Force and Motion: Understanding the Driving Force Behind Scientific Learning

Jennifer Dalesandro

Overview

Some of my earliest childhood memories of Science in elementary school mainly involved the use of a textbook and worksheets. This clinical form of learning did not spark a love for the subject that I have today. The concept of "hands on" Science did not enter my educational career until high school Botany and Zoology. I absolutely loved the feeling of Science "coming alive" through the use of hands on labs and the drawing and labeling of various diagrams. I had always preferred Social Studies and Literacy because of my love of reading and history, but suddenly I found Science to be one of my most memorable classes.

As an elementary school teacher, I strive to make Science a hands-on experience in my classroom with the goal of having my students experience that same feeling I had so many years ago. My students thrive when performing the messiest of experiments and can regurgitate every step of the scientific method. They enjoy using Interactive Science Notebooks, which make my students feel like real scientists. Due to the interaction that my students have in making scientific concepts come alive, I believe most of my students will claim science as their favorite subject.

Background

I am a National Board Certified, third grade teacher at Bain Elementary School in the Charlotte suburb of Mint Hill, North Carolina. I have been a professional teacher for 10 years, the first of which was teaching 3-year-old pre school in West Virginia. This is my ninth year of teaching for the urban school system known as Charlotte-Mecklenburg Schools, which is the second largest school district in North Carolina and the nineteenth largest school district in the nation. I teach on a team of eight third grade teachers, which affords me a vast support system from a diverse group of education professionals with varying backgrounds.

The demographics of my school differs in comparison to the Title 1 school category as my school has a low percentage of students on free or reduced lunch and a high percentage of parent involvement. Parent volunteers are a regular part of my classroom environment on any given day giving support to the students and enriching the learning experience. Bain Elementary is considered an Honor School of Excellence for high growth on standardized testing with a rich history dating back 120 years ago when John Bain founded the original Bain Academy in the Town of Mint Hill, NC. Since then, the school has grown to its current size of 1,000+ students, reflecting the corresponding growth in the town of Mint Hill. During the 2013-2014 school year, Bain Elementary will move into a new, state of the art building. This earmarks a new era in Bain's long history by providing all teachers access to new technologies such as SMARTboards.

In my classroom, I use an economy-based system for rewards and consequences. My students earn Dalesandro Dollars (DD) for completing classroom jobs and weekly homework. They also earn DD for good behavior. To the contrary, students lose DD if they fail to complete homework, their job, or are not on their best behavior in and out of the classroom. I will tie my classroom economy into the student activities and labs I have prepared for this unit by compensating students for performing various NASCAR related jobs within their "pit crew."

Rationale

To enhance the Science curriculum in my classroom, I have been attending "The Science of NASCAR" seminar at The University of North Carolina instructed by Dr. Peter Tkacik, Assistant Professor of Motorsports. Under the guidance of Dr. Tkacik, I am experiencing the world of NASCAR through hands-on experience. I chose to attend this particular seminar because it relates directly to my students' lives as Charlotte is the home of many things NASCAR. Charlotte Motor Speedway is located in Concord, NC and the NASCAR Hall of Fame is in downtown Charlotte. Many NASCAR race car drivers and their families live on and around Lake Norman, NC.

Teaching Strategies

In my curriculum unit entitled, *Force and Motion: Understanding the Driving Force Behind Scientific Learning*, my students and I will use various force and motion labs to develop a deeper understanding of how the force affects race cars when drafting or when going into the extreme turns of a race track. With a functional understanding of the structural design and weight of the cars used on the NASCAR track, I will be able to implement these scientific principles in a working concept that my students will be able to relate to and apply to a "real world" construct.

I will use a variety of teaching strategies including **Interactive Science Notebooks** (ISN). ISN are composition notebooks students will use on a daily basis to incorporate writing across the curriculum. In their ISN, students will use the steps of the scientific method to record their observations of various force and motion lab activities, ask questions, and illustrate their findings into labeled diagrams. Throughout the unit, students will add essential vocabulary to the glossary section of their ISN.

The KWL Chart

A **KWL** chart will be used in cooperative learning groups for students be afforded the opportunity to collaborate on the topic of force and motion. Students will record what they know and what they would like to know about force and motion in the world of NASCAR racing. The KWL chart will also provide a place for students to record concepts they have learned from this unit.

Educational websites

Educational websites, like Discovery Education and NASA.gov will be used as the unit progresses to provide the students with visual representations of the scientific principles presented.

To introduce my curriculum unit to my students, I will read various third grade level picture books about Sir Isaac Newton and discuss his work with the laws of nature. Sir Isaac Newton was a mathematician and scientist who lived in England during the 1600s. In 1687, Newton first published his theories and observations about force and motion. Newton's three laws would become the basis and foundation of modern physics. Students will be able to identify Newton's First, Second, and Third Laws of Motion and give examples of how these laws are evident in the world around them. (Louviere 2006)

Summary of Newton's Three Laws:

Newton's First Law of Motion

Newton's First Law of Motion-an object at rest tends to stay at rest, and an object in motion tends to stay in motion, unless acted upon by an outside, unbalanced force. Examples of unbalanced forces include: friction or air resistance

Newton's Second Law of Motion

Newton's Second Law of Motion- Acceleration of an object depends on force and mass.

