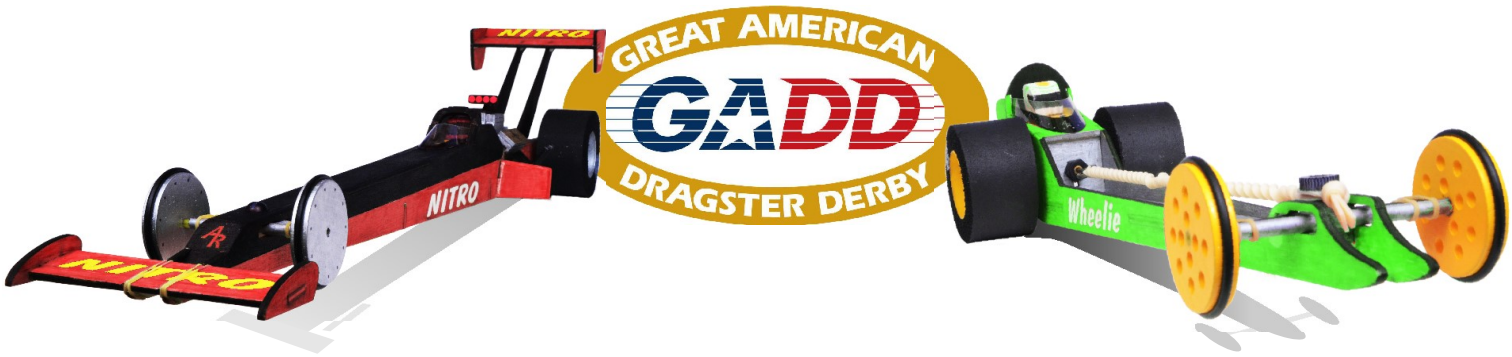

Spotlight on Teamwork, Careers & STEM

Author: Luc Bausch

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Contents

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Lesson Plan 1

Time needed: Approximately 1 hr.

Prior to class, do the following:

☐ *Familiarize yourself with the curriculum by reading through the entire document prior to class.*

☐ *Print the entire document and make 1 copy for each team as well as officials.*

Forming the teams:

☐ *Depending on your class size, form 8 teams of 2 to 4 students per team and 4 to 5 race officials.*

☐ *Use page 3 to briefly explain the different race team member and race official functions.*

☐ *Select 8 race team leaders.*

☐ *Let the students in each team decide which function they want to perform.*

☐ *Have each race team leader complete their race team member list by end of class.*

Selecting the race officials:

☐ *Use the Race Official List to fill the four race official positions.*

Introducing the GADD dragsters:

☐ *Have the students visit the Great American Dragster Derby site at* dragsterderby.com *and watch the short video on how these racers work.*

☐ *If possible show a GADD dragster from a previous class and briefly explain how they work.*

Homework

☐ *Students should familiarize themselves with drag racing by logging onto* nhra.com *which is the official site for the National Hot Rod Association (NHRA).*

☐ *Students should read up on their responsibilities as a team member or race official.*

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The GADD Teamwork and Careers Experience

The Great American Dragster Derby® (GADD) allows students to experience what it is like to have a career in motorsports. They can choose to be involved with a race team and challenge for the win. They can also choose to experience what it is like to be a race official or a reporter/media specialist.

Generally, a class should be divided up into 8 race teams. A race team should consist of a minimum of 2 students and a maximum of 4. Not all race teams need to have the same amount of students. Students can work on their own and assume all team functions.

The Race Team

The race team consists of the following individual functions (all team members can help build the racer):

Driver: *responsible for winding and launching the car, setting the steering, analyzing the runs, analyzing the competition, suggesting racing strategies.*

Crew Chief: *responsible for building the racer, for recording racer set up and performance data, timing the car, interpreting data and suggesting improvements to the car set up.*

Mechanic*: responsible for helping to build the racer, maintain it in perfect running condition, be able to change gear ratios and ballast at a moments notice, help wind the racer.*

Artist: *responsible for the coloring scheme and decorating of the racer. Also helps with the design of the team presentation board or any advertising related to the race team.*

Public Relations Specialist: *responsible for gathering information about the team and being the team representative to the reporter. Must be able to receive technical information from the race official and be able to communicate pertinent information to the different team members. Optional: Secure sponsorship for the racer from a small business in the area.*

Official Race Organization Team

The official race organization team consists of the following individual functions:

Race Official: *responsible for working with the instructor and school officials regarding when and where testing sessions as well as the race can be held. Must be able to lay out the track and run the event along with the instructor. Must enforce the GADD rules and should be able to run the drag racing elimination chart.*

Official Starter: *the starter stands behind the two drivers and shouts "GO" when both drivers are ready to race.*

Finish Line Official: *the finish line official calls the race winner.*

Reporter / Media Specialist*: responsible for writing up a race report that can be published on the GADD website as well as shooting photographs/video.*

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Race Team Member List

List all the student names participating as a race team member below.

Race Team Name:

Driver:

Crew Chief:

Mechanic:

Artist:

Public Relations Specialist:

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Race Official List

List all the student names participating as a race official below.

Race Official:

Official Starter:

Finish Line Official(s):

Reporter/Media Specialist:

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Task Sheet: Driver

The GADD Driver … cool, calm and collected.

As a driver, you are responsible to wind your racer according to your crew chief's recommendation. You need to be able to focus among all the race hoopla on race day so you can accurately count the winds.

Once your dragster is lined up on the race track, your main responsibility is to launch it straight AFTER the "GO" signal. If you become nervous and launch before you hear the "GO" command, you will forfeit the race. You should have fairly quick reflexes and upon hearing the command "GO" release your team's racer instantly and smoothly.

You are also responsible to know the racing characteristics of your car and the surface where you are competing. Testing will tell you whether your racer runs straight or tends to divert to either side during the run. You should be able to adjust the steering so your car runs as straight as possible. The shortest line between start and finish is a straight line.

Building the racer … you never know too much.

If you have building experience you should get involved in the building of your team's racer. As a driver it is important that you know the workings of the differential (how the gears work) and how the wheels are attached to the rear axle. This becomes very important if on race day things go wrong during the winding portion just before the race and there is not enough time for the mechanic to fix it. The more you know, the better you will be able to quickly diagnose and fix a problem, thereby increasing your chances at winning the race.

Winding the racer.

You will wind the racer for all test and race runs. You must use the rear wheels to wind the racer. ***A mechanical winder (manual or electric) is not permitted****. Use the winding tool provided in the kit. Insert the winding tool into the* ***left*** *wheel to wind your racer. Make sure you wind it backwards.*

You can pack more winds into your racer if you stretch wind your motor. That means you hold the racer as your teammate unhooks the rubber motor in the front of the vehicle and stretches it to 3 or 4 times its original length. Now you start winding the car with your winding tool on the left wheel. As you have about 70% of the total winds packed into your motor you keep winding as your teammate moves the end he/she is holding closer to the motor hook up point. Practice makes perfect.

The Start.

At the start, you must hold your racer by the rear wheels. The front wheels are aligned at the start line.

You may ***NOT*** *push start your racer. It is considered a false start and gives the win to the opposing team.*

One option to hold your car is shown. This allows you to quickly lift your hand and your racer is free to accelerate towards the finish line.

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Task Sheet: Driver

Racing Strategy … know your competition.

You need to observe your competition and time some of their runs to see how your team measures up. If you know that you are going against a much slower team, you can relax because your car is faster. If you are going against a team that has a faster racer than yours, you can still beat them by releasing your car the very moment you hear the "GO" command and hope that the opposing driver has a slower reaction time at the start.

Know your competition!

Winning! … share the joy.

You just won the final elimination heat and you are the champion. Don't forget to mention all your teammates by name during the interview and give them credit towards the win. Winning is a team effort.

Loosing … don't blame your team.

You will not win every time. Shake hands with your team mates and the winning driver. Thank your team mates regardless of the lost race. You might have another shot at winning the next race. Think about how you could turn your racer into a winner next time.

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Task Sheet: Crew Chief

The GADD Crew Chief … the one calling the shots.

As a crew chief, you are responsible for the completion of your team's racer. You also need to be able to record data from each run and make new set up recommendations after considering all the variables.

You write down the set up of the car such as amount of power used (how many rubber loops, width of the rubber loops), amount of winds, gear ratio, amount of ballast and the result of the run in seconds. Then you compare the data from the last run and try something new to make your racer go faster. Use the engineering sheets in the back of this publication to your advantage.

The crew chief communicates the power/gear changes to the mechanic and makes sure the driver knows the minimum amount of winds it takes to make the racer cross the finish line.

On race day, race strategy comes into play. If you are going against a car that has been consistently slower than yours, you can go with a safe set-up. If you are going against a car that you know is faster than yours, you might try something that you have not done before in order to beat that car.

Building the racer … you never know too much.

You are responsible for leading your team in building the dragster. As a crew chief it is important that you know what you can change on your race car. The more you know, the better you will be able to react and change the set up, thereby increasing your chances at winning the race.

Recording data from each run.

Use the engineering data sheets in the back of this publication and record all pertinent information such as gear ratio, amount of power, amount of winds and the elapsed time (ET) of the run. The Elapsed Time is the time it takes your racer to go from start to finish. You should use a stopwatch to record the ET from each run and use it to compare whether your car set up is headed in the right direction. After a day of testing, sit down and analyze your data. Then, think about what you would like to try to make your car faster such as more power, different gearing, increased amount of winds or changing the ballast. Use the science provided in this manual, your data collected and your wits to suggest set up changes for your racer in order to make it the fastest of all.

