Undergraduate Student Research

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TENDEK

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Acknowledgements

Dr. Cohen – Project Advisor

•Dr. Cohen motivated us and pushed us to new levels. He gave us a lot of responsibility and freedom. His inspiration and enthusiasm got us to our final product.

Dr. Abdallah – Project Advisor

•Dr. Abdallah added great insight in tensegrity structures. His advice and suggestions provided what was necessary to develop our kite. His expertise was invaluable to our team.

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Outline

- TENDEK
  - What we have done
  - What we are doing
  - What we want to do
  - What we learned
- Importance of Research

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TENDEK
(Tensegrity Deployable Kite)

So far...

- Background research on tensegrity systems
  - What they are
  - How they work
  - Where they are useful

- Background Research on kites and flying
  - Different kinds of kites
  - What they are used for
  - Aerodynamic forces on flight

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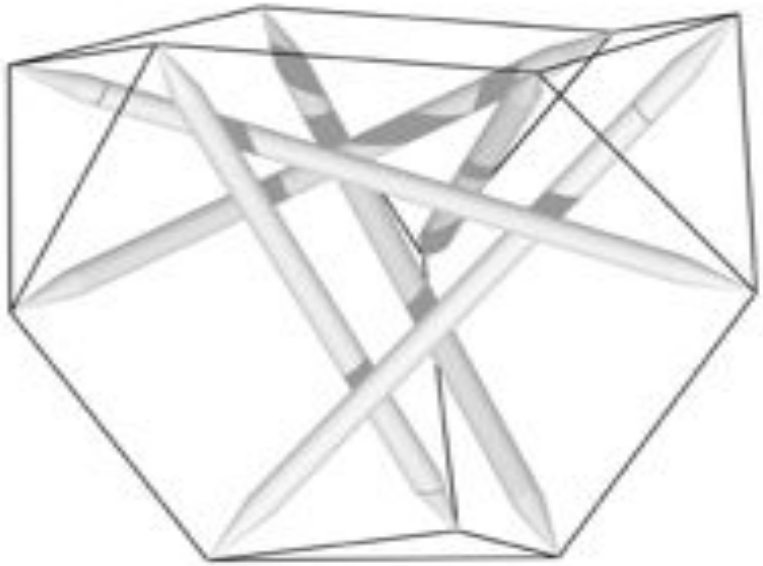
What is Tensegrity?

- Structures with *tensegrity* are said to have both tensile and compressive members in a specific configuration that it is held stable solely from internal forces.



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History of Tensegrity

- R. Buckminister Fullller is responsible for the word ‘tensegrity’, a combination of the words ‘tension’ and ‘integrity’.
- Kenneth Snelson made some of the first breakthroughs and discoveries with tensegrity.

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Advantages to Tensegrity

- Tensegrity structures are stable without the presence of external forces.
- Tensegrity systems allow for lightweight construction of robust structures
- Allows for optimal arrangement of members in load-bearing structures, leading to economic advantages.
- Wide range of applications.

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History of Box Kites

- Invented – 1893
  - Lawrence Hargrave
- Attempt at manned aircraft
- Eventually led to designs for planes

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Structure of Kites

- Box kites feature a boxed structure (hence the name)
- Boxes are held rigid by cross members at opposite ends.
- Sails, which create lift, are fixed at the ends of the kite and are each about a quarter the length of entire kite.

Kite Flying – The Achilles Heel

- Difficulties of flying
  - Kite flying can be frustrating when you cannot get the kite off the ground
- Launching the kite
  - Need two people

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Kite Flying – Overcoming the Achilles Heel

- With our unique tensegrity collapsing concept, we have the opportunity to develop a launching device. Now, it only takes one person to launch the kite.
- Our plan: collapse the kite into a rod shape. Place it in a tube or along rods and use a spring to give the kite initial velocity.

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Forces on a Kite

- Flight of a box kite is similar to flight of a plane
- Lift overcomes drag, weight, and pull to fly
- Drag adds stability and control to the kite
- Torque forces are applied and accounted for by the ability of the kite to spin on the string

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Flying a Kite

Nate attempting to fly our box kite
(conducting research)

What we are doing:

- Building a working model of our tensegrity kite for the Airwaves Kite Fest in April
- Launcher concept design
- Practicing kite flying skills

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Research Application

- Build tensegrity kite models
  - Decide on shape
  - Find the dimensions
- Scientific Process
  - Research
  - Design
  - Purchase
  - Develop
  - Adjust
  - Research
  - Finalize