Newton's Third Law of Motion

Newton's Third Law of Motion-For every action, there is a reaction that is equal in magnitude and opposite in direction. Forces always occur in pairs. Every time a force, or action, occurs, it causes a reaction. (Louviere 2006)

We will then define gravity and its connection to force and motion. What is gravity? Gravity is a force between any two objects. Gravity also keeps your feet on the ground unless another force pushes or pulls you off the ground. Gravity is what helps pull your bike down a hill and it is why you pick up speed as you continue down the hill. It is also what makes it harder for you to ride uphill.

Content Objectives/Implementing the Common Core Standards

My curriculum unit's content objectives will seek to explain the effects of earth's gravity on the motion of any object on or near earth, compare and contrast the relative speed of objects that travel the same distance in different amounts of time, and infer changes in speed or direction resulting from forces acting on an object. After establishing a base of knowledge of force and motion, we will further investigate how force and motion plays a pivotal role in the world of NASCAR racing. This unit will cover the following Common Core State Standards objectives:

Objective 3.P.1.1 infer changes in speed or direction resulting from forces acting on an object.

Objective 3.P.1.2 compare the relative speeds (faster or slower) of objects that travel the same distance in different amounts of time.

Objective 3.P.1.3 explain the effects of earth's gravity on the motion of any object on or near earth.

The unit will also cover the following objectives:

- Students will be able to identify Newton's First, Second, and Third Laws of Motion and give examples of how these laws are evident in the world around them.

Essential Questions for my unit include:

- What is force and motion? What role does it play in our everyday lives?
- How does earth's gravity affect the motion of any object on or near earth?
- How is force and motion related to the Nascar motorsports field?
- What changes did you make to your test car in order to produce better results in the car you used for your final run?
- Compare/Contrast the results from your test car with the results from your final run.

History of NASCAR timeline

*Immediately following World War II, stock-car racing was experiencing the greatest popularity it had ever seen. Tracks throughout the country were drawing more drivers, and bigger crowds. Many tracks were built to handle the cars, but not the crowds of fans. The rules varied from track to track and there was a serious lack of organization. (NASCAR.com 2010)

*In December 1947, Bill France Sr., of Daytona Beach, Fla., organized a meeting at the Streamline Hotel across the street from the Atlantic Ocean to discuss the problems facing stock-car racing. France enjoyed racing and was a strong willed man with a great deal of ambition. By the conclusion of the meeting at the Streamline Hotel, the National Association for Stock Car Auto Racing was born. (NASCAR.com 2010)

* The first NASCAR-sanctioned race was held on Daytona's beach course Feb. 15, 1948, just two months after the organizational meeting. Red Byron, a stock car legend from Atlanta, won the event in his Ford Modified. Six days later on Feb. 21, 1948, the National Association for Stock Car Auto Racing was incorporated. (NASCAR.com 2010)

*Jim Roper of Great Bend, Kan., was the winner of the first ever NASCAR Grand National (now Sprint Cup) event, held at the Charlotte (N.C.) Fairgrounds on June 19, 1949. (NASCAR.com 2010)

*1950- the country's first asphalt superspeedway, Darlington Raceway in South Carolina, opened its doors for the new division. (NASCAR.com 2010)

*1959-Bill France Sr., began construction of a 2.5-mile, high-banked superspeedway four miles off the beach in Daytona Beach. Daytona International Speedway. With its long back straightaway and sweeping high-banked turns of more than 30 degrees, the 2.5-mile tri-oval was one of the largest speedways in the world. (NASCAR.com 2010)

*The first Daytona 500 didn't end for three days. It took that long for NASCAR officials to study a photograph of the finish between Petty and Johnny Beauchamp before declaring Petty the winner. (NASCAR.com 2010)

*1960 superspeedways were opened just outside Atlanta and Charlotte. ABC televised the 1961 Firecracker 250 from Daytona Beach as part of its Wide World of Sports. (NASCAR.com 2010)

*The 1979 Daytona 500 became the first 500-mile race in history to be telecast live in its entirety. This race was significant because it occurred during a giant snowstorm, dramatic finish which resulted in a fight between two race leaders, and single-handedly put NASCAR on the map as a top form of competitive entertainment. (NASCAR.com 2010)

*By the mid 1980s, Fortune 500 companies not only were involved in sponsoring NASCAR, but individual races and teams as well. (NASCAR.com 2010)

*In November 2000, Mike Helton became the third president in NASCAR history as the torch of leadership passed to a non-France family member for the first time. (NASCAR.com 2010)