Engineering knowledge … understanding and applying the Science.

You need to read and understand the science that makes your racer tick. Every change you do to your racer brings along consequences. While more power might make your racer faster, more wheel spin at the start may be the consequence. If you find a set up that works really well for your car, keep it to yourself. The more data you collect with different set ups, the more knowledgeable you will be. There is no substitute for testing.

Race distance … to the finish line and not far beyond.

Get the race distance from the race official and make sure you calculate how many winds it takes to make it to the finish line. Account for some wheel spin at the start and add a few winds. The power, gear ratio and ballast need to be adjusted so that your racer makes it past the finish line every time, but does not keep going too far to hit an object down the race track. Know the location where you are running and make sure your racer is not going to be wound so much that it will hit a wall or sidewalk past the finish line at high speed. Calculate the maximum amount of winds possible to prevent damage to your racer.

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Task Sheet: Crew Chief

Racing Strategy … know your competition.

You need to observe your competition and you or a team member should time some of your competitors' runs to see how your team measures up during testing.

Race Day … it's about the details.

You should make sure that you crossed all your t's and dotted all your i's on race day. Make sure you pick a set up that has been consistently fast. Communicate to your mechanic all the tasks that have to be accomplished on the car well before the car goes to the start line. It helps to have a "to do" check list before each run.

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Task Sheet: Mechanic

The GADD mechanic … the one wrenching on the car.

As the mechanic you are responsible for the trouble free operation of your team's dragster.

You make sure that everything on the racer works to perfection.

You make sure all wheels turn freely without excessive wobble.

You make sure the gears mesh perfectly.

You make sure that the rubber motor is in good condition.

You make sure that the drive shaft assembly is in place, tight against the fire wall.

You make sure the gears and the drive shaft are lubed.

You make sure that the car features the exact set up recommended by your crew chief.

Building the racer … you never know too much.

You should be involved in the building of your team's racer. As the mechanic it is important that you know what you can change on your race car. The more you know, the better you will be able to react and change the set up, thereby increasing your team's chances at winning the race.

Righty-tighty, lefty-loosy.

Make sure you know how to adjust the rear wheel gap fairly quickly by turning the right rear wheel in or out.

Practice a crown gear change a few times so you can do it in a few minutes.

Keep your tools handy. You should have the winding tool, the allen wrench and a 3/8 inch hex key close by at all times.

Make sure you know how to fix your race car.

Race car maintenance … it's very important.

You should check the twin hex nuts holding the drive shaft assembly in place for tightness after each run.

Use WD-40 to lube the gears and drive shaft when needed.

Check the rubber band motor for cracks and suggest replacing it when you see that it starts deteriorating.

Race car storage/transport … that is your job.

You are responsible to store the race car and the tools.

It is your responsibility to bring the car, tools and extra gears/rubber string to testing and the race.

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Task Sheet: Mechanic

Race Day … make sure your race car is in top mechanical shape.

You need to go over the whole car and check everything the day before race day. You do not want to have to rush on race day to change gears or similar. Just go over the whole drive train, make sure the nuts are all tight and check the rubber motor. After each run, check the the twin hex nuts on the drive shaft assembly and lube the gears/drive shaft.

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Task Sheet: Artist

The GADD artist … making it pretty.

The artist for the team is not a full time position and should be taken on by the team member with the most artistic talent.

As the artist, you are responsible for decorating the racer.

Make sure to talk to your team, especially the public relations specialist about possible sponsorship. In that case you have to wait with the decoration until the sponsorship deal is finalized.

Present your team with a sketch of the paint scheme before proceeding to color the racer. Go to aeroracers.com *and go to the page that shows your racer. You can download the side view pdf and you can use it to test how your decorating ideas look on paper first. Show it to your teammates and get them to agree on a coloring scheme.*

Prep the completed racer for decoration by using medium grit (220 grit sandpaper) to sand away the laser burn marks.

Keep in mind that the marker color will "run" on the wood unless you use a ball point pen to draw a line on the wood for the color to stop. Think before you color.

Use permanent markers to decorate the racer and the rims. (Permanent Sharpies work best)

Use the computer to make any stickers to glue to the car.

Read in the car's assembly instructions as to how to color the windshield.

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Task Sheet: Public Relations Specialist

The GADD Public Relations Specialist … the spokesperson of your team.

As the public relations (PR) specialist, you are responsible to put together and coordinate any press releases or news concerning your racing team. You are in charge of securing sponsorship for your race team.

The race team "presentation" board.

You are tasked with putting together a presentation page about your race team. It should be in printable format 8.5 x 11 inches (std. page) as well as being able to be emailed on the GADD website. This presentation page should be mounted such that it can stand on it's own next to your car (see next page for example).

The page needs to contain:

The name and logo of your Race Team

A photograph of your completed and colored racer

The first names and functions of all team members

The Sponsor's name(s) if applicable.

Broadcasting your race team's participation in the "big" race.

Use social media to broadcast your team's progress to your friends, family and sponsors. Answer any questions they may have.

Sponsorship.

Ask your instructor whether he/she permits you to go ask a family member, neighbor or small business for sponsorship of your race team. The money is to be handed to the instructor to cover the purchase of more racer car kits for the next class as well as racer hop up parts. Work with your team's artist to include your sponsor's name(s) on the car.

Team photography.

Shoot some action pics to send to your friends.

Shoot a picture of your whole race team including the race car for publication online. You can submit it to us at dragsterderby.com *for publication on our race team page.*

Working with the race officials.

You are the speaker for your team. If for example, your team finds that it needs more time for additional testing, you need to contact the race official and submit your request.

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Task Sheet: Public Relations Specialist

Below an example of a team presentation board.

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Task Sheet: Public Relations Specialist

Summary of your race team's participation and race result.

Use social media to broadcast your team's race experience and result to your friends, family and sponsors.

Thanking your sponsor.

If your racer was sponsored, have all the team members sign a team photograph including a "Thank you" to be presented to the sponsor. That sponsor will be eager to contribute towards your next adventure or towards a future team from your school.

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Task Sheet: Race Official

Race Official.

As the race official you will work closely with your instructor to organize the race. You communicate with all involved on when, where and how the race will be run.

Finding a venue to test and run the race.

Work with your instructor to find a venue (see GADD track layout page) where the race teams can test and the official race will be held. Keep noise control in mind.

The venue needs to be fairly smooth like a schoolyard. It could be indoors in a multi purpose room as well.

The length from start to finish line should be between 30 and 50 feet. The width should be between 15 and 20 feet.

The run off area behind the finish line should be an additional 15 to 20 feet. It should be clear of objects that cars could run into.

Once you have found a venue, use chalk or tape to mark a start and a finish line.

Do a few test runs and report eventual problems to your instructor.

Once the venue and distance chosen are finalized, communicate the location and distance along with possible testing times as well as the date of the official race to all the PR specialists for all teams.

The drag racing ladder.

Use a portable whiteboard to draw a large drag racing ladder. Use the pattern shown on the next page.

To figure out who races whom, put all the team names on identical pieces of paper, fold them up and throw them in a hat or similar. Have a neutral person like your instructor pull the team names out of the hat. As the names are read out, write them down from team position 1 to 8.

Drag racing works best with 8, 16, 32 teams and so on. What if you have only six teams? Then you would choose the grid for 8 teams. In addition to the 6 team names on the folded papers, you will add two marked "Single Run". Whichever team draws the "Single Run" gets an automatic advancement to the next round. Those teams get to do two runs each if they wish, although there is no competitor in the lane next to them. (If you draw two single runs against each other, you have to put them back into the hat and draw again.)

Teams with two out of three GADD race wins advance.

In GADD, the winner in each round is the team that wins two out of three races.

In many cases drivers get nervous and make elementary mistakes in the first race. In order to give them a chance at redeeming themselves, we recommend you run an minimum of two races or heats per round.

If the same team wins twice in a row against the same competitor, the winning team moves on.

If both teams win a race, then you run a third race to determine the winner. The winner goes on to the next round.

