



Wheelchair Tennis Adaptive Devices for Quad Tennis

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Client: Dan Dorszynski

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Presentation Topics

- **Background**
 - **Current Devices**
 - **Problem Statement**
 - **Design Specifications**
 - **Design Inspirations**
 - **Grip Support**
 - Preliminary designs
 - Design matrix
 - Final preliminary design
 - **Serving System**
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 - **Moving Forward**
 - **Closing**
-



Figure 1: Affected Muscles¹

Background - Becker's Muscular Dystrophy

- Genetic, progressive muscular disease ²
 - Causes: insufficient use of dystrophin ²
 - Treatment: medication (steroids), surgery, and therapy ³
-



Figure 2: Paralympic Quad Tennis Players⁴

Background - Quad Tennis

- Eligibility for Play⁷
 - Loss of function in one or both of the upper and

lower extremities

- Gameplay and Assistive Devices

- Warm - Up⁷
- Racket length (< 29 inches)⁸

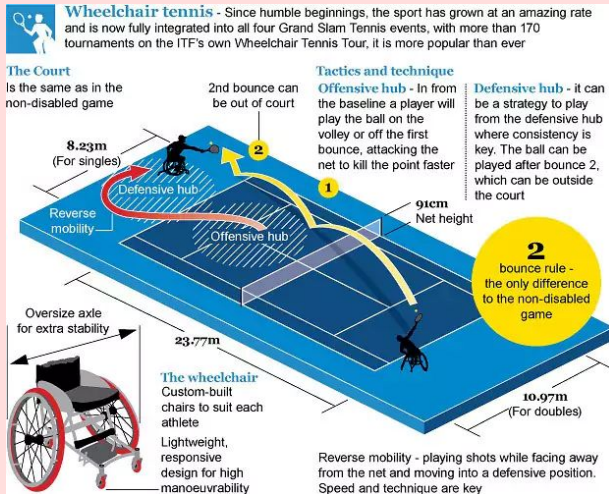


Figure 3: Wheelchair Tennis Infographic⁵

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Current Devices

- Grip securing devices
 - Athletic tape
 - Velcro
 - Rubber Bands

- Off-court serving systems



Figure 4: Athletic Tape Commonly Used to Secure Hand to Tennis Racket⁶

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Problem Statement

The client has Becker Muscular Dystrophy and plays in a quadriplegic tennis league. Players are allowed assistive equipment in the league. The client currently lacks ideal grip strength and a consistent serve. The client requires an optimized tennis racquet grip and tennis ball serving system in order to increase his level of play.

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Design Specifications - Serving System

- Mounted to wheelchair
 - Easily detachable when not in use
 - Provides consistent ball placement
 - Adjustable
 - Can't interfere with play
-

Design Specifications - Grip

- Maintains firm grip on racquet
 - Allows full range of wrist motion
 - Can't strain wrist
 - Able to withstand tennis conditions
-

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Design Inspirations

- Projectile launching systems
 - Potato cannon
 - Nerf gun
 - Football passing machine

 - Grips and hand supports
 - Baseball gloves
 - Elastic wrist brace
-

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Racquet Grip Preliminary Design