*Expanded 36-race schedule and its new television package in 2001. (NASCAR.com 2010)

*In 2003, NASCAR made two major announcements to help the dawn of the new era become even clearer. NASCAR announced in June that Nextel would become the new series sponsor in 2004, replacing R.J. Reynolds' Winston brand after 33 years. Three months later, in September, Brian Z. France was named NASCAR's CEO and Chairman of the Board replacing his father, Bill France Jr. (NASCAR.com 2010)

Student Activities/Labs

Students will form cooperative learning groups or "race teams". Each race team will name their team based on a list of NASCAR sponsors. Students will perform the following list of activities as a team and will have the opportunity to earn points for their team like real NASCAR racers. At the end of the unit, the race team with the most points will be rewarded with Dalesandro Dollars in the form of their winnings. Other top placing teams will also be compensated in DD for their race team's effort.

Student Activity #1: Creating a KWL Chart

Objective: Students will collaborate in cooperative learning groups to compile a list of what they currently know and what they would like to know about force and motion.

Materials Needed:

- Chart paper for each group
- Markers

Directions: Each race team will complete a KWL chart on the topic of Force and Motion as it pertains to NASCAR racing. In the first column groups will list what they know about force and motion. In the second column race teams will list things they would like to discover or find out. Bring the entire class back together and invite each group to present their information to the class. Post KWL charts around the classroom and refer to the charts throughout the study of force and motion.

To stimulate the students' prior knowledge of force and motion for this activity, utilization of photos, projections, or movie clips from the Pixar movie *Cars* can aid n connecting with students of all levels. This will initiate discussion among the students about what the characters in the movie reference about auto racing and the concepts of NASCAR. For those students that do not have a general knowledge of NASCAR, this will level the core knowledge for this topic. For example; in the movie, Lightening McQueen gets lost during the night because his headlights are stickers and for "show only." This concept is true to NASCAR vehicles as well due to safety concerns regarding the possibility of broken glass caused by collisions or malfunctions.

Student Activity #2: Race Team Ramp Competition

Materials Needed:

- assorted matchbox cars
- preassembled race track (See Appendix)
- modeling clay
- stopwatch
- Student ISN to record different race results

Assembling the ramp (See Appendix B)

Fasteners from McMaster-Carr

Line		Description
1	97008A616	Zinc-Plated Steel Spade Head Thumb Screw with Shoulder, 1/4"-20 Thread, 1" Length, packs of 25
2	96659A106	18-8 Stainless Steel Type A SAE Flat Washer, 1/4" Screw Size, 5/8" OD, .05"-.08" Thick, packs of 50
3	92001A321	18-8 Stainless Steel Wing Nut, 1/4"-20 Thread Size, 1-3/32" Wing Spread, packs of 25

Blu Track; Qty 1, Item #1100, description 30.48 Meters or 100 feet of BluTrack PRO (ON-LINE ONLY)

http://www.shop.blutrackpro.com/product.sc?productId=7

- The material we used was 16 gage Stainless Steel although regular sheet metal is fine.
- We then cut the parts out, deburred them, and then polished everything.
- We used wing nuts for easy assembly; however, a ¼"–20 nut and bolt tighten just fine with fingers for this job.
- Our track was BluTrack:

  Qty 1, Item #1100, description 30.48 Meters or 100 feet of BluTrack PRO (ON-LINE ONLY)

  http://www.shop.blutrackpro.com/product.sc?productId=7

Directions: Using the ramps assembled by myself and my NASCAR seminar colleagues, students will test the speed of various matchbox cars on the track. Students will perform several trial runs before choosing the car to race in the classroom competition. The teacher will use the stopwatch to determine the place standings for each race team after the initial race. Race teams will then adjust the height of the track and add modeling clay to the matchbox cars to create a drag. Does the drag speed the car up or slow it down? How does the ramp height affect the force and motion of the matchbox car? Students will record race trials in their ISN to determine which car/ramp height combination produced the fastest racing results.

Understanding the NASCAR points system/Connecting Math and Science

NASCAR uses a points system where racers earn points for the following:

* Any driver who leads a lap during a race receives one bonus point.

* The driver who leads the most laps receives an additional one bonus point.

* The race winner receives three bonus points

* Points are awarded for each driver based on which place the driver finishes the race in

*Maximum Points per race 48

After race teams complete various trials with their matchbox cars, the classroom will host an abbreviated NASCAR point's competition among the race teams. Race teams will be awarded points based on the criteria above. After each race team has competed in different trials with the ramp at alternating levels, the points will be calculated and the top teams will be rewarded in Dalesandro Dollars money.

Student Activity #3: Styrofoam Racers

Objective: Students will use Newton's Third Law of Motion to design and test Styrofoam race cars.

