S.E.M. RACING

-RACING

SEAN ERIC and MATT

RACING

-BUSINESS PLAN

sorship from various companies, we came up with a
rm which explained how their Name and Logo was going
sed on the amount of money they donated.

SPONSORSHIP PLATFORM

Full Sponsorship- $25,000

ughout Car's Graphics Scheme
ted on Team Uniforms
Marketing Display

tinum Sponsorship- $3,000 up to $25,000

Team Car

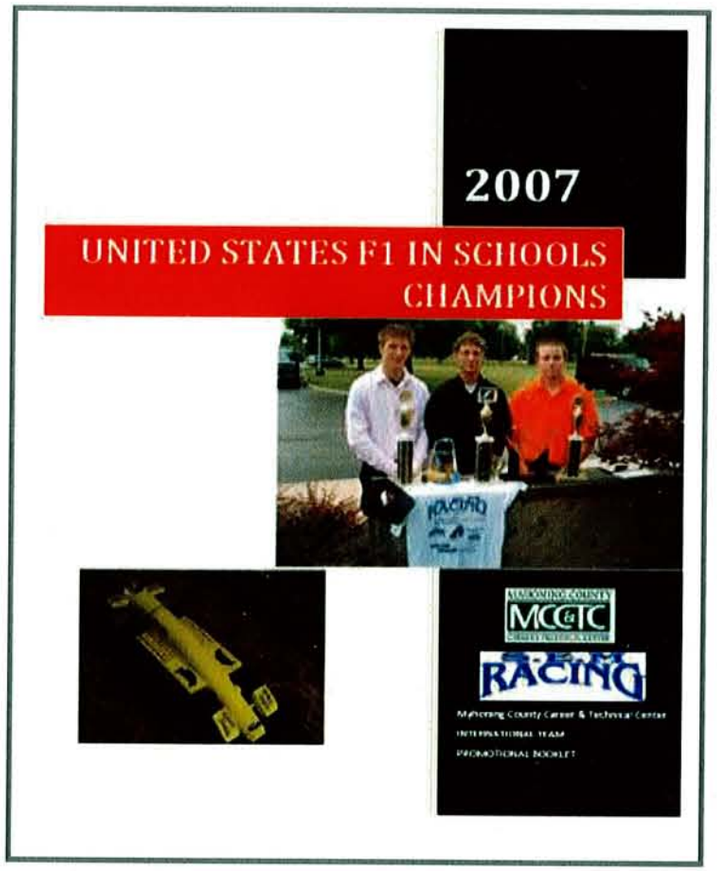
Gold Sponsorship-$1,000 up to $2,999

Team Uniforms

ilver Sponsorship-$1.00 up to $999.00

Marketing Display

Promotional Booklet



In this booklet it contained the following which explained to a potential sponsor what F1 in Schools stands for and why we were seeking sponsorship:

-Our Team
-Introduction to F1 in Schools
- What is the F1 Technology Challenge?
- Why F1 in Schools
- Participants
-Promotional Videos
- Our Team Budget
- Sponsorship Platform
- S.E.M Racing Awards, Honors, and Media Coverage

EAN O'BRIEN
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GRADE: 12
MAHONING COUNTY CAREER & TECH. CENTER
CANFIELD, OHIO, U.S.A
ION OF STUDY: ELECTRICIAN

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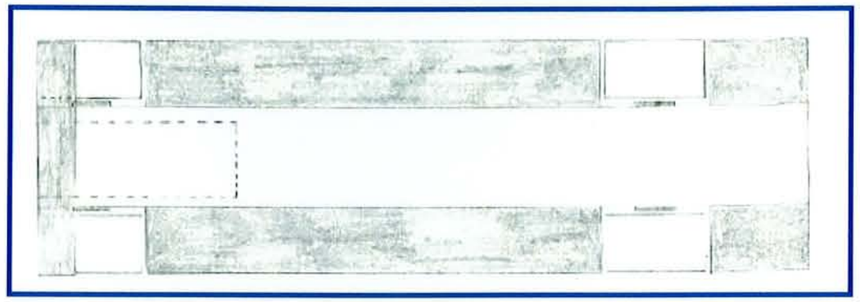
SCHOOL: MAHONING COUNTY CAREER & TECH. CENTER
CANFIELD, OHIO, U.S.A
OCCUPATION OF STUDY: ENGINEERING