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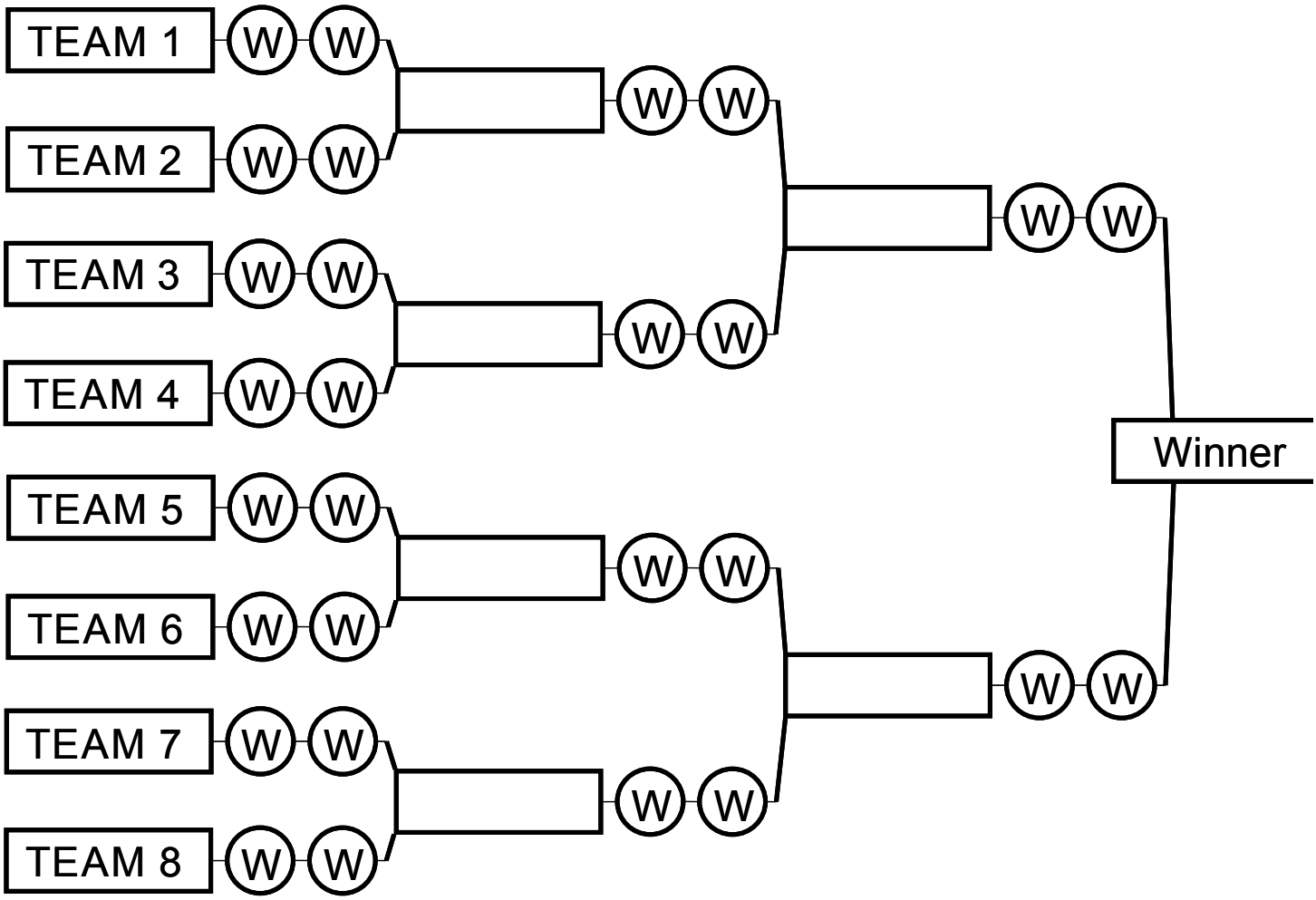
Task Sheet: Race Official

The drag racing ladder.



Round 1 ***Round 2*** ***Round 3***

Semi-Finals ***Finals***

For starters, team 1 race against team 2. If team 1 wins, then you mark the circled W with a bright marker next to their name. Continue this method until all teams have raced. If they also win the next race, they get another circled W marked and move on to the next round. You then fill in their team name in the next bracket.

The semi-finals (round 2) are made up of the four teams that won twice in the previous round. The winners of the semi-finals move on to the finals. Whoever wins two out of three races in the finals, is the overall event winner.

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Task Sheet: Race Official

Pre-Race Drivers Meeting.

On race day, prior to the race, invite all drivers to a drivers meeting. In that meeting you need to go over how the race will be run and what you expect each driver to do. You need to re-iterate the following:

How the drag racing ladder works.

Who is racing whom in the first round.

2 wins out of 3 races will decide which team advances to the next round.

What it means to be called on deck. (Start winding, be ready to proceed to the start line.)

After the team has been called to the start line, the driver has a maximum of 1 minute to line up his/her racer at the start line.

If the rubber motor snaps during the winding process while on deck, the team has 2 minutes to appear at the start line or forfeit that race.

Drivers line their car up with the front wheels at the start line.

Drivers hold their cars by the rear wheels only prior to launch.

Let the drivers know the agreed upon "ready" signal that they are expected to give the official starter standing behind them, once their racer is in position and they are ready to launch.

Give the drivers the launch command (such as GO! or the sound of an air horn etc.) to expect from the official starter which will indicate when they should release their racers.

No push starting is permitted.

Push starting the racer will result in loosing the race.

If two racers collide, the race will be re-run until there is a clear winner.

If a driver releases his/her racer prior to the start signal, he/she looses that race.

Inform the racers that decisions of the finish line officials as to who won the race are not up for discussion.

Who is racing and who needs to get ready.

You need to announce who needs to come to the start line to race and who is on deck (needs to get ready). For example, as you call teams 1 and 2 to come to the start line to race, tell teams 3 and 4 that they are up next and need to get ready (on deck).

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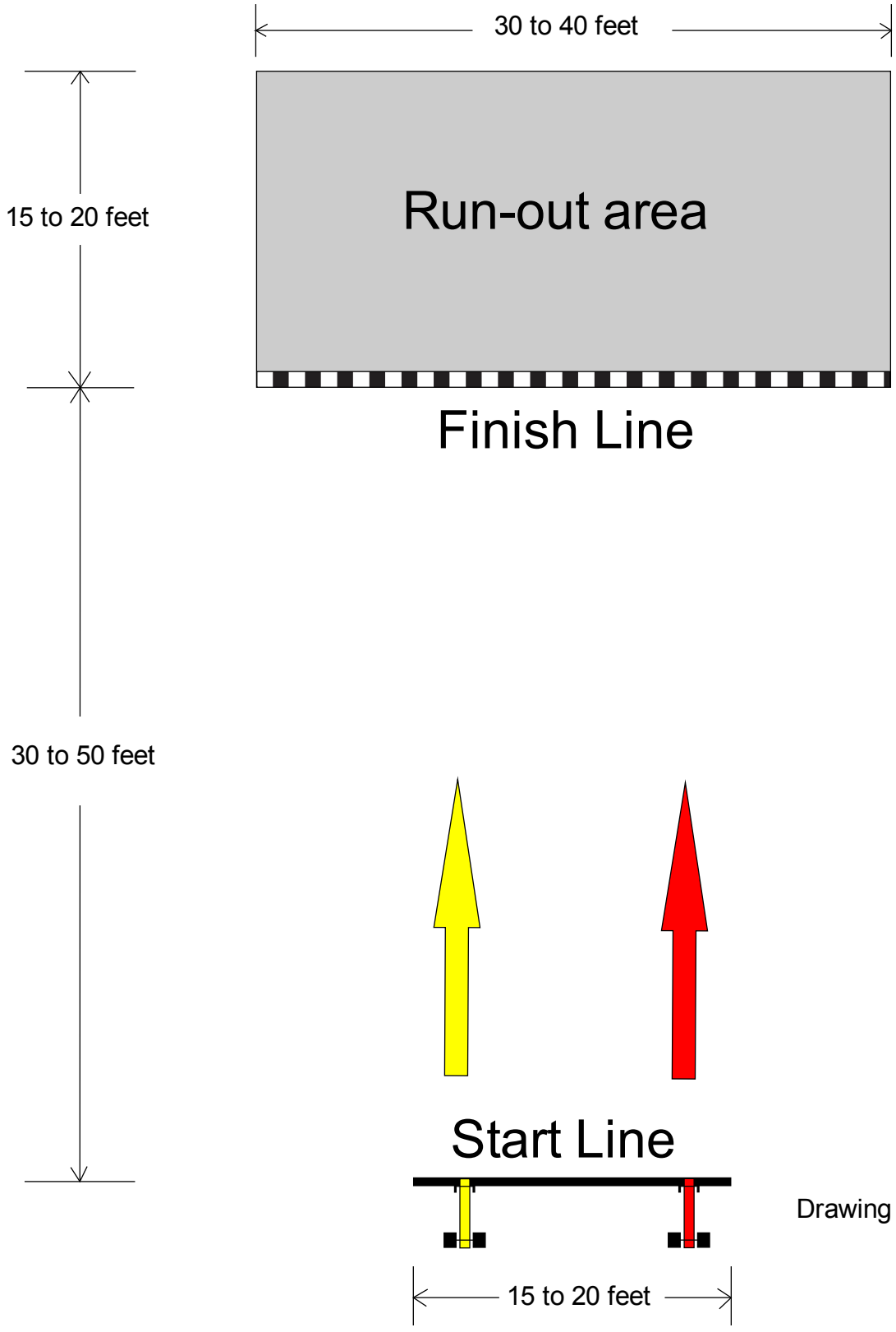
Task Sheet: Race Official

A typical GADD track lay-out.

Below you see a typical GADD track lay-out. We recommend the race distance to be 30 to 50 feet. If you are organizing multiple events, the race distance can be different for each event. The GADD racers can be set up to run in excess of 100 feet race distance.



Drawing is not to scale.

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Task Sheet: Official Starter

Official Starter.

As the official starter, you will be responsible for starting each race.

You give both drivers on deck a time limit of 2 minutes to wind their racers.

Once the drivers are called to the start line, they have 1 minute to position their racers to launch.

Make sure both drivers are separated by a few feet so their racers have less chance to collide.

Make sure that the front wheels of their racers are at or on the start line.