Materials:

- balloons
- tape measure
- circle and rectangle stencil patterns
- straws with flexible top
- pen
- Styrofoam tray
- masking tape
- scissors
- ruler
- pins

Directions:

1. Students will use the stencil patterns to trace four circles and one rectangle onto the Styrofoam tray

2. Cut all of the parts out of the tray

3. Blow up the balloon and then let the air out. Tape the balloon to the flexible end of the straw.

4. Tape the straw and the balloon to the rectangle car body

5. Use straight pins to attach the wheels to the body of the car

6. Model how to operate the race car: blow air into the straw to inflate the balloon and squeeze the end of the straw to hold the air in the balloon. Release the tip and watch the car zoom forward

Once each race team has assembled and tested their balloon racer, cars will then be raced against one another to determine which race team has assembled the fastest racer. Move race cars to a slick floor area. Use masking tape to label a starting line and a finishing line. Each balloon racer will bring their car to the starting line and inflate their balloon. When the teacher gives the start cue, each racer will let go of the straw and the car will race towards the finishing line. Next, two race teams at a time can face off to determine which team has assembled the fastest balloon racer.

After the race has concluded, students should respond to the following questions in their ISN:

1. Which car went the fastest?
2. Why or what made some cars go faster?
3. How did the balloon racer show each of Newton's laws in action?
4. What additional changes could you make to your balloon racer to make it perform faster?

Essential vocabulary

Essential vocabulary for this unit to add to Glossary in Interactive Science Notebooks:

Friction - occurs when two objects rub against one another. This is normally a force that dissipates energy as heat. Friction is what slows a car as it rolls along.

Position - is the location of an object. It can be the position of our little race cars at the top of the ramp or where they end up at the bottom.

Motion – is the change in the position of an object. For our race cars, they move down the track and their motion is that movement.

Relative position - position of one object compared with the position of other objects. Again using our race track for a learning lesson, did your car move ahead of my car while racing? Was your relative position ahead of mine. In a NASCAR race, relative position is how the moving cars relate to each other. Who is ahead and who is behind in the race. This may also be a static thing. Where was my pit stop compared to yours?

Speed – is the rate at which an object changes position. For our little race cars, the speed is the distance they travel in a specified time. For example, twelve inches per second. For a NASCAR race car, the speed is an instantaneous number like 185 miles per hour or an average like 155 miles per hour over the whole 500 miles (including slow yellow flags for crashes and pit stops).

Force – is a push or a pull. Gravity supplies the force that pulls our cars down the ramp. My shoe may supply the force at the bottom when the car hits me and stops.

Work – is what happens when a force moves an object over a distance. The force of gravity on the little cars as they ride down the track does work on the cars.

Simple machine – is a machine that helps make work easier. How do we get forward motion out of cars at the top of our track? We use a machine called an inclined plane.

Inclined plane – is a simple machine consisting of a slanting surface connecting a lower level to a higher level. Our little ramp race track is an inclined plane. It takes a car that would otherwise fall and turn it into a speeding race car.

Ramp - another name for an inclined plane, (only with a cooler name).

Resources

Annotated Bibliography for Teachers

Keveney, Matt. *AutomatedEngines.com.* 1 1, 2012. http://www.automatedengines.com/index.html (accessed 10 12, 2012).

* This website is interactive and a great resource for both teachers and students to see how different engines function.

Leslie-Pelecky, Diandra. *The Physics of NASCAR: The Science Behind the Speed.* New York, NY: The Penguin Group Inc., 2008.

*This book is an informative resource for teachers to better understand the scientific principles as they apply to NASCAR.

Louviere, Georgia. *TeacherTech.rice.edu.* October 26, 2006. http://teachertech.rice.edu/participants/louviere/Newton (accessed November 2, 2012).

*This website offers background information for Newton's Laws and includes quizzes as well as a variation on student activities.

NASCAR.com. *NASCAR.* March 8, 2010. http://www.nascar.com/news/feature/history (accessed October 22, 2012).

*This is the official website for NASCAR and offers a variety of information from current news, to history, and general NASCAR information.

Reading List for Students

Graham, Ian. *You Wouldn't Want to Be Sir Isaac Newton!*. Scholastic: Paw Prints, 2013.

Entertaining book for students to read.

Mooney, Loren. *A kids' guide to NASCAR*. New York: Sports Illustrated for Kids, 1999.

"NASA - Multimedia - Video Gallery ." NASA - Home . http://www.nasa.gov/multimedia/videogallery/index.html?media_id=18132261 (accessed October 26, 2012).

This link shows how NASA connects to sport of NASCAR.

Westphal, Laurie E.. *Hands-on physical science: 75 real-life activities for kids*. Waco, Tex.: Prufrock Press, 2008.

This book is a wonderful resource for hands on physical science labs.

Chicago formatting by BibMe.org.