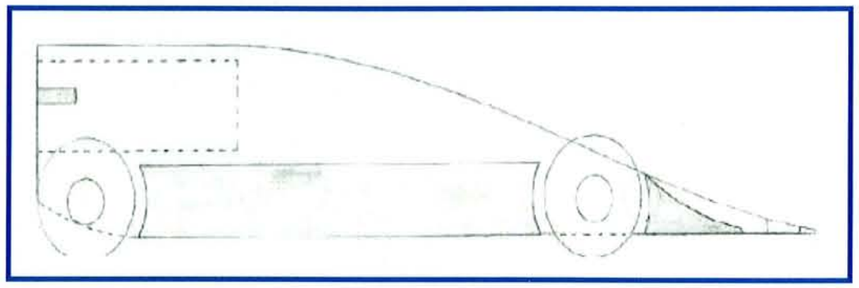
NAME: MATT CRNARICH
TEAM STATUS: TEAM MANAGER, MANUFACTURING ENGINEER, DESIGN ENGINEER
AGE: 18 GRADE: 12
SCHOOL: MAHONING COUNTY CAREER & TECH. CENTER
CANFIELD, OHIO, U.S.A
OCCUPATION OF STUDY: ENGINEERING

S.E.M. RACING -DESIGN

INITIAL SKETCH



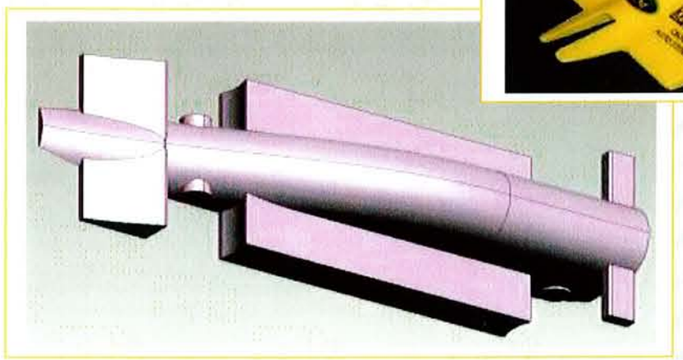
(Side View)



(Top View)

These are our initial sketches of our F-1 car. We made almost twenty different sketches until we decided on our final design. After we got our design on paper we then started to draw it on Pro Desktop 8.0.

(Computer aided drawing using Pro Desktop 8.0)

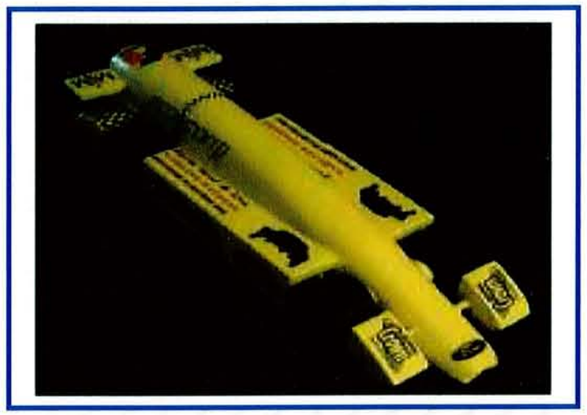


When using Pro Desktop 8.0, it took a long time to get used to the program. We had no experience with it, so it took a lot of help from the teacher to learn about the program. After we did this, drawing the car on the computer aided program was no problem.

PHASE 1

S.E.M. RACING -DESIGN

PHASE 2



This was our second design for our national car. It ran an average time of 1.09 seconds. We made several changes from Phase One to Phase Two. The changes were:

- Airfoil behind the rear wheel.
- Convex front wing opposed to a concave wing to reduce drag on wheels.
- High profile side pods to keep air from hitting the rear wheels.