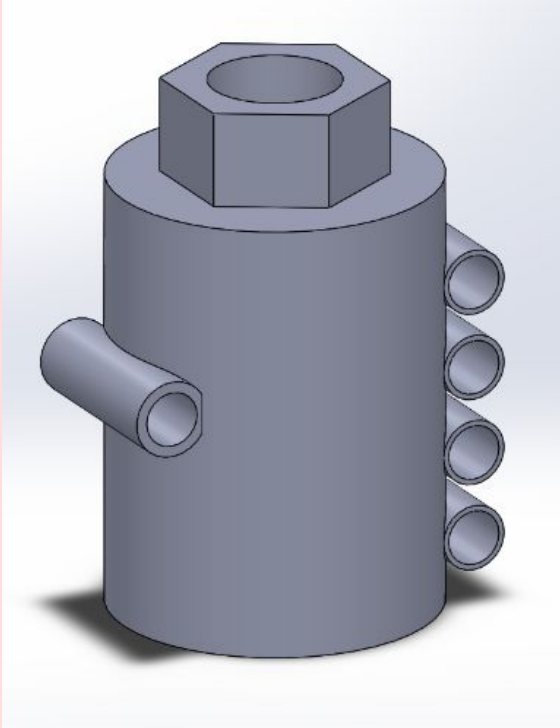


Figure 5: The Mold Preliminary Model

The Mold

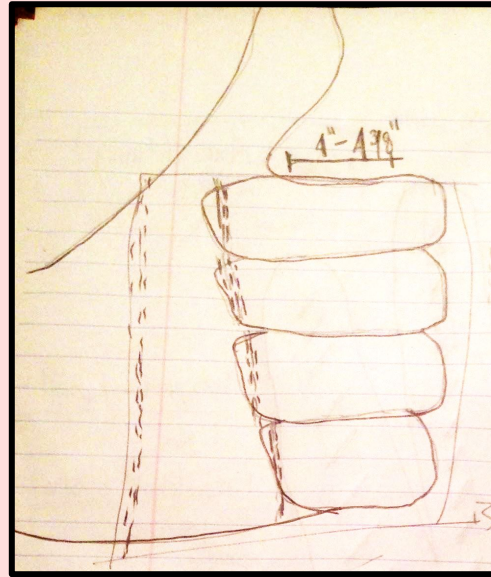
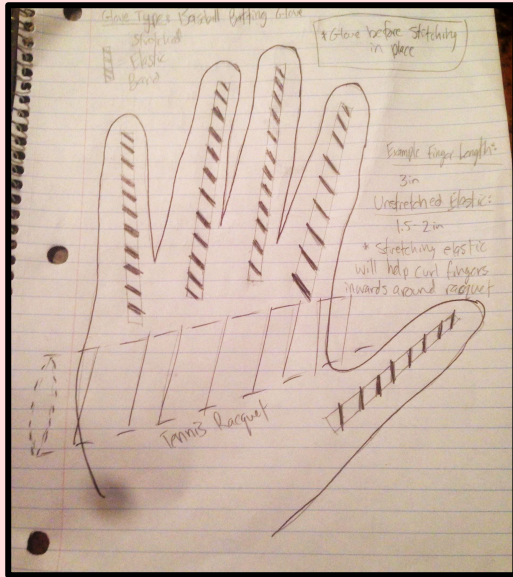
Pros:

- Holds hand firmly to racket
- Allows for different angles of grip

Cons:

- May increase size of grip on racket
 - Finger positions is rigid
 - Relatively expensive to 3D print
-

Racquet Grip Preliminary Design



Elastic Glove

Pros:

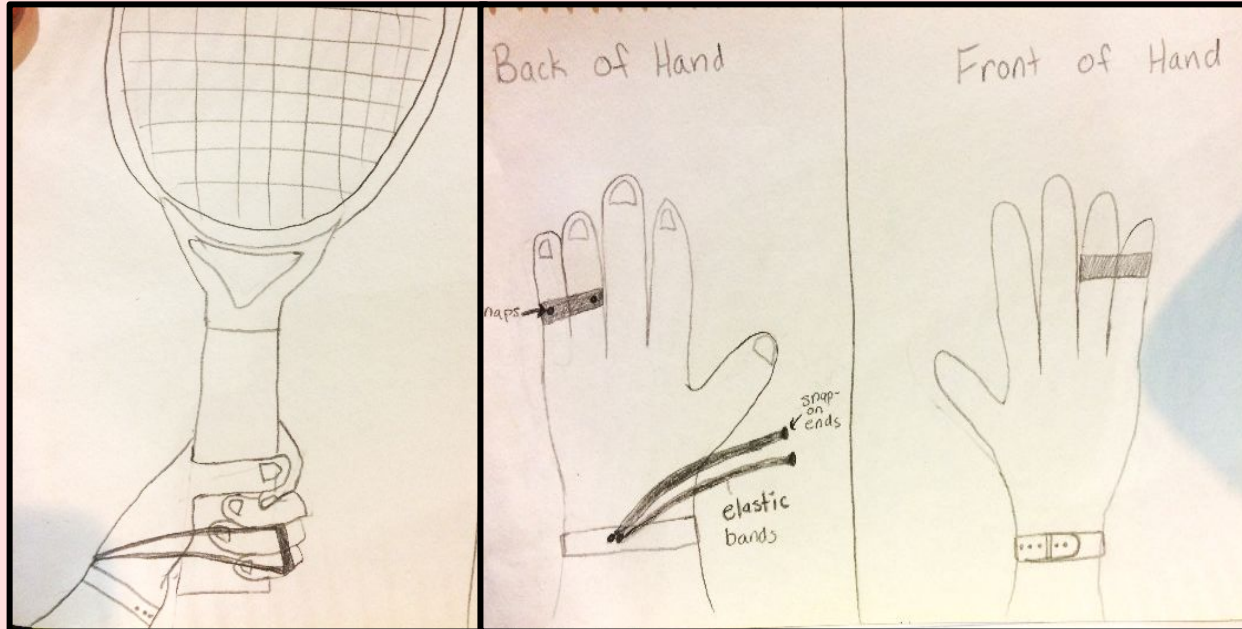
- Comfortable to wear
- Secures all fingers in place