List of Materials for Classroom Use

- Various “read alouds” on topics such as NASCAR, force and motion, Sir Isaac

Newton and his laws

- Materials to build the classroom sized racing ramp (See Appendix)
- Chart paper and markers for KWL charts
- Assortment of nonfiction, grade level text for students to explore the topics of NASCAR and force and motion independently
- Discoveryeducation.com for streaming videos to incorporate technology

Appendix 1. Fasteners and track for the force and moment ramp kit.

Fasteners from McMaster-Carr

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2	96659A106	18-8 Stainless Steel Type A SAE Flat Washer, 1/4" Screw Size, 5/8" OD, .05"-.08" Thick, packs of 50
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Blu Track; Qty 1, Item #1100, description 30.48 Meters or 100 feet of BluTrack PRO (ON-LINE ONLY)

http://www.shop.blutrackpro.com/product.sc?productId=7

Appendix 2. Ramp Drawings

- The material we used was 16 gage Stainless Steel although regular sheet metal is fine.
- We then cut the parts out, deburred them, and then polished everything.
- We used wing nuts for easy assembly; however, a ¼”–20 nut and bolt tighten just fine with fingers for this job.
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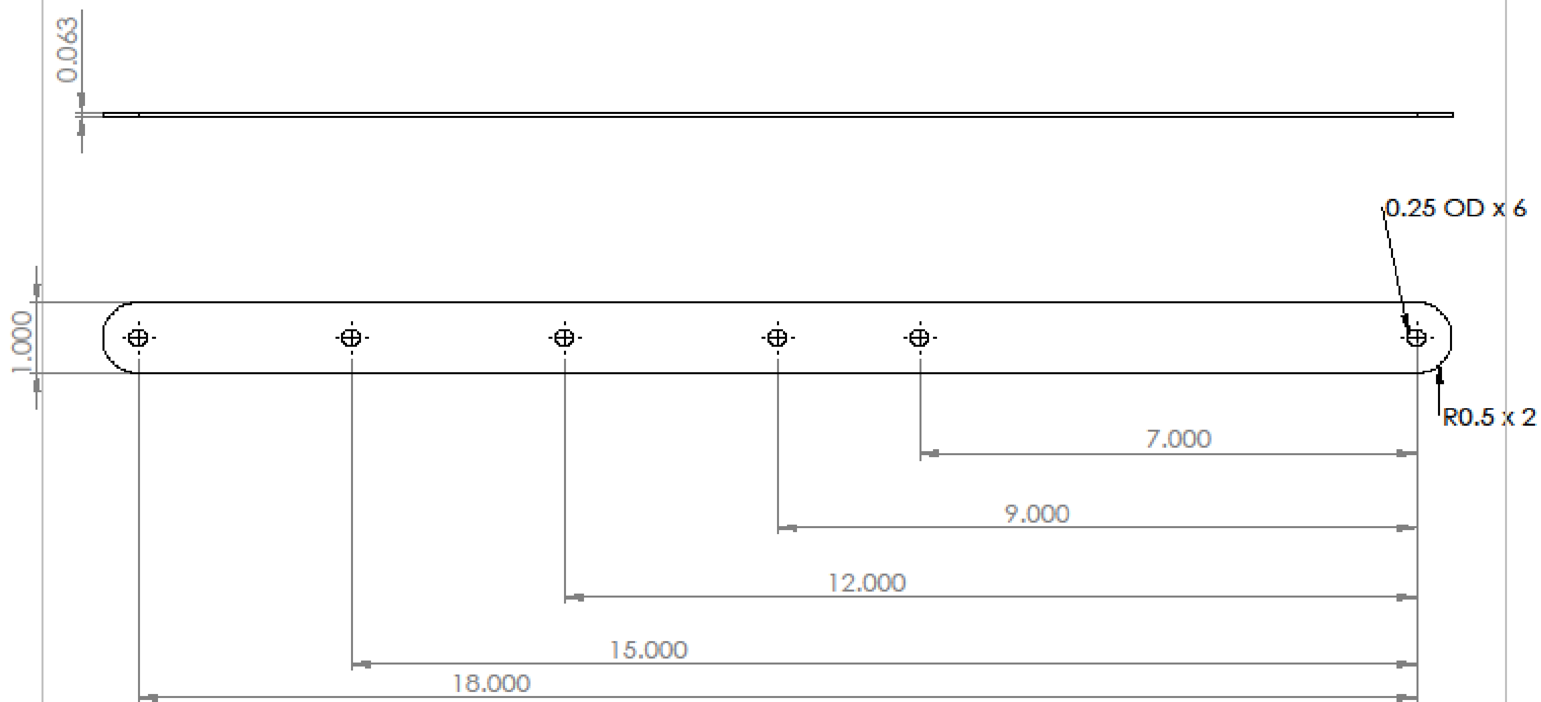