PHASE 3

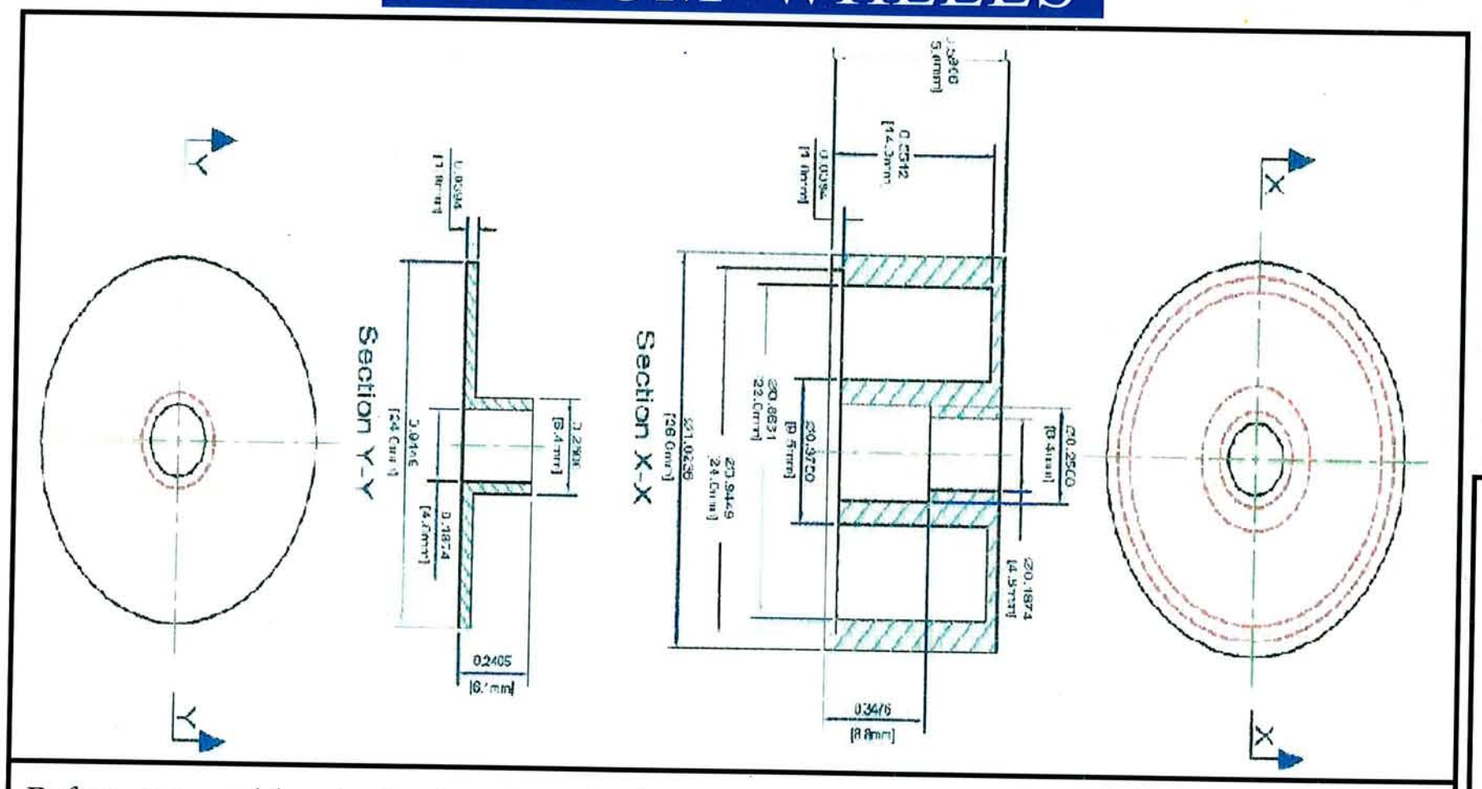
We designed the car using a French curve design. This resembles the most aerodynamic shape which is a tear drop like an airplane wing. We made the car sit low to the ground so that there would be less air resistance on the top of the car and to lower to the center of gravity. This will also give the car less airflow underneath it so that there would not be lift under the car. We utilized every aspect of an airfoil to divert the air away from or over any necessary part of the car.

Do to drawing a more complex design we switched from using Pro Desktop 8.0 to Solid Works. Solid Works is higher class software that allows you to do more diverse options.

SolidWorks

S.E.M. RACING -DESIGN

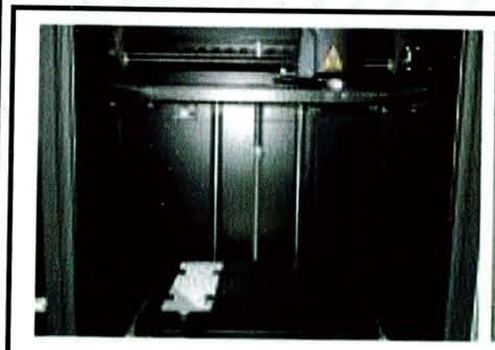
CUSTOM WHEELS

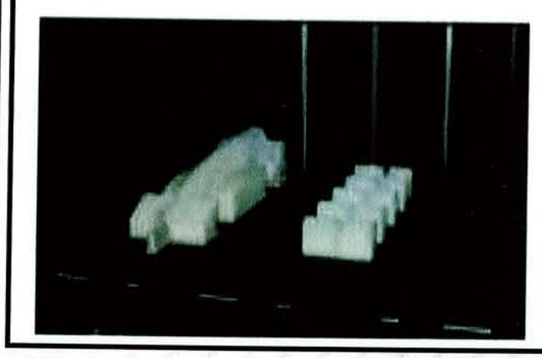


Before we could cut wheels out we had to come up with the design for them. When doing this we used Auto CAD 2007 to draw the wheels. You can see that the wheels are a two piece construction. This type of construction allowed the wheels to be hollow, making them lighter, (The lighter the wheel the quicker the acceleration). Also, if you look at the centerline of the wheels, they have a bored out section where the axle goes through the wheel. All four wheels on our F-1 car have ball bearings so that we achieve the most efficiency and reduce the most friction from them.