Drivers are only allowed to hold their racers by the rear wheels/tires so they cannot push start their cars. See picture below on how you should recommend the drivers hold their racers at the start.

Have both drivers give you the signal that they are ready to race. It is best to inform the drivers before the start of the race which "ready" signal you are looking for. Work with the race official so he/she informs the drivers during the pre-race drivers meeting of the "ready" signal.

Stand behind the drivers and shout "GO" without counting down or giving them a warning. That way their reaction time to launch their car makes a difference in the race.

After the cars have launched, make sure the drivers on deck are ready to come to the start line.

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Task Sheet: Finish Line Official

Finish Line Official.

We recommend you have two finish line officials on race day.

The finish line officials determine who the race winner is by determining which car's front tires crossed the finish line first.

It is a good idea to record the finish line on video so you can go back and look at the recording in case of a race that is too close to call.

The decision as to which racer won the race should be unanimous by both finish line officials.

If the race is too close to call, have the drivers go back to the starting line and run it again.

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Task Sheet: Reporter / Media Specialist

Reporter / Media Specialist.

The official reporter follows the whole dragster derby event, from initial team forming to the final race.

The reporter also works as a photographer/videographer and shoots team pics, dragster building, race action photos/video such as start line action and team member reactions after a win or a loss to be published in the final report.

Shadow the teams as they test and get their reactions.

Make sure you interview the winning team after the finals. Start with the driver and then each member of the team.

After the finals are run, make sure you have access to the completed drag racing ladder so you can use it to write the story.

You then prepare an article and/or video about the event containing some photographs to be published in the school paper/website and/or on the official GADD website.

Remember to keep everything in good taste and put a positive and fun spin on the article / video.

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Lesson Plan 2 - Race Teams

Time needed: *Approximately 2 to 3 sessions*

Materials needed:

☐ *GADD racer 8 pack from AeroRacers Inc. Order your dragsters at* ***aeroracers.com****.*

☐ *Glue - Use white, carpenters glue or super glue to build the racers. We recommend you have at least one bottle of medium super glue available during the building phase and the race itself. Super glue will allow students to repair their car quickly. It is a good idea to also have accelerator spray available as it cures super glue instantly.*

☐ *Tape - Tape is used to hold the racer together while drying (only necessary when using white/carpenters glue).*

☐ *Double sided scotch tape – Optional. Students use double sided scotch tape or glue to hold the tires to the rims.*

☐ *Waxed paper - Waxed paper prevents the racer from gluing to the building surface.*

☐ *Sandpaper - Divide one sheet of 150 to 220 grit sandpaper into eight parts. Each team receives one small sheet of sandpaper.*

☐ *Permanent markers - Permanent markers are used to decorate the racers. (Permanent Sharpies work best). We recommend you purchase Sharpies of different colors with medium size tips or make the students responsible to provide their own.*

☐ *WD-40 – Have a can of WD-40 handy as the students will need to lubricate the gears of their racers.*

☐ *Wrench 3/8"- Have one or more 3/8" wrenches handy that the teams can borrow to help secure the drive shaft assembly to their racer.*

Hand out the racer kits to the teams.

☐ *Copy the racer assembly instructions and hand a copy to each race team.*

☐ *Hand each race team one complete racer kit.*

☐ *Make sure each team has access to glue, waxed paper, tape, sandpaper, permanent markers and WD-40.*

Assembly Rules*.*

☐ *Teams should read the entire assembly instructions before starting to build the racer.*

☐ *Parts should be trial fitted prior to using glue.*

☐ *Waxed paper is to be used as a protective cover over the building surface at all times when gluing.*

☐ *All sanding should be done outside if possible.*

☐ *When using white/carpenters glue, 24 hours drying time should be allowed in between building sessions to allow parts to completely dry.*

Decorating the GADD dragsters.

☐ *All decorations on their racers should be kept in good taste. No tobacco or alcohol advertising is allowed on the racers.*

☐ *Allow each team to use no more than 1 permanent marker at a time.*

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Lesson Plan 2 - Race Officials

Time needed: *Approximately 2 to 3 sessions*

Materials needed:

☐ *Mobile Display board for the drag racing ladder*

☐ *Tape or chalk to mark start and finish lines. Duct tape works great and sticks to the ground.*

Meeting with the race officials.

☐ *Meet with the race officials and listen to their recommendations for a suitable testing and race venue as well as date(s).*

☐ *Assist the race officials in securing the venue.*

☐ *Help the race official with the layout of the drag racing ladder.*

☐ *Make sure the reporter has access to a camera and/or video camera.*

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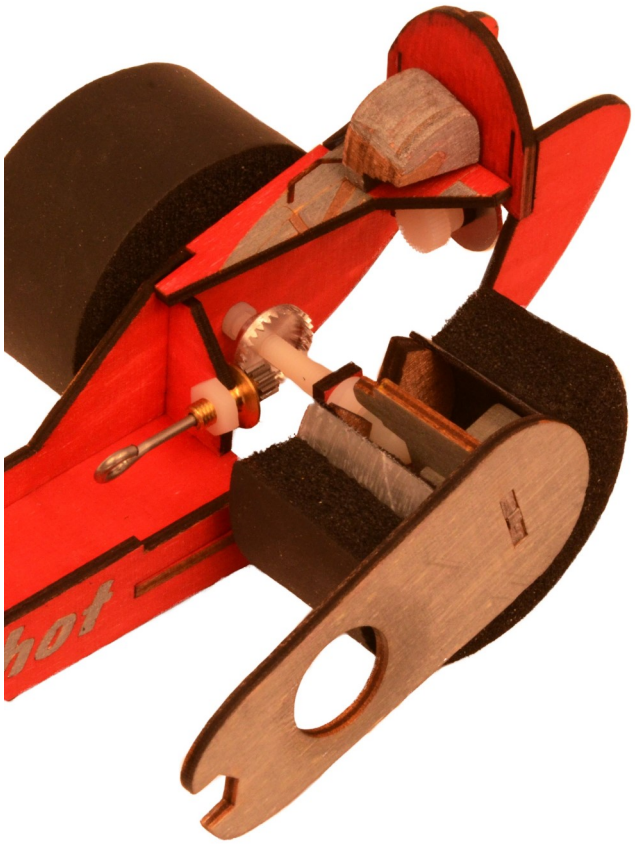
GADD Dragsters: Science Section



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Great American Dragster Derby (GADD) racers are designed to race side by side in a straight line, hence we call it a drag race. The GADD cars are designed to race distances of up to 100 feet.

Most real professional drag races today are run on a distance of 1,000 feet. GADD races should be run on a distance of 50 feet. Just pick any flat, fairly smooth open area like a schoolyard. Draw or mark a start as well as a finish line and you are ready to race.

The GADD Dragster

Your dragster should be built from an official AeroRacers kit. The body has to be of plywood and the wheels and tires have to be stock. The rear drive axle has to be of threaded 10-32 nylon. The wheels have to be held to the axle with cap/hex nuts. No set screws are allowed to hold the rims to the axle. The drive shaft assembly has to be a stock AeroRacers part. The crown gear has to be made from aluminum and has to be stock. Different gear ratios can be used.

The amount of rubber band motors and the width can be changed. No mechanical external winders are allowed. The potential energy has to be stored into the rubber band by turning the rear wheels. The use of the winding tool included in the kit is permitted. The rubber motor(s) can be stretch wound as long as the winding tool is used to turn the wheels.

Launching Your Racer

In order to launch your racer, you are only allowed to hold it in such a way that it cannot be push started. The best way to hold your racer is by the rear tires as shown. Upon hearing the start signal, release your racer by simply lifting your hand. If you are driving a Top Fuel Dragster with a big wing or similar vehicle, make sure that you hold your car in such a way that you do not hit the wing when removing your hand to launch the vehicle.

Overall Vehicle Weight

In order for your vehicle to go as fast as possible from the start to the finish line, it is important to keep it light. You are operating with a given amount of power under the form of potential energy that is stored into the rubber motor during the winding process. You want to use that power as wisely as possible.

It is a lot easier for that amount of power to push a lighter car down the track than a heavier one. Keep in mind that the rubber band has the most power and torque right at the start. You want to use that high power to get off the start line and rolling as quick as possible.

It is a good idea not to paint your GADD dragster, but color it with permanent markers. It is easy to add weight to a light racer by simply adding washers or taping coins to it. It is a lot harder to make a heavy car lighter.

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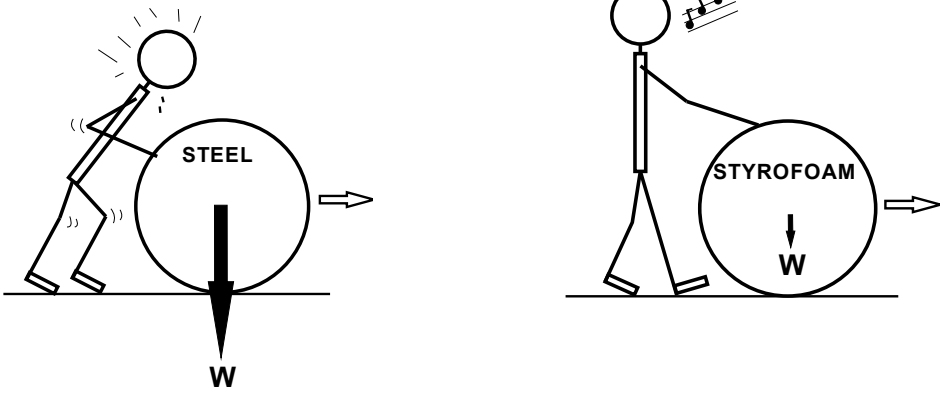
Inertia

The definition of Inertia states that an object at rest will remain at rest and an object in motion will remain in motion unless acted upon by an unbalanced force.