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304 Stainless Steel

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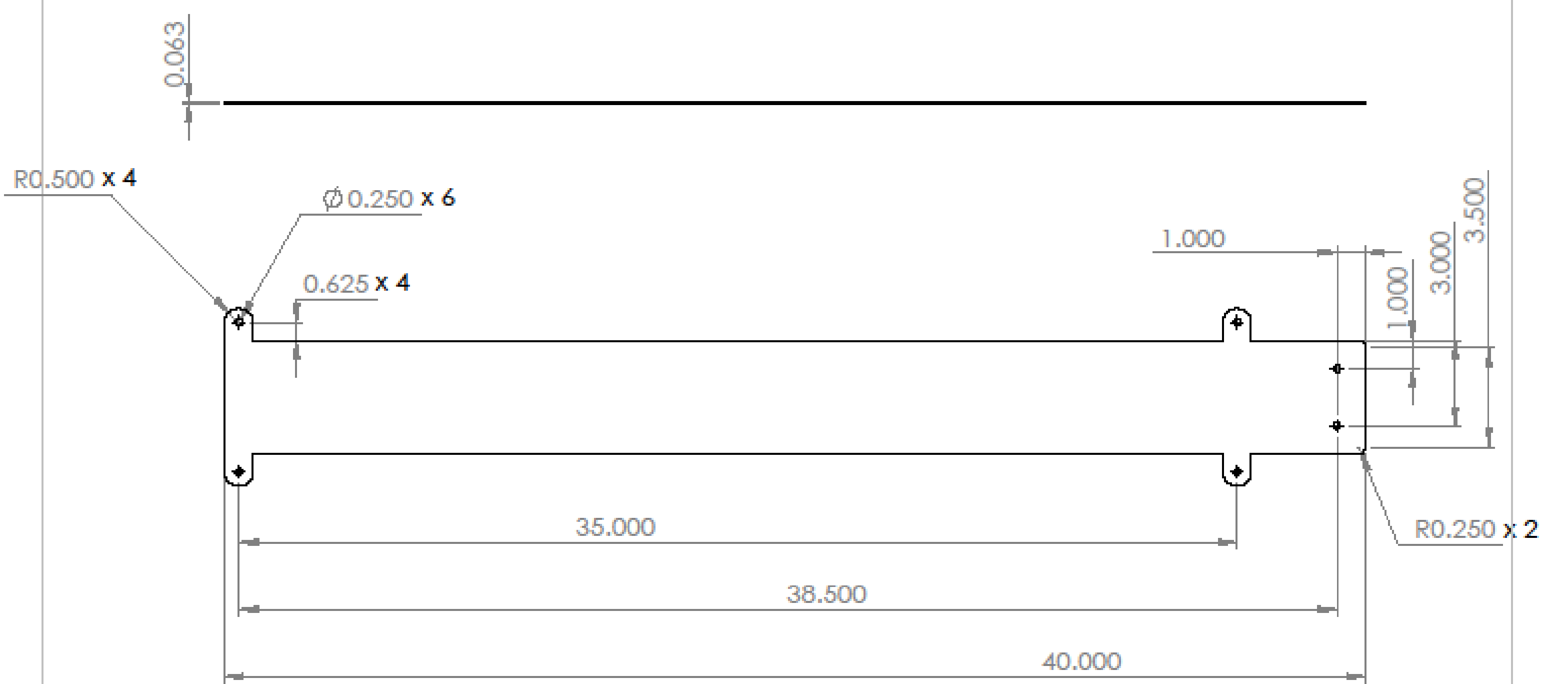

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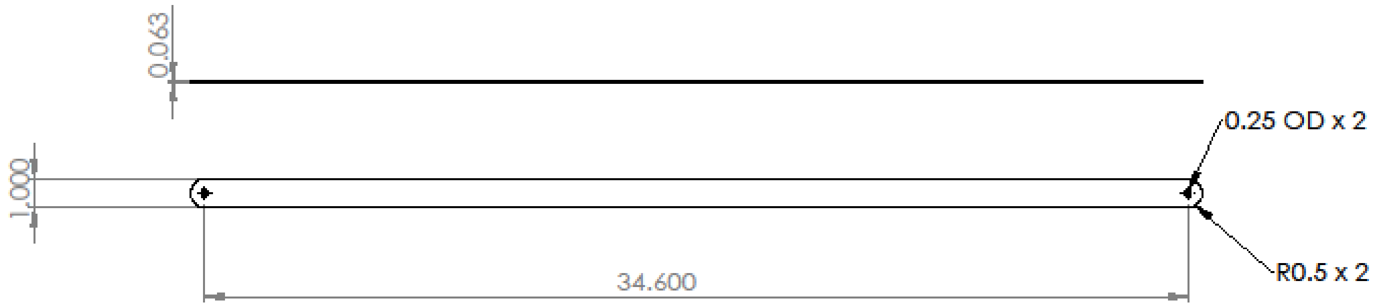