3-D MODELING

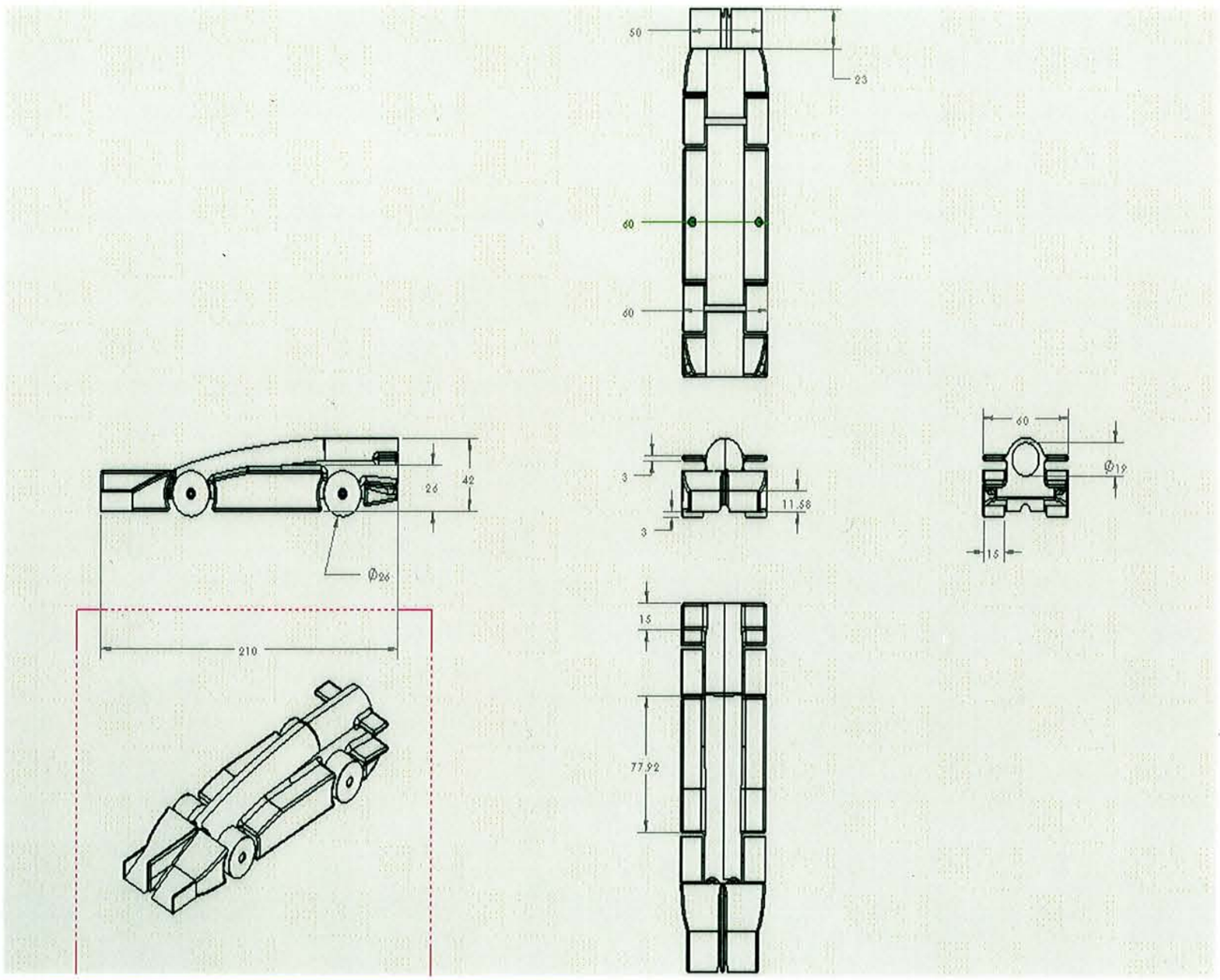
To make sure our design was what we wanted before we went ahead and cut them out, we used a 3-D Dimension bst 1200 Printer (shown in the bottom right). Using Catalyst Software (top left) and a Stereo lithography file of our car we printed a model of our car out of ABS plastic. (Top and Bottom left pictures.)





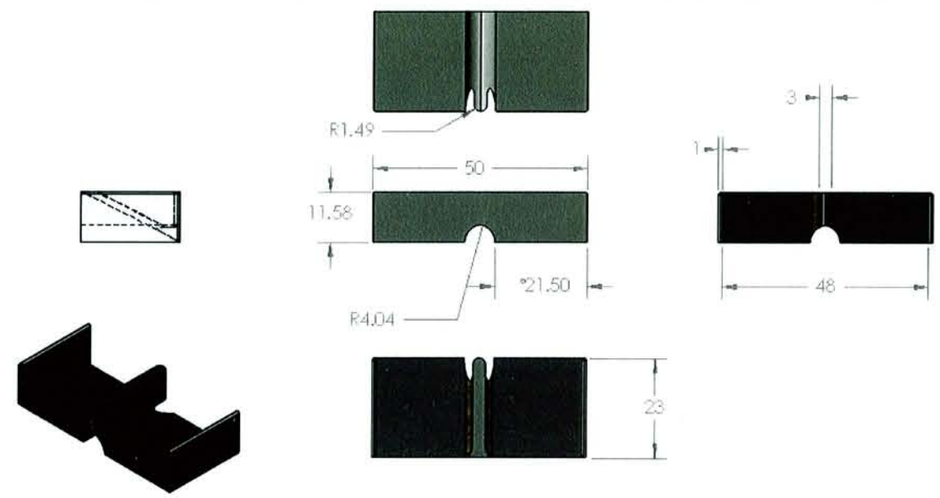
S.E.M. RACING -DESIGN

ASSEMBLY OF CAR



ENGINEERING DRAWINGS

FRONT WING



PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF <INSERT COMPANY NAME HERE>. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF <INSERT COMPANY NAME HERE> IS PROHIBITED.

