: Nathan and his sister
Purpose

- Current Problem:
  > Nathan can not enjoy all outdoor activities with his family and friends due to limitations of his current devices
  > Most people find Nathan’s devices exhausting or hard to use

- Intended Solution:
  > Design Nathan an intuitive all-terrain power chair
    • Allows him to participate in more outdoor activities
    • Provides him more independence
    • Increases safety
Current Products

- Planet Mobility’s X4-Extreme 4-wheel-drive power chair
  - $16,995
- UConn’s ATPC X42 – Spring 2010
  - $4,400 (including estimated costs of donations)
- Both, as well as other similar products, utilize joystick control, oversized wheels, ergonomic seats, and suspension.
Project Overview

- True four-wheel drive system
- Four-wheel independent suspension for good wheel articulation.
- Wide and long wheel base for extra stability.
- Low center of gravity
- Many safety measures implemented.
- Custom motor-controlling circuits.

Figure 1: Complete powerchair
Design: Mechanical 
→ Lower Frame

- Frame/Chassis – lightweight and rugged
  - Aluminum 2”x2” square tube stock
- Independent four-wheel suspension for superior mobility
- Lever arms for attaching components
- Rugged, latex-free wheels

Figure 1: Lower Frame
Design: Mechanical 

Lower Frame continued

- Low-friction bearings for lever arm and wheel rotation.
- Custom axles
  - Lever arms
  - Wheels
- Motor mounts

Figure 1: Mounted lever arm bearings and axle
Figure 2: Axles
Figure 3: Motor and motor mount
Chain-drive power
- Power from motor to wheel axle via 30 teeth sprocket
- Four motors to individually power each wheel
Custom-plexiglass container to house electrical components.

Custom-mounted headrest with variable height, depth, and angle adjustment.

Rear back support
  - Easy to exchange with larger back support that will be provided to Nathan to accommodate for his growth

Custom height-adjustable armrests

Left-side joystick and right-side accessory mounts
Design: Mechanical → Upper Frame Continued

- Height-adjustable foot plate to accommodate growth
- Easy-to-remove chair for transportation:
  - Release front latch
  - Unbolt two screws at the rear
    - The armrests can be removed in a similar manner
- Safety mechanism:
  - Five-point buckle to restrict upper body movement.
  - Two-point buckle for more relaxed situations.

Figure 1: Upper frame
Figure 2: Harnesses
Design: Electrical

- Joystick – easy control
- Power supply – Single 36V rechargeable Lithium ion Battery
- Microcontroller – brains of the chair
- 4 Motors – 24V DC motors
- Audio Circuit
- Remote killswitch
Design: Electrical continued

- Custom motor controller and power-supply PCB
- Custom amplification for joystick signal
  - Potentiometers 2-3V
  - Need 0-5V for microcontroller
Embedded C in microcontroller

- Interprets joystick input and calculates a low-speed output
- Has to send signal and direction to each of the motors individually

```c
//forward
if (yMod >0) {
  //straight
  if (xMod == 0) {
    output = int(yMod*63.0);
    analogWrite(fRight1, output);
    analogWrite(fRight2, 0);
    analogWrite(fLeft1, output);
    analogWrite(fLeft2, 0);
    analogWrite(bRight1, output);
    analogWrite(bRight2, 0);
    analogWrite(bLeft1, output);
    analogWrite(bLeft2, 0);
  }
  //turning left
  else if (xMod <0) {
    //turning in place
    if (yMod <= 0.25){
      output = int(abs(xMod)*63.0);
      analogWrite(fRight1, output);
      analogWrite(fRight2, 0);
      analogWrite(fLeft1, 0);
      analogWrite(fLeft2, output);
      analogWrite(bRight1, output);
      analogWrite(bRight2, 0);
      analogWrite(bLeft1, 0);
      analogWrite(bLeft2, output);
    }
  }
}
```
## Budget

- **Allotted Budget:** $2,000
- **Total Spent:** $1,991.50

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Conclusion

- Nathan is in need of a versatile power chair that will allow him to enjoy more outdoor activities.
- A capable all-terrain power chair has been designed and built to satisfy and exceed expectations for Nathan’s enjoyment.
Acknowledgements

- Dr. J. D. Enderle – Guidance and funding
- Marek W. – General guidance and assistance
- Serge D. and Peter G. – Guidance and assistance in mechanical fabrication
- Joe LaRosa – Guidance for power electronics
- N.E.A.T. Marketplace
- Nathan Lamb and family
Any Questions?