Imagine a 3 ft. diameter Styrofoam ball and a steel ball of the same size. Which one would be easier to push start from rest? The Styrofoam ball of course. It is easier to move a lighter object than a heavier one.

Inertia is the force that tries to keep your GADD racer from accelerating and reaching top speed. However, once your racer is in motion, Inertia also keeps it going through momentum. (Try slowing down the 3 ft steel ball compared to the Styrofoam version.) Forces like friction and drag are trying to slow it down.

So Inertia is against our racer at the start, but helps to keep it going once it is at speed.

Inertia at the Start

For our racer to start moving, it is important to keep the overall vehicle weight, the wheels and axle weight as low as possible. Light wheels start spinning faster than heavier ones and the same goes for the axle.

Inertia can help us at the start if we understand how to use it to our advantage. Start running your dragster with the stock rubber band provided in the kit. Wind it about 50 times at first, then increase the number of winds to make the finish line.

Your light racer will have the tendency to spin the tires on launch, just like real dragsters. You can draw a white line on the side of the tire with a white permanent marker. Set your phone or camera next to the car and record the launch. On the replay you can see how badly you are spinning the tires. There are two other ways to tell:

- *Your racer does not run straight, but kicks sideways at the start*
- *Your racer runs out of winds before reaching the finish line although you wound it enough to go the distance*

Spinning the tires means you are using too much power or your racer has too little traction. Since you have to make it to the finish line, you cannot back down on power. You have to rely on Inertia to help you out. Here's two simple things you can try:

- *Increase the overall weight of your racer by adding ballast (washers or coins) to your racer. This will increase traction of the wheels on the ground as the wheels are now pushed harder to the ground by the increased vehicle weight*
- *Increase rear wheel weight by mounting a washer between the back of the rim and the hex nut that holds the rim to the axle*

In both cases, the car will spin the wheels slower on take off and give you a launch with minimal wheel spin. The extra weight will slow the car down slightly in top speed as the friction of the wheels on the ground as well as the friction produced by the axle running in the bushings has increased.

You can lighten the front wheels by sanding them and/or drilling them to remove weight.

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If you choose to add weight in the form of washers to the rear wheels, simply place a washer between the rim back plate and the hex nut holding the axle to the wheel as shown. This will increase the rotational mass of each wheel. This will increase the resistance to spinning and the traction with the ground.

Make sure to add the same amount of weight to each side. If you were to add a wheel weight to only one wheel, your car will no longer run straight. (Assume you added a wheel weight to the left side, but forgot to add the same weight to the right side. Your car will turn right during the run as your left wheel has more traction and pushes your racer towards the right.)

Your heavier wheels will help your racer keep it's top speed for longer as your motor looses power all along the run. The wheels with their increased rotational mass tend to keep spinning faster for a longer time.

Inertia and High Speed

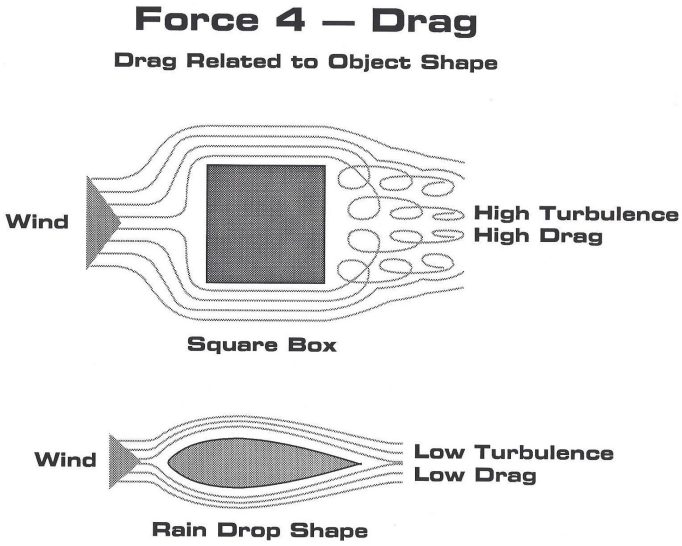
Imagine your racer reaching top speed as it is loaded up with ballast for better traction. Inertia actually helps the car maintain that speed longer than if the car was lighter. The extra weight turns into Momentum at speed and aerodynamic drag/rolling friction have a harder time slowing your racer down. The increased weight produces higher vehicle Inertia and we know that it is harder to slow a heavy object compared to a lighter one.

Aerodynamics - Drag

The shape of an object affects the amount of drag produced. A square box moving through the air creates a lot of drag because the air becomes turbulent behind the box. Turbulent air refers to air that is moving around in several directions instead of smoothly in one direction. Turbulent air creates a lot of drag. Boxes are not shaped "aerodynamically". This means they produce a lot of drag.

In order to find things that are aerodynamic, look at nature. What seems to move easily through the air? Birds have an aerodynamic shape, as do raindrops that fall from the sky. As they fall from the clouds, raindrops naturally form the best aerodynamic shape for the speed they go.

Our GADD dragster has a pre-determined shape as they are semi-scale reproductions of real racers. In order to minimize aerodynamic drag on your racer, sand all the edges of the vehicle in order to minimize turbulent air.



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Aerodynamics - Lift

Aerodynamics are very important on real race cars. Top fuel dragsters feature front and rear wings. Those wings produce a down-force. Downforce is a force produced by an inverted wing that pushes the car to the ground. The faster the dragster goes, the more downforce that wing produces.

As a dragster is travelling down the track at ever increasing speeds, the rear wheels need to be planted firmly on the ground. If the dragster breaks traction at any time during the run and starts smoking the tires, most likely the race is lost. This is why top fuel dragsters feature a big rear wing. The top fuel dragster has enough power to start smoking the tires even at speeds around 300 mph.

A wing will provide your racer with downforce, but on the flipside, downforce (negative lift) produces drag. As the dragster accelerates, the amount of downforce goes up as the speed increases. Drag however increases exponentially with speed. In other words, you need to carefully pick your wing size and settings as downforce has the consequence of increased drag.

If you drive a GADD dragster with an adjustable wing, such as a T/F dragster, it is important to understand how a wing works.

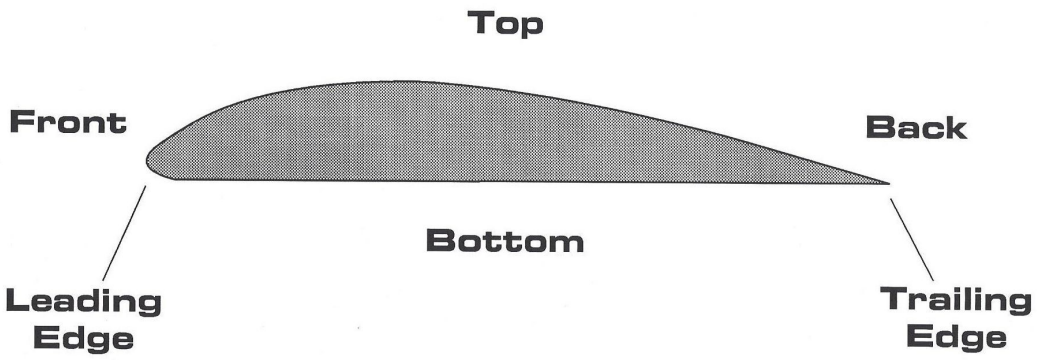
In order to explain how a wing works on a race car, it is best to understand first how a wing works on an airplane.

A wing on a dragster is basically an inverted (upside down) airplane wing.

A Closer Look at the Airplane Wing

Earlier it was mentioned that lift is produced by the wings. Here we will explain how the wings manage to produce enough force to lift an airplane into the air.

The shape of the wings help to create the force. If we take the wing off of an airplane and then look at the wing from the side, we would see a distinct wing shape. The wing is curved at the front, what we call the "leading edge" and it is pointy toward the end, what we call the 'trailing edge". The top of the wing is curved. This shape is called an airfoil.



Airfoil

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There are several basic airfoils, or wing shapes, that airplane designers can choose from. We will concentrate on the flat bottom airfoil. The flat bottom airfoil earns its name because the bottom of the airfoil is flat and straight.

The wings cannot lift the airplane when the airplane is not moving. The wings must be moving through the air in order to lift the plane. An airplane sitting stationary on the ground will not fly, no matter how efficient the wing design may be.

Bernoulli

We need to understand a physical principle that a scientist by the name of Daniel Bernoulli discovered many years ago. He discovered that when a fluid like air or water moves from a large area into a smaller area, the speed of the fluid increases. We can do a simple experiment to illustrate this: Hold a garden hose with the water running out. If we hold our thumb to cover some of the opening, the water will jet a lot faster than before. As the water reaches the smaller hose opening diameter, water speeds up and it therefore jets further.

Bernoulli also determined that as the speed of a fluid increases, the pressure decreases and vice versa.