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN METRIC
TOLERANCES:
TWO PLACE DECIMAL ±.10
THREE PLACE DECIMAL ±.10

MATERIAL ABS
FINISH MACHINE FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	MC	1-23-08
CHECKED	EA	1-25-08
ENG APPR.	MC	1-25-08

COMMENTS:

TITLE: Front Wing

S.E.M RACING

SIZE	DWG. NO.	REV
A	0801A	1

SCALE: 1:1 WEIGHT: 6.5g SHEET 1 OF 1

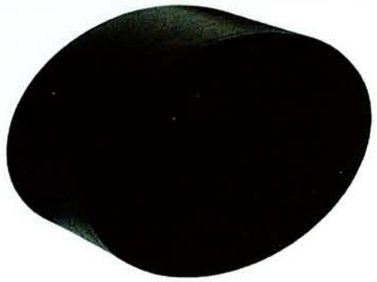
S.E.M. RACING -ANALYZE

WHEEL ENGINEERING

MOLD INJECTION

Mold injected wheels are okay but they are not perfectly round and true. The plastic is a soft material which would create surface friction more easily.

DELRIN WHEELS



We machined our wheels out of a hard material called Delrin which has a low friction rating. Delrin wheels are perfect for racing these type of cars. They are great because they are machined on a mill which makes them well balanced and symmetrically true all the way around.

MASS REDUCTION

Next we realized that a lighter wheel would mean quicker acceleration. For national competition we machined the inside of the wheel to have a 1mm wall around the whole wheel. This brought our wheels from 5 grams to 2 grams. We sure saw a difference in time.

EXPERIMENTING

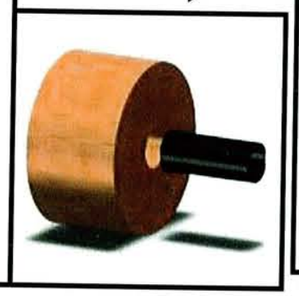
After winning the national competition it was time to experiment. We discovered that a two piece construction wheel is the way to go because you could hollow the wheel out. A cover on the inside and out would keep air from going inside the wheel. We tried an inner and outer bearing in the wheel, but realized it was double the friction.

1 GRAM WHEELS

Then we went back to a bearing positioned in the center of the wheel. This was optimum for going in a straight line. We also machined the wheels as thin as we could. We went from 2 gram to 1 gram which had a .012 in. thick wall.

BALSA WOOD

We then machined balsa wood wheels. This was great because they were solid, and lighter. We turned a little faster time out of the car, but it wasn't consistent because the wheels were fragile and became deformed. We were having trouble gluing and keeping together the caps to the thin Delrin wheels..

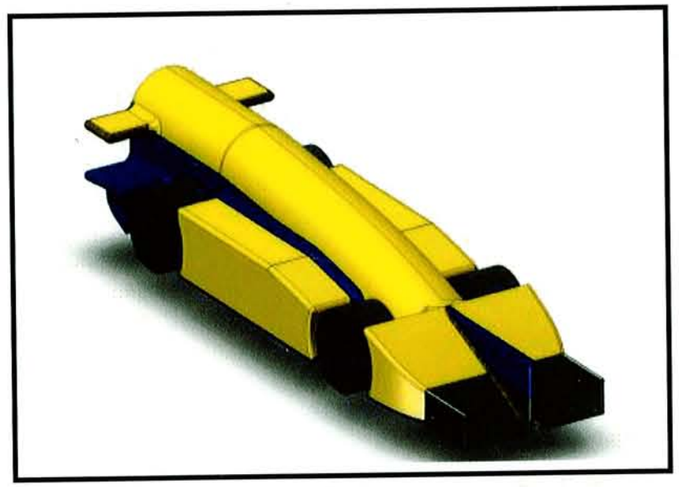


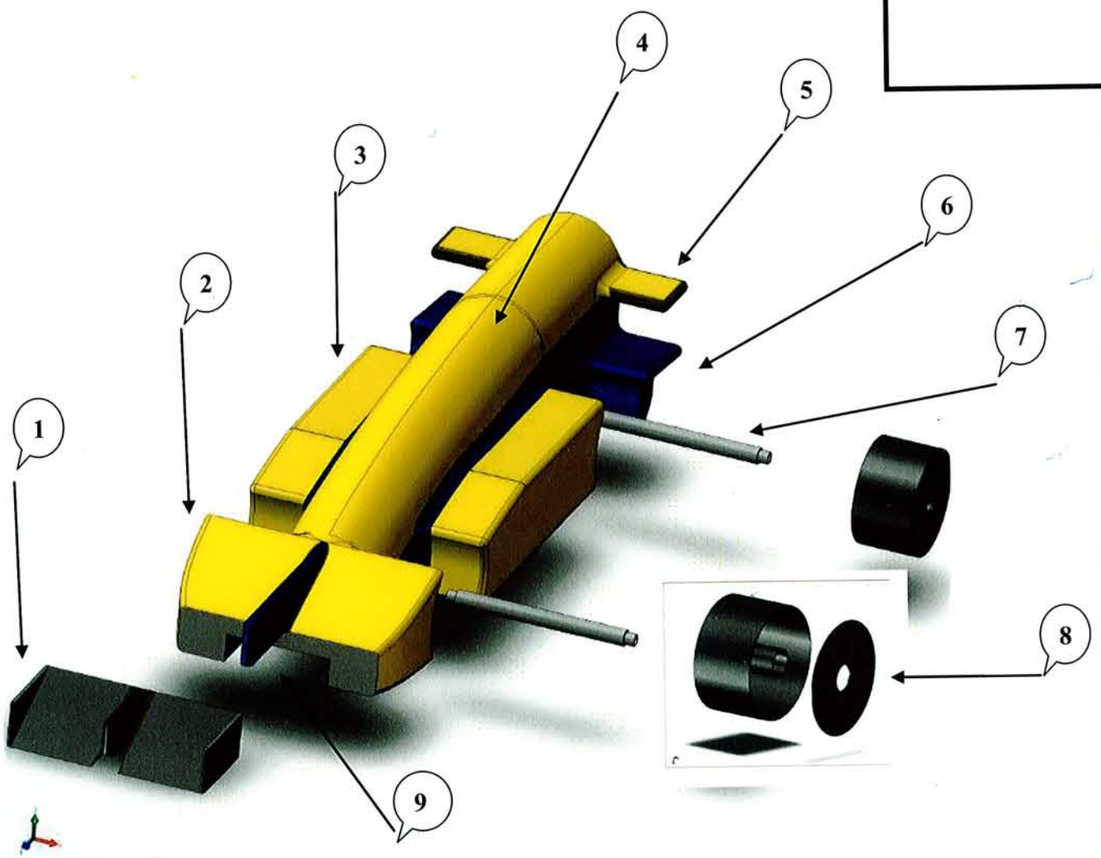
THE DECISION

Having inconsistency in the balsa wood wheels we went back to the thin light weight, two piece construction, Delrin machined wheels. After in depth research we found a glue specifically for Delrin. The glue made by 3-M was fairly expensive, and called Bondit B-45. After gluing the wheels we had consistent time on the car and a true balanced wheel.

-ANALYZE

Physics behind the car

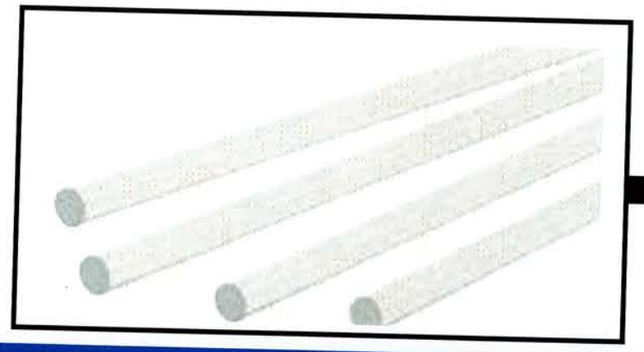




1- 3-D printed wing made out of ABS plastic for a precise front end.
2- Front airfoil to divert air over front wheels to reduce drag.
3- Side pods designed with a high profile to guide air away from rear wheels.
4- Bullet shaped body to achieve the smoothest aerodynamics.
5- Zero degree tilt on the rear wing due to the weight of the CO_2 cartridge. No down force is needed.
6- Rear airfoil behind rear wheels to decrease turbulence coming off the wheels.
7- Steel axles to reduce flex, decrease vibration throughout the car, and to be able to attach and detach the wheels easily from the car.
8- Two piece Delrin machined wheels to produce a light weight wheel for quick acceleration. Along with that are independent spinning wheels. Each wheel has its own ball bearing to reduce rolling friction.
9- Vertical fin stabilizer to achieve a strait directional shot down the track. This acts on the car in correcting side to side movement which results in a slower time down the track.