Figures: Initial box kite designs

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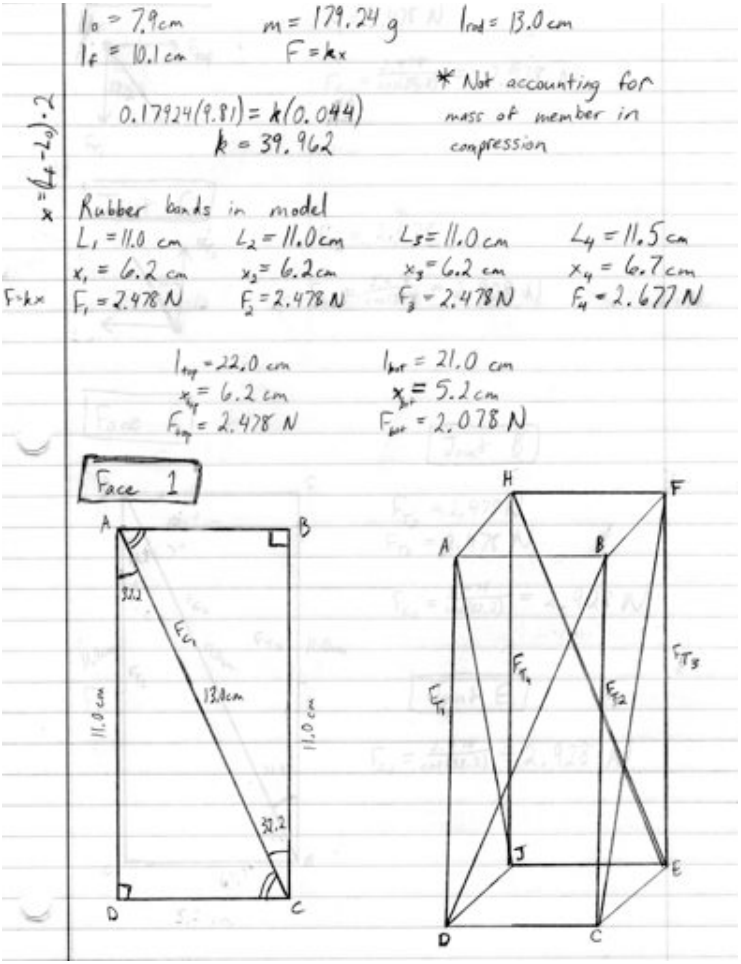
Materials



- Force Analysis
- Material Strength Research
- What was needed?

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Material Selection

- Carbon Fiber Tubes
  - Pultruded
- Elastic Strings
- Metal Key Rings
- Fabric
- String Clamps

Courtesy of dragonplate.com

Courtesy of Amazon.com

Courtesy of Made-in-China.com

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Working Model

- Caps held on by tension
- Collapsible
- Lightweight
- Similar Dimensions to Box Kite
- Sleeves to Attach Fabric to Strings

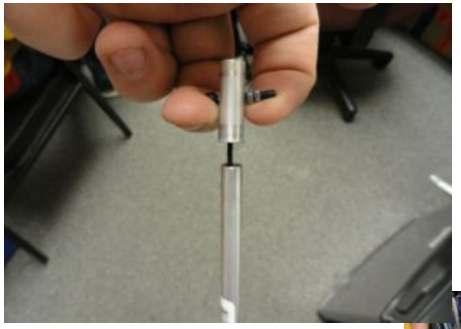
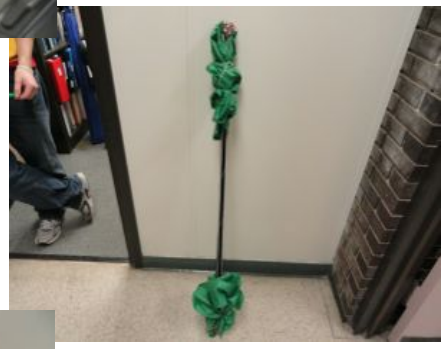


Image of the caps



Kite: collapsed

Assembled Kite

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Future Developments

- Design simplification
- Launcher
- Different materials

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What we are doing

- Airwaves Kite Festival
  - Working model of kite
  - Concept design for launcher
  - Published paper on idea
- Cincinnati Innovates
  - Launcher
  - Flying kite
  - Demonstration

Nate building our tensegrity kite working model

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Airwaves Kite Festival

Kite flying at the festival

Phillip assisting the take off of the kite

Nate flying the kite

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Airwaves Experience

- The kite works
  - It is far from perfect
  - The one person launch needs major work
  - Launching device would help
- System needs to be lighter
- Difficult to compress

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Learning Experiences

- Scientific Process
  - Concept to Design
  - Design to Model
  - Model to Product
- Teamwork
  - Our key to success
  - Weekly meetings
- Overcoming Difficulties
  - Wanting to give up
  - Pushing through
  - It worked out!

Initial concept

Failed attempt

Final product

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Importance of Research

- Work experience in engineering
- Writing a technical paper
- Publishing that paper
- Learning about intellectual property and invention disclosures
- Public presentations
- Personal benefits
  - Letters of recommendation
- Accomplishment

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