What you need to learn and remember from Bernoulli:

Higher fluid speed = lower pressure

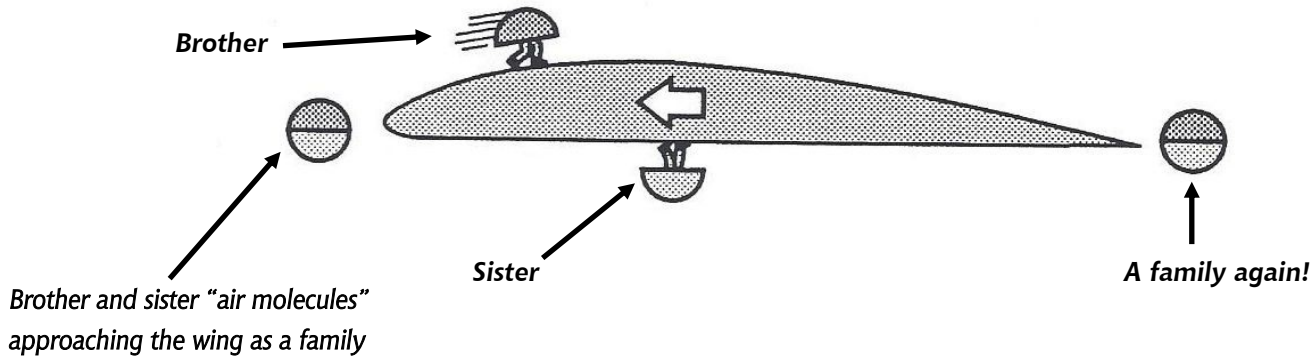
Lower fluid speed = higher pressure

How the Wing Generates Lift

When a wing moves through the air, it slices the air into two halves. Imagine a family of air molecules consisting of brother and sister approaching the leading edge of the wing. Brother goes over the top of the wing and sister proceeds along the bottom. They have to rejoin after the trailing edge of the wing to remain a family.

The brother on the top half of the wing has a greater distance to travel than sister on the bottom half. Because of the greater distance, the brother on top of the wing must travel much faster than sister on the bottom, if they want to rejoin and be a family again just after passing the trailing edge.

Wing moving through the air



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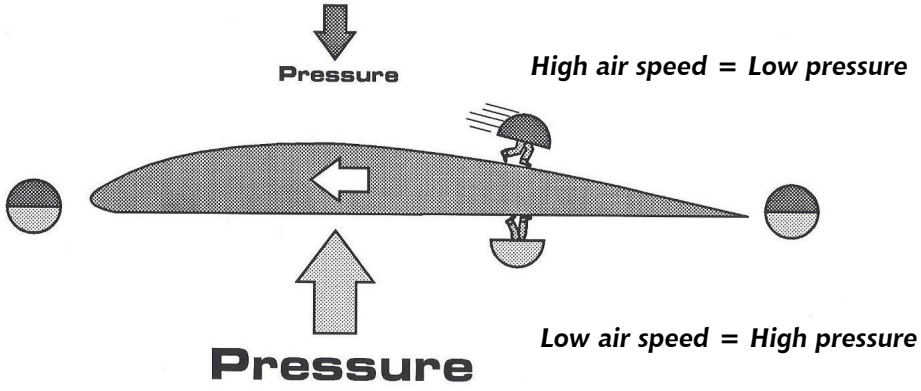
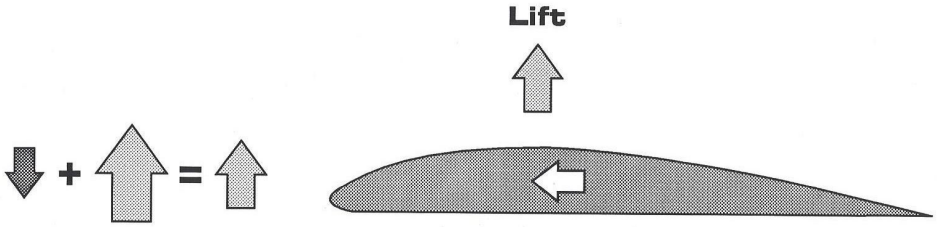
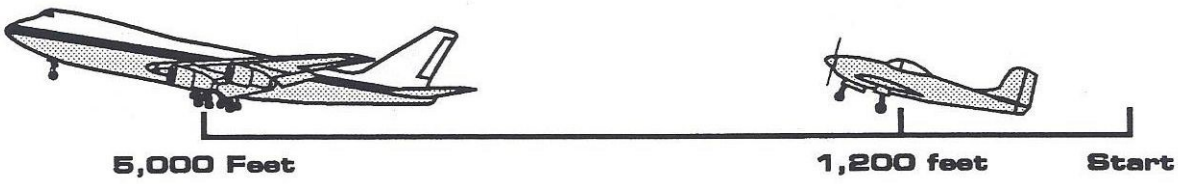
When air moves rapidly on one side of the wing and slowly on the other side, a difference in pressure is created. We have to remember Bernoulli's equation, which says that higher speed is equal to lower pressure. The increase in air speed on the top half of the wing reduces the amount of pressure. While a slower air speed on the bottom half of the wing, causes the pressure to be greater and pushes the wing upward. This change in pressure, according to Bernoulli's equation, produces lift.





Lift is directly related to the speed at which a plane travels. A plane that sits on the ground on a calm day produces no lift. A plane that travels at maximum speed produces more lift than when it is flying at slow speed. A plane has to travel at a determined speed in order for the wing to produce enough lift to fly. This speed is called mimimum flying speed and it varies with different airplane designs. It will take a longer runway for a Jumbo Jet to reach its minimum flying speed of approximately 160 miles per hour. A smaller sport plane requires less distance to reach its minimum flying speed of about 60 miles per hour.



Take off distance

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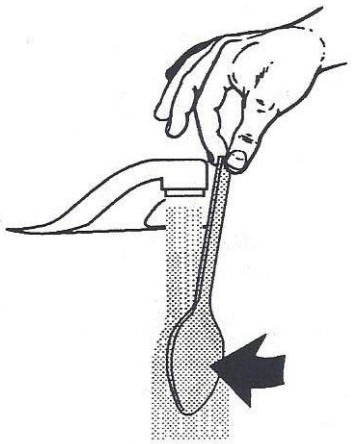
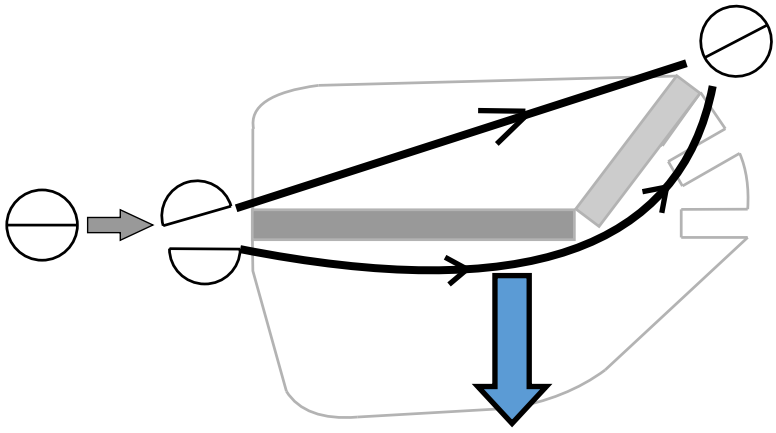
Experiment

Here is an easy experiment the illustrate lift. Turn on the water faucet in your home or the classroom sink. Take a large plastic spoon and hold it lightly between two fingers as shown. Move the spoon, with its cupped side facing toward you, slowly into the steam of water. Notice that the spoon is pushed away from the water stream. Now turn the spoon around, so that the cupped part faces the water stream and repeat the experiment. This time the spoon is drawn into the stream; you are experiencing lift. The water that runs over the cupped part is speeding up and the pressure drops. A wing in air acts the same way as the spoon in the water stream.



Dragster Rear Wing

Your rear dragster wing is an airplane wing upside down. The front is a flat plate or fully symmetrical airfoil at a negative angle which generates downforce. Going back to our family or air molecules approaching the leading edge of the wing...



Our family of air molecules going around the rear wing with the wing flap at maximum angle.

It is clear that the air molecule on the top has a shorter distance to travel and therefore can go slower in order to meet up again after the trailing edge with the air molecule having to go around the bottom of the wing. Remember that increased air speed results in reduced pressure on the bottom part of the wing. The wing in this configuration will produce maximum downforce. If you use the medium slot, the wing produces less downforce. If you use the third slot which makes the entire wing a flat plate, the rear wing will produce no downforce as both the top and bottom distances to be travelled are the same.