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Appendix 3. Ramp images

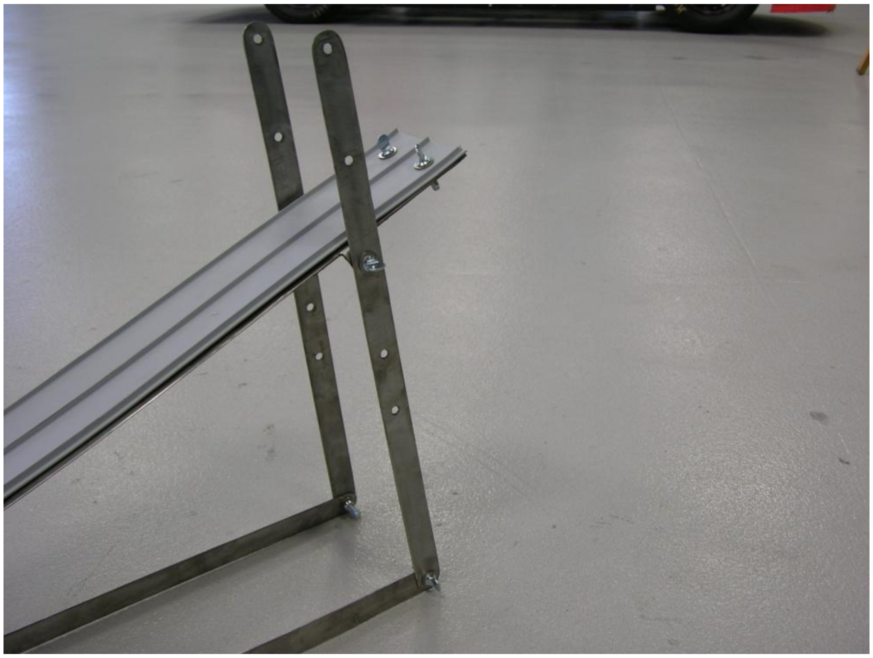

Figure 1. Adjustable height struts

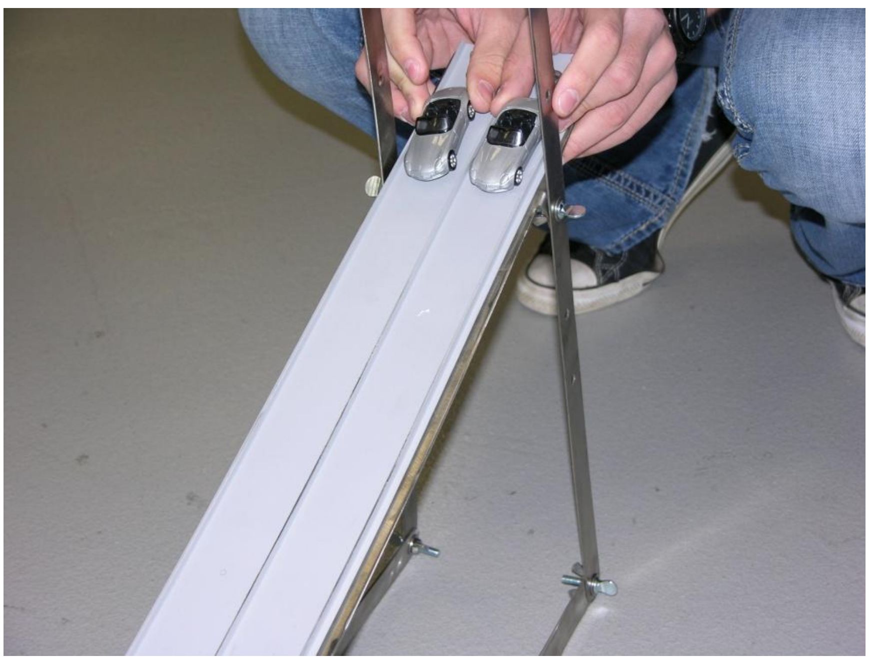

Figure 2. The starting line

Figure 3. Wing nut and wing bolt fasteners