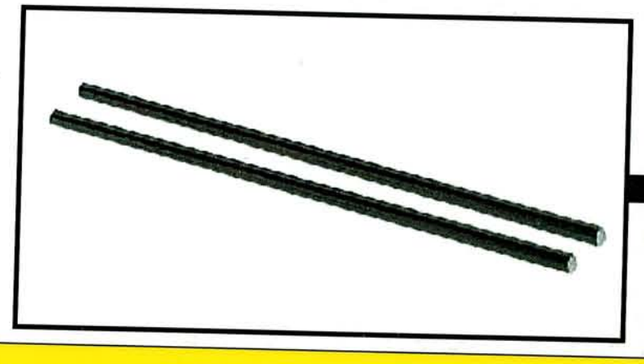
Choosing Axles

DELRIN AXLE



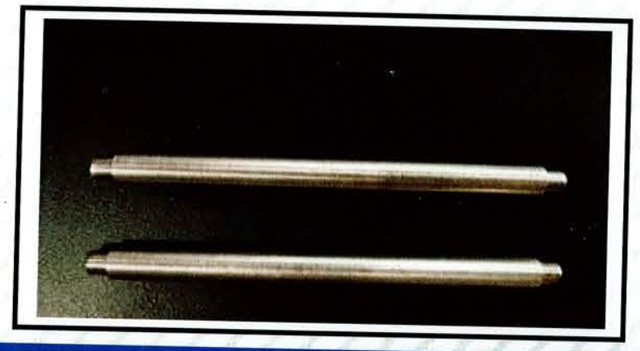
We first chose Delrin axles for the first runs at the beginning of this competition. We found through testing that Delrin axles bend and flex. This caused vibration throughout the car resulting in loss in time down the track. The flex caused the car to turn back and forth down the track also resulting in loss in time. We changed to a different axle type and show a positive change in time.

CARBON FIBER AXLE



Next we went to a carbon fiber axle which is light weight and high tensile strength. This was good because we had a stiff axle in the car. A problem arose when we press fitted the bearings onto the axles. This tight fit caused the inner ring of the ball bearings to distort in shape which made the bearing not function

STAINLESS STEEL AXLE



For our phase three car we had solved our axle problems. We machined steel axles that had a step down on each side to slip the bearings and wheels on and off the car easily. To keep them on the car, we threaded the inner part of the axle to attach and detach them with small machine screws. This let us experiment with different wheels.

Choosing Line Guides

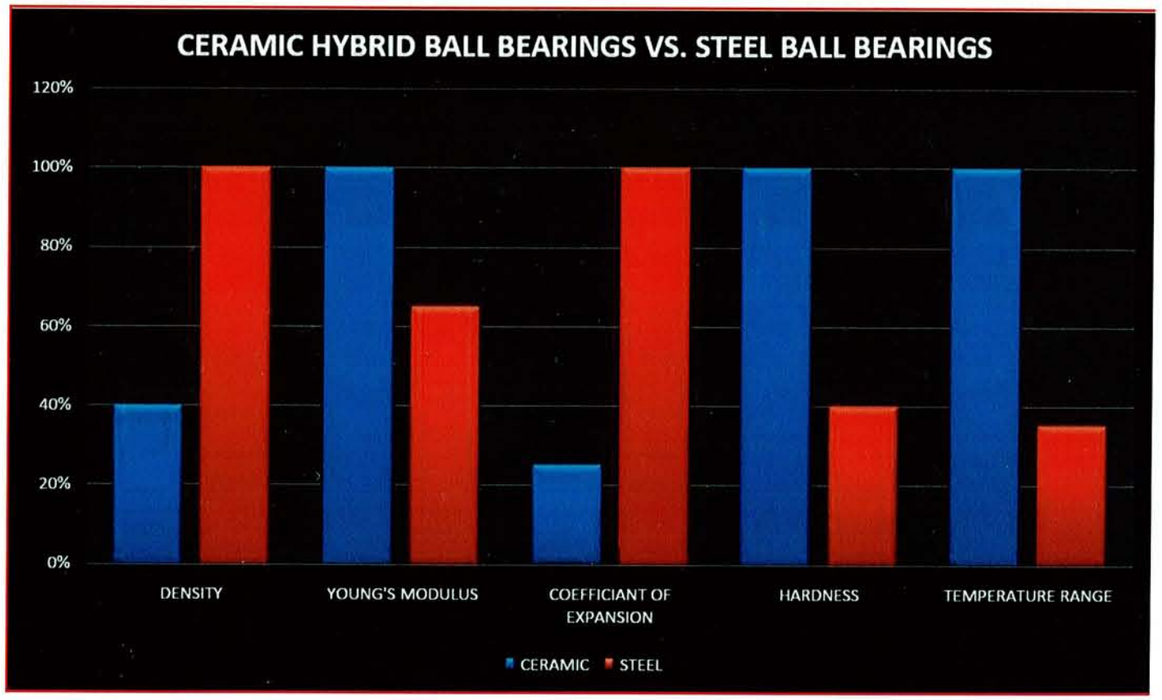
Fishing Line Guides

Standard Eye Hook

Rather than using a standard eye hook for line guides, we chose to use fishing line guides. A standard eye hook is not a fully conjoined circle and chrome coating has a higher friction rating than silicon carbide which is what the fishing line guides are made out of. Since the line on the track is fishing line, a fishing line guide fits the application. They have a enclosed ring made out of silicon carbide that is extremely low friction.