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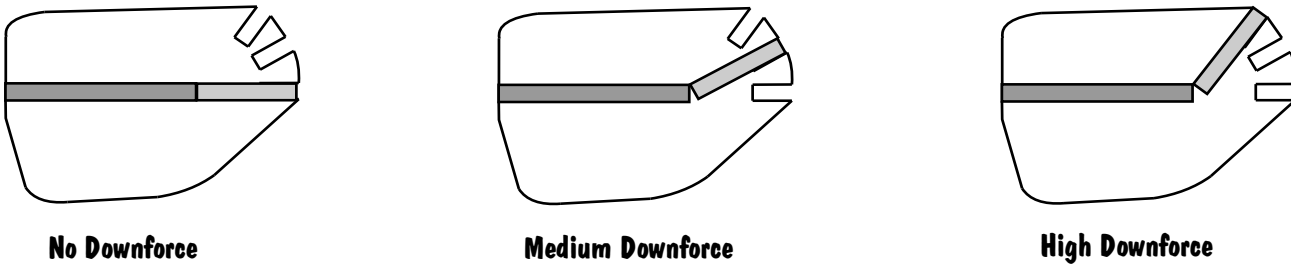
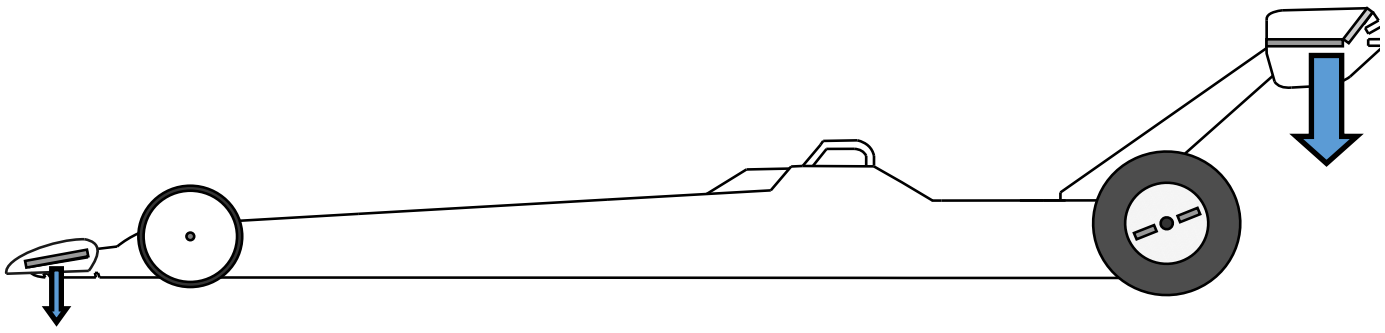
Rear Wing Different Downforce Settings

Use the rear wing flap to adjust the downforce and drag on your rear wing. It is a good idea to do multiple runs with you racer to figure out what works best.



Top Fuel GADD Dragster Front Wing

The front wing is a flat plate at a negative angle. Since it is very small, it does not produce a lot of downforce, nor does it produce a lot of drag. If you find that your racer veers off course, you can increase the amount of front downforce produced by increasing the angle of the front wing. You can accomplish that by raising the trailing edge (back) of the front wing.



Downforce Diagram for a Top Fuel GADD Dragster

The front wing produces little downforce while the rear wing can produce a lot more downforce due to it's larger size and moveable flap.

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Gear Ratio

Your stock GADD racer comes with a given gear ratio. Assume that the pinion gear has 10 teeth and the crown gear has 30 teeth.

Let's divide 30 by 10 to find out how many times the pinion needs to turn in order to get one full revolution of the crown gear and rear wheels at the same time.

30 / 10 = 3 (the gear ratio is 3)

The pinion needs to spin 3 times for the rear wheels to turn once.

If you changed the crown gear to 28 teeth for a gear ratio of 2.8, the pinion only needs to spin 2.8 times to spin the rear wheels once. It should now make sense to you that the lower the ratio, the higher top speed and longer distance your racer can run on a given amount of winds.

A lower gear ratio will potentially:

- *give you a higher top speed*
- *power your racer over a greater distance*
- *accelerate slower from the start line*

If your dragster is very light and you spin the tires at the start, try a 2.8 gear ratio instead of adding weight to your racer for increased traction. You can also consider increasing the power (more/wider rubber string or additional winds) as your racer is less prone to spinning the wheels at the start with a lower gear ratio.

If you are looking for greater acceleration at the start, change the crown gear to 32 teeth for a gear ratio of 3.2. Now the pinion needs to spin 3.2 times to spin the rear wheels once. It should now make sense to you that the higher the ratio, the lower top speed and less distance your racer will run on a given amount of winds. But you will get faster acceleration at the start.

A higher gear ratio will potentially:

- *give you a slower top speed*
- *power your racer over a shorter distance given a certain amount of winds when compared to a lower gear ratio*
- *accelerate faster from the start line*
- *be more prone to spinning the tires at the start*

Changing the Pinion Gear

You can vary the gear ratio of your racer further by changing the pinion gear unit (drive shaft) to one with more teeth. Do the simple math explained previously to calculate your potential gear ratio.

It is a good idea to have several gears available. If the race is run over a short distance, you want to run a higher gear ratio and if the race is run over a long distance, you want to run a lower gear ratio.

You want to use all the power available from your rubber band motor. It does not make sense to have your car power 30 feet past the finish line. You could have used that power to get to the finish line faster, rather than wasting it going far past the finish. Since your wheel diameter is fixed, use different gears to adjust your racer to the track length to be run. Additional pinion gears with different teeth count and various crown gears are available directly at aeroracers.com

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Power

When you wind your racer, you store potential energy into the rubber band. When you release your racer at the start, this potential energy is transferred into kinetic energy as it moves your racer down the track.

New Rubber String Motor

Your rubber string is strongest for the first run. As the rubber motor ages with more runs, it loses some of that initial high power. This means that while you have to add weight to the car or wheels to prevent wheel spin on a new motor, you can and should remove weight from the car or wheels as the rubber string ages. The fastest runs generally are on a fairly new rubber motor. An older motor will let you wind more winds into a given rubber loop length compared to a new one.

You can increase the amount of power to your racer by using more or wider rubber string or shortening your rubber loop.

Short loop: higher power with less winds but shorter distance run

Longer loop: lower power but more winds and longer distance run

Assume that your basic GADD racer comes equipped with one .187" wide world championship rubber string. You could choose to go to twin .125" motors, bringing the total rubber string width theoretically to .250". This will give you a lot more power on the one hand. On the other hand, you might not be able to wind it enough to go the required distance. Aging the rubber motors by winding them a few times might stretch them enough to let you crank in more winds. Stretch winding for more cranks works too.

If you run a longer dragster such as a Top Fuel Dragster, you can try increasing the power.

Keep in mind that with more power comes more trouble. You will have to increase traction by increasing the weight of your racer as it will be very prone to spinning the rear wheels at the start.

You can buy the world championship rubber string directly at aeroracers.com.

We have .063', .093" .125" and .187" wide world championship rubber string available for your racer. We also have competition motor packs available with feature .079", .086", .093", .101" and .108". These allow you to really fine tune your power as you couple those sizes with other widths.

Lubing Your Motor

You can use AeroRacers Super Lube to lube your racer's motor. Apply a little super lube to the palm of one hand and place the rubber loop in it. Rub the motor between your two hands to work in the lube.

Rubber lube will reduce the friction between the winds which will allow you to crank in more winds into a lubed motor. You will also extend the life of your motor. On the flip side, your motor will have a little less power since there is less friction between the winds.

Rubber lube comes in handy especially if you cannot wind your racer enough to make the finish line, yet you do not want to modify the gear ratio.

Prior to using rubber lube, it is a good idea to super glue the knot of your rubber motor. If you get Super Lube on the knot it will come undone very easily.

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Winding Your Racer And How It Relates To Math

You want to wind your racer with the GADD winding tool. Here's why:

At a race you want to be in control of all engine parameters. Since the amount you wind your racer is directly related to available power and how far your racer will potentially travel, you want to make sure you crank the exact amount of winds that you know work for your racer.

First you need to make sure your racer makes it to the finish line and allow for some wheel spin at launch. Let's assume the race distance is 50 feet. How many times does the rear wheels of your dragster need to rotate to travel 50 feet? Simple mathematics will do the trick.

Example:

Assume the outside diameter of a rear tire is 2.1 inches.

That means the radius is 1.05 inches (2.1 / 2 = 1.05)

Armed with that information we can now calculate the circumference of the rear tire which translates into how far the racer travels forward with one wheel revolution. The formula for the circumference of a circle is:

$2 \times \pi \times r = \text{circumference} \quad \pi = 3.14 \quad r = 1.05 \text{ inches}$

$2 \times 3.14 \times 1.05 = 6.59 \text{ inches}$

So the racer moves forward 6.5 inches (rounded down for simplicity's sake) when the rear wheels rotate once.

Now let's find out how many times the wheels need to turn to go 50 feet. Since there are 12 inches to one foot, there are

$50 \times 12 = 600$ *inches for 50 feet.*

We divide 600 by 6.5 to find out how many times the rear wheels rotate to go 50 feet:

$600 / 6.5 = 92$

The rear wheels rotate 92 times to go 50 feet. Since we rounded down in the circumference calculation, we have a little safety margin in that calculation.

You now know that you have to wind your GADD dragster a minimum of 92 times to reach the finish line on a 50 feet run. This is assuming no wheel spin at launch.

Rear Wheel Diameter

The above calculations were performed assuming that the wheel diameter stays constant during the run. In reality, this is not true. To better understand wheel diameter during a run, I recommend you watch a professional drag race on television or better yet, visit a real race. Carefully watch what happens to the rear wheels as a Top Fuel Dragster goes down the track. The rear tires become larger in diameter as they accelerate.

The same happens on a smaller scale to your GADD dragster. Wind your dragster and observe the wheels as you let them spin freely. You notice that the wheels increase in size as they spin at high speed.