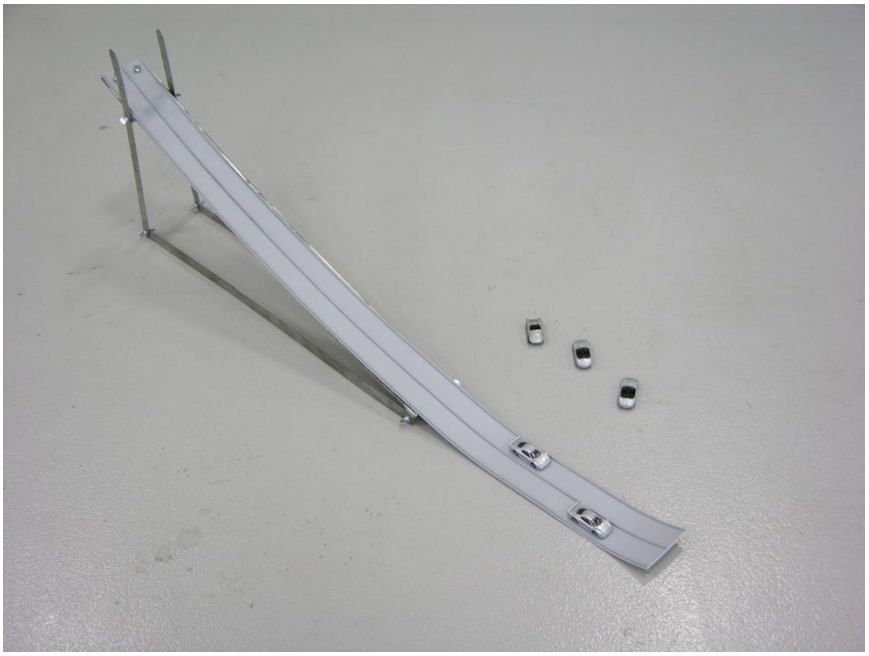

Figure 4. The ramp as used.

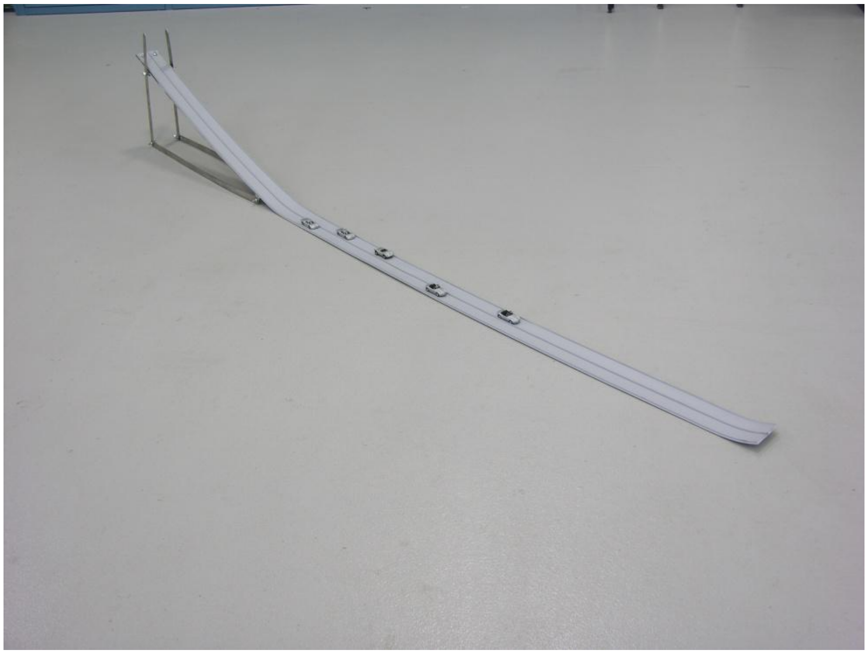

Figure 5. Ramp with 10' track.

Figure 6. Car with standard clay load set up for high drag.

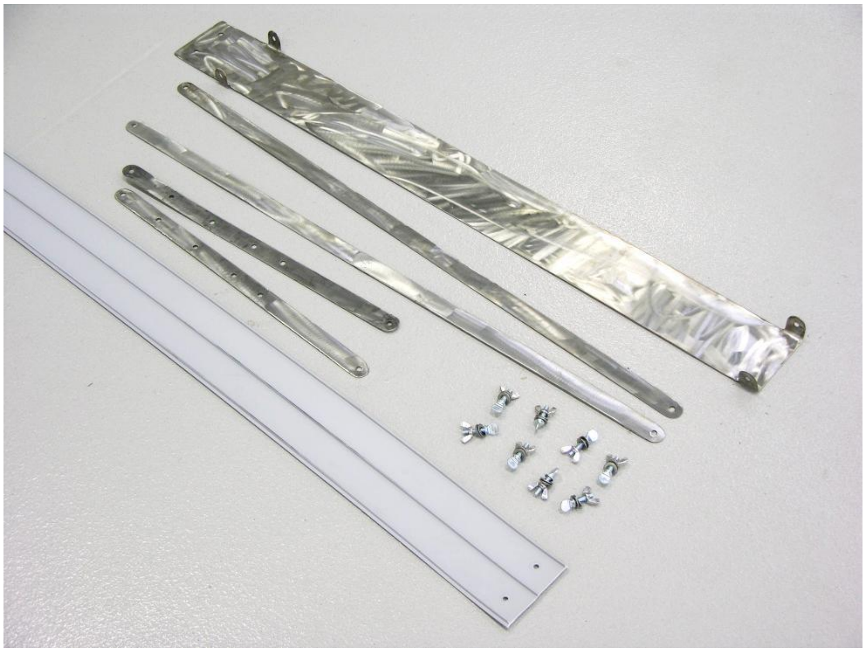

Figure 7. Disassembled track ready for storage.