Why Ceramic Bearings?

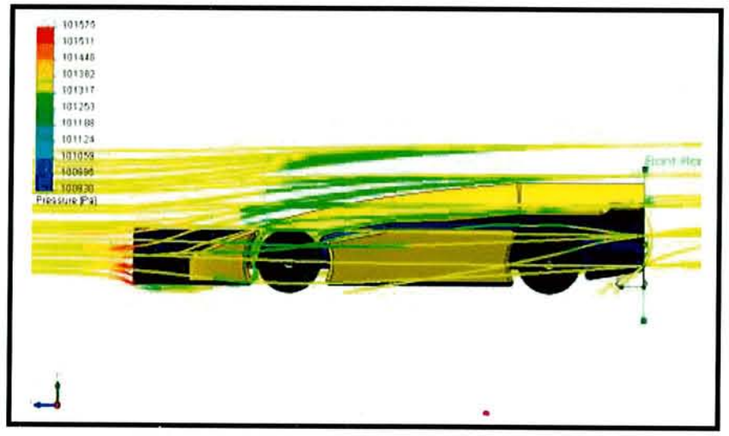
Ball bearings are the ultimate way to reduce rolling friction. We used ball bearings instead of having an axle spin inside a tube because there is a lot of surface friction between the axle and the tube. In ball bearings there is angular contact friction. This is where friction occurs between the balls and the rings in the bearings. (There is hardly any at all). The graph to the right compares why we used ceramic bearings instead of steel bearings.

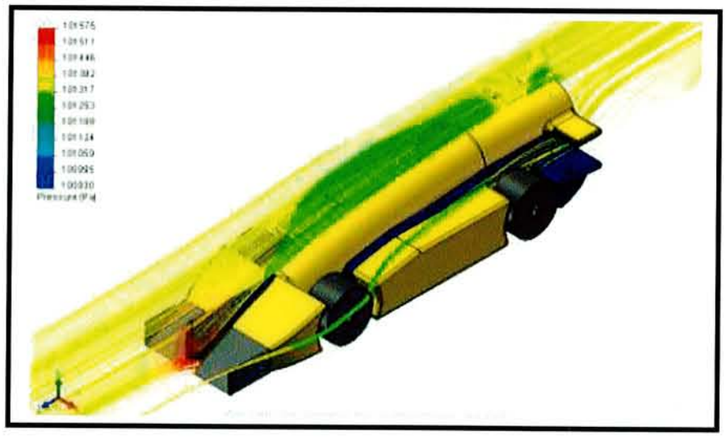


-ANALYZE

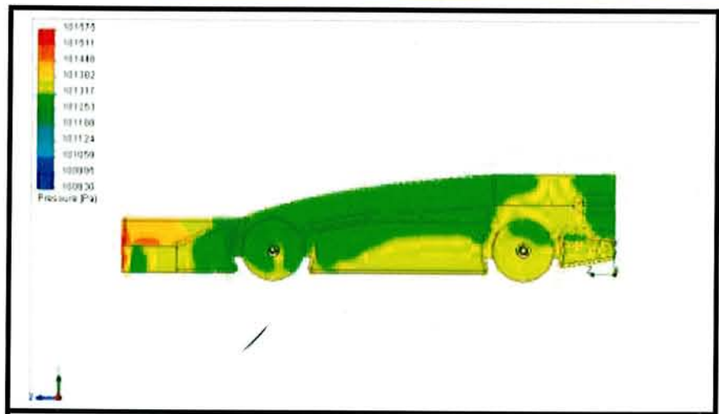
COSMOS Flow works teaches you how and where to pinpoint your troubles with the car. This can be helpful before you cut the car out to make any changes needed to make the car run better.

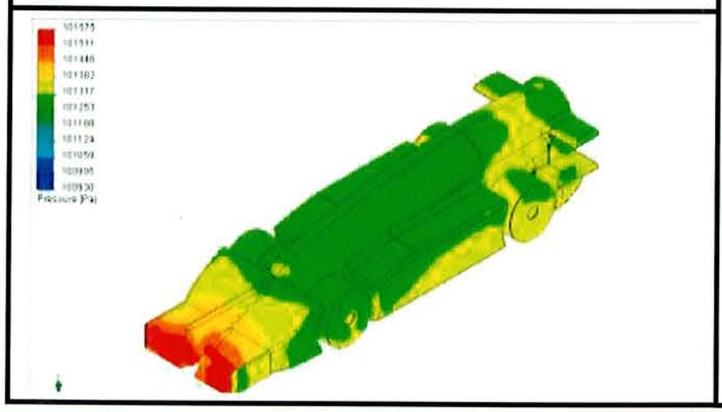
Velocity Readings





Virtual Wind Tunnel Analysis (Pressure Readings)