What this means for you is that your dragster actually might run longer than your calculations predict. This is because the car covers a little more distance with each wheel revolution due to the fact that the tires increase in diameter slightly during the run.

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Winding and Gear Ratio

Let us assume for a moment that you have trouble winding your car 92 times because your rubber motor is too short or you are using multiple rubber loops. Since you cannot win a race if you cannot reach the finish line, your options at this point are:

- *Reduce the amount of power*
- *Switch to an older rubber motor as they allow you to crank in more winds*
- *Use Super Lube on your rubber motor*
- *Change to a lower gear ratio*
- *Try stretch winding your motor by seeking the help of a teammate*

Stick to what you know for the Race

Use your data and knowledge to wind your car sufficiently to make the finish line in the fastest possible way. It is very tempting to crank in a few extra winds on race day especially when facing an opponent that consistently runs faster than you. Stick to what you know works and let the other driver make a mistake. A few extra turns into the rear wheel can bite you in the way of excessive wheel spin and you will certainly loose the race if your car then stops short of the finish line.

A Straight Run

We all know that the shortest distance between two points is a straight line. If your racer spins the rear wheels at launch it will most likely head to the finish line at an angle. This can add many feet to the run leaving your car potentially short of the finish line and/or loosing the race because your racer needed extra time to travel the extra distance.

Use the steering to adjust the turning tendency of your racer. The straighter your racer runs, the quicker it will get to the finish line.

Timing your Run and Taking Notes

Use a stopwatch to time your racer's run from the start line to the finish line (elapsed time, ET). It is a good idea to note down the ET, amount of power and gear ratio used for each run. In addition, you should keep record of the amount of winds you cranked the rear wheel along with whether your racer spun the tires and/or ran straight.

Set up Changes to your GADD Dragster

If you decide to change something on the set up, change one thing at a time so you can tell whether your change produced a positive result. Take notes after each run because at the end of the day you will not remember which combination worked best.

Lubing your racer with WD-40

Your GADD dragster is a real race car. The better you maintain it, the quicker it will go. It is a very good idea to occasionally squirt a little WD-40 into the brass bearing and onto the gears. You will be amazed how much it reduces friction and how smooth your racer will run after you lubed it.

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Maintaining your Racer

After each run you should:

- *Inspect the motor for rips and cracks*
- *Inspect the thrust bearing/pinion assembly hex nuts. The thrust bearing/pinion needs to be held tight to the firewall. Due to vibration the hex nuts can become loose which will allow the pinion to not make good contact with the crown gear. This is why you should use two hex nuts to hold the thrust bearing in place. If you hear clicking (teeth jumping) during winding, stop winding immediately and inspect the gear drive. Most likely, your hex nut holding the drive shaft assembly is loose and needs to be tightened. It is best to use a 3/8" wrench to tighten the hex nut*
- *Inspect rear wheel axle play, side to side*
- *Inspect crown gear/pinion alignment*
- *Lube the drive shaft and gears regularly with WD-40*

Troubleshooting your GADD Dragster

The average GADD dragster will run fairly straight. On a 50 ft. run, it should not deviate more than 3 feet to either side. If your dragster runs erratic to a side instead of fairly straight, inspect the following:

- *Is my racer spinning the tires wildly at the start*
- *Are the rear wheels the same diameter*
- *Are both rear wheels of equal weight*
- *Are both rear wheels of equal width*

Mounting an Action Camera to Your Racer

You can mount an action camera to record your runs and even film cars in the lane next to yours while you are racing them. Use Velcro or similar to mount the bare camera to your racer. You can remove some ballast from your racer as the camera adds plenty of weight. It is a good idea to mount the camera before you wind your racer so you don't have to fiddle with the camera after your GADD dragster is ready to launch.

Keep in mind that action cameras add a lot of weight to your racer. They are a lot of fun to use, but when the time comes for serious racing, keep the cameras off your racer.

Make sure that when you mount a camera, there is an even amount of camera weight distributed to each side of your dragsters center line. Even a little more weight towards one side will make your car turn away from the "heavy" side.

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Testing Data

# of Winds	Motor Configuration and Age	Gear Ratio (Pinion/ Crown Gear)	Ballast Configuration	Wing Setting	Tracking (Straight, Left, Right)	Distance	Elapsed Time (ET)

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Testing Data

# of Winds	Motor Configuration and Age	Gear Ratio (Pinion/ Crown Gear)	Ballast Configuration	Wing Setting	Tracking (Straight, Left, Right)	Distance	Elapsed Time (ET)

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Testing Data

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Lesson Plan 3 Race Team Presentation

Time needed: *Approximately 1 hour*

Each team presents their completed racer to the class

☐ *Have the public relations (PR) specialist of each team, backed by their team members, introduce their race team to the entire class.*

☐ *The PR specialist's introduction should include:*

Presentation of the team members by name and function in the team

Presentation of the team name

Presentation of the team racer

Mentioning of any sponsors of their racer

Race officials presentation:

☐ *Have the race officials introduce themselves and present the following to the race teams:*

Where and when they can test their racers

How the race is run

How the drag race ladder works

Where, when and the exact straight line distance from the start to the finish line of the official race to be held

Race officials should be ready to answer any questions the teams may have pertaining as to how the race is run

Racer presentation board

☐ *After the teams are done presenting, have them line up their racers with the team's presentation board.*

Reporter/Media Specialist

☐ *The reporter should take this opportunity to interview the teams before the race.*

☐ *The reporter should photograph each team with their racer for publication on the schools website and/or the Great American Dragster Derby website at dragsterderby.com.*

Future Testing

☐ *We recommend you give students a couple of sessions to test their racers.*

☐ *We recommend you have extra rubber string ready as the teams will experiment with different power settings.*

☐ *We also recommend you have different gears available for the teams to use for testing. (You or the teams can purchase additional gearing and rubber string direct from* aeroracers.com*)*

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Lesson Plan 4 Testing Session(s)

Time needed: 1 to two testing session(s) of 1 hour

Test runs

☐ *Make sure the race official has reserved the place to run and test the cars. It should be the same place where the race is held.*

☐ *Make sure the race official has measured and taped (or drawn) a start and a finish line onto the ground.*

☐ *Teams should test individually and time their runs.*

☐ *The crew chief should write down how the car is set up prior to the launch and the Elapsed Time of each run using the Testing Data sheet.*

Race officials:

☐ *Hold a test race towards the end of each testing session. This gives the race officials as well as the teams a chance to get ready for the real deal.*

☐ *Have the race official run the test race as if it was the real deal.*

☐ *Start line official should start each race.*

Preparation for race day

☐ *Make sure the race officials and the teams know what to expect on race day. You will need 1 session (50 minutes) to run the race.*

Establishing the drag racing ladder for race day

☐ *Have the race official write all the different team names on individual pieces of paper and fold them up. Place them in a hat or similar. Have someone draw two names out of the hat.*

☐ *You always need to have a ladder of 8 (next one would be 16) teams. If you only have 7 teams, you still need to put 8 names into the hat. The 8th name is called Single Run. That means that whichever team draws to race against the "Single Run" gets to move on without racing. That team gets to practice two single runs if they so desire when they are called to the start line.*

☐ *The first two names are teams 1 and 2. The second pair are 3 and 4 and so on. The race official should write them into the drag racing ladder to be published prior to race day.*

☐ *The completed racing ladder (including all team names) should be copied to a large whiteboard.*

Trophies

☐ *If possible make a trophy or similar available to the winning team. This could be a hand made "trophy" or even a certificate which can be downloaded from our website at* dragsterderby.com *to be handed to the winning team at the end of the race.*

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Lesson Plan 5 Race Day

Time needed: 1 session

Race day

☐ *Make sure the race official has reserved the place to run the race. It should be the same place where the testing took place.*

☐ *Make sure the race official has measured and taped (or drawn) a start and a finish line onto the ground.*

☐ *Test runs are no longer permitted on the course.*

☐ *Make sure the drag racing ladder is ready and drawn on a large whiteboard. It should be situated at the start or finish line . The race official should be standing next to it during the race and call the race from that position.*

☐ *Make sure the race official holds a driver meeting and makes sure that everybody is on the same page.*

☐ *The opposing teams run against each other 2 or 3 times until one team has won twice. If for example team 1 beats team 2 twice in a row, it is not necessary to run a third race.*

☐ *Observe and let the students run the race.*

☐ *Make sure the reporter does his/her job of shooting photography/video.*

☐ *Keep the drag racing ladder at the end of the race so the reporter can use it for his/her reporting.*

☐ *Be ready to intervene if needed.*

Trophies

☐ *If a trophy or certificate is available, make sure the race official hands it to the winning team.*

The last Hurrah!

☐ *If you have a couple of minutes left, have all drivers wind their racers again and call for a* **mass launch**. *This is a lot of fun.*

☐ *Have all drivers line up at the start line with their cars wound and everybody releases their racer upon hearing the start command. The first racer to cross the finish line is the winner for bragging rights only.*

Cleaning up the race venue

☐ *Make sure that your students remove all the tape or markings on the ground and leave the premises the way they found them.*

The next race

☐ *If you have additional time, you could have the race official change the race distance for the next race. It is a good idea to increase the distance as the teams will have to totally change the set up of their racers.*

Help is available

Call (310-377-6105) or email (propracer@gmail.com) Luc at AeroRacers with any questions.

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