Cons:

- May be hard to get on
- Not very replaceable

Figures 6-7: Elastic Glove Preliminary Model

Racquet Grip Preliminary Design



Spiderman Wrist Strap

Pros:

- Simple fabrication
- Replaceable parts
- Allows for variety of finger positions

Cons:

- May affect wrist movement
- May be tight on fingers

Figures 8-10: Spiderman Wrist Strap Preliminary Model

Racquet Grip Preliminary Design

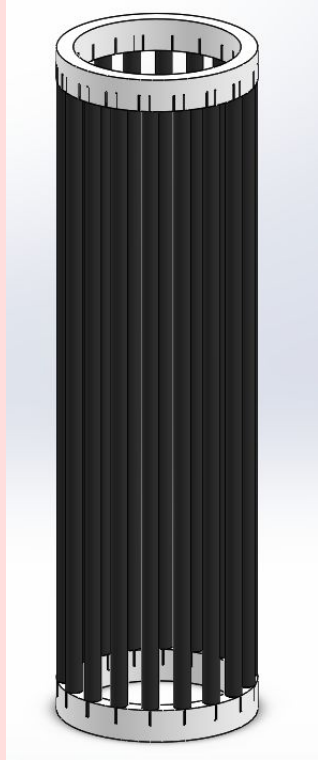


Figure 11: Racket Cords Preliminary Model

Racket Cords

Pros:

- Flexibility in grip
- Simple to fabricate
- Replaceable

Cons:

- May affect interaction of racket with the ball
 - Elastic may lose flexibility over time
-

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Design Evaluations- Racket Grip

Criteria (weight)	Elastic Glove		Racket Cords		The Mold		Spiderman Wrist Strap	
Client Input (10)	4	8	5	10	3	6	4	8
Client Safety (20)	5	10	4	8	5	10	3	6
Comfort (20)	5	20	4	16	3	12	3	12
Fabrication (10)	4	8	5	10	2	4	5	10
Mobility (20)	3	12	4	16	3	12	3	12
Cost (10)	4	8	5	10	3	6	4	8
Durability (10)	3	12	3	12	4	16	3	12
Total (100)	-	78	-	82	-	66	-	68

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Final Preliminary Design- Racket Cords

- Winner:
 - Client Input
 - Fabrication
 - Mobility
 - Cost

- Total score: 82

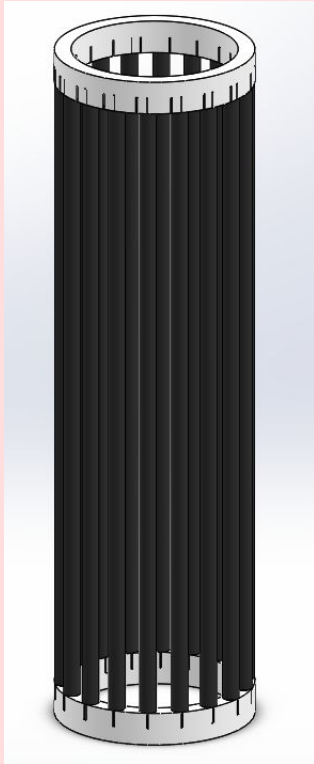


Figure 12: Racket Cords Preliminary Model



Figure 13: Preliminary Prototype of Racket Cords Design

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Ball Launcher Preliminary Design

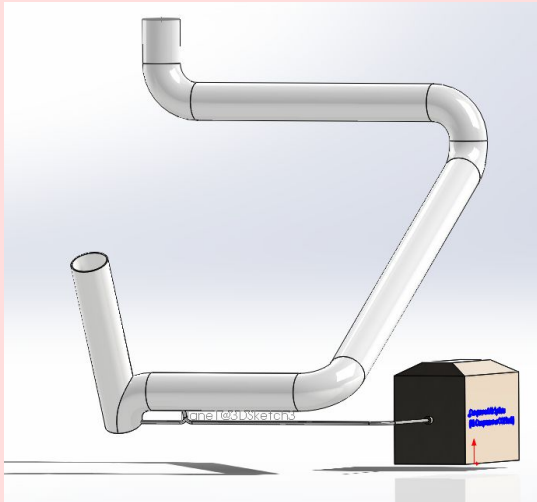
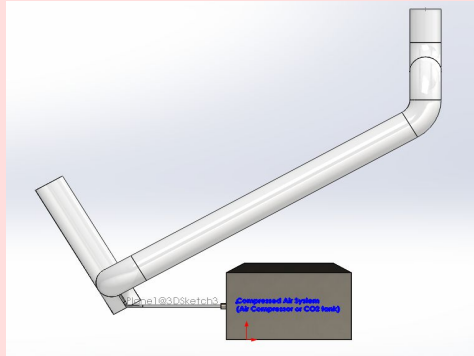
Compressed Air Cannon

Pros:

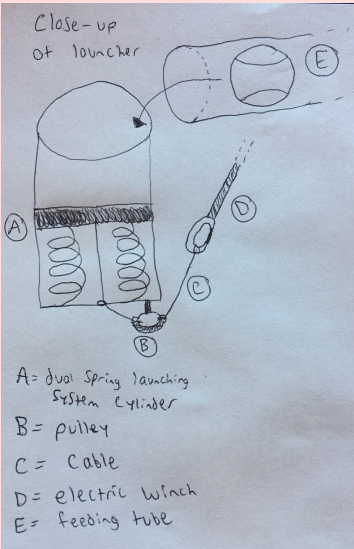
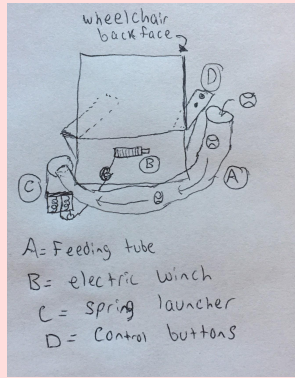
- Consistent means of launching the tennis ball
- Readily accessed by client during game play
- Easy to attach and remove from chair
- Adjustable launch height
- Automatic reloading system

Cons:

- Increased fabrication costs and difficulties
- Increased maintenance requirements for client



Figures 14-15: Compress Air Cannon Preliminary Model



Ball Launcher Preliminary Design

Compressed Spring Launch

Pros:

- Mechanical launch system
- Powered by wheelchair battery

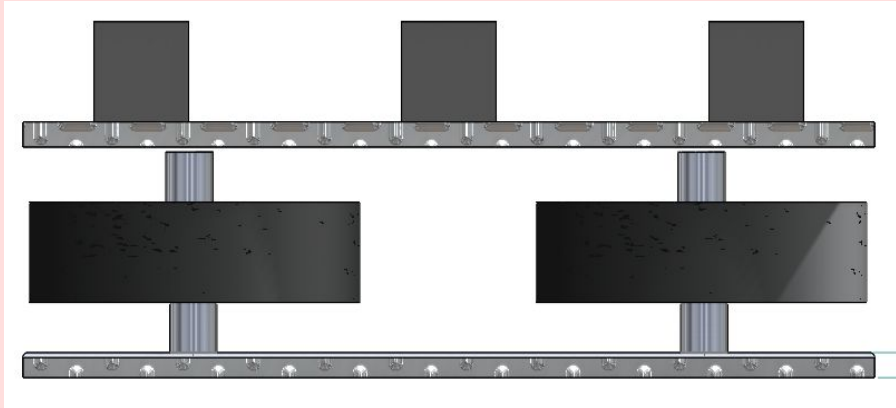
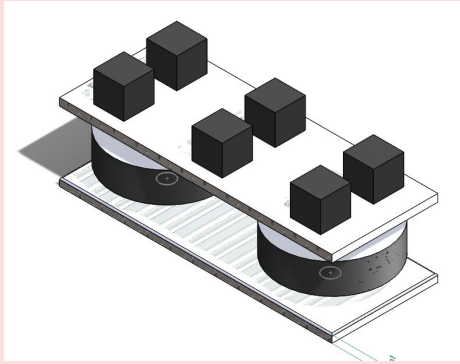
Cons:

- Easy to break due to launch stress and forces
 - Harder for client to reload
-

Figures 16-17: Compressed Spring Launch Preliminary Model

Ball Launcher Preliminary Design

Caster Wheel System



Pros:

- Existing design currently used in most tennis ball launchers
- Powered by wheelchair battery

Cons:

- Spinning wheels may create hazard
- Warm up time necessary to launch
- Too powerful

Figures 18-19: Caster Wheel System Preliminary Model

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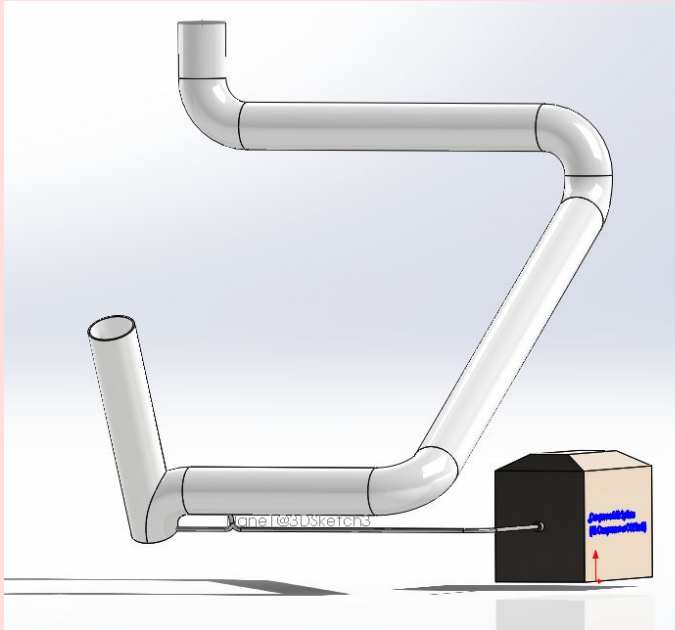
Design Evaluations- Serving System

Criteria (weight)	"Air Cannon"- Compressed Air		"The Launcher"- Caster Wheels		"The Spring Gun"- Compressed Springs	
Client Input (10)	5	10	4	8	5	10
Client Safety (20)	4	16	3	12	3	12
Accuracy/Precision (15)	5	15	4	12	4	12
Fabrication (10)	3	6	2	4	3	6
Ease of Use (15)	5	15	3	9	4	12
Cost (10)	3	6	2	4	3	6
Durability (10)	4	8	4	8	3	6
Adjustability (10)	4	8	3	6	3	6
Total (100)	-	84	-	63	-	70

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Final Preliminary Design- Compressed Air Cannon



- Winner:
 - Client Safety
 - Accuracy/Precision
 - Ease of Use
 - Durability
 - Adjustability
- Tied:
 - Client Input
 - Fabrication
 - Cost
- Total Score: 84

Figure 20: Compressed Air Cannon Preliminary Model

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Moving Forward

- Materials
 - Compressed Air
 - CO₂ tank or air compressor?
 - Racket Cords
 - Best elastic fiber?
 - Design
 - Design for easy attachment/detachment
 - Fitting designs to wheelchair/tennis racket
-

Moving Forward

- Fabrication
 - Compressed Air
 - Connecting tube system?
 - Racket Cords
 - Base- 3D print or clamp?
 - Testing
 - Compressed Air
 - Must reliably supply ball at consistent serving height
 - Racket Cords
 - Must maintain grip under force of ball hitting racket
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Acknowledgements

- Dan Dorszynski
- Ed Bersu



References

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Questions/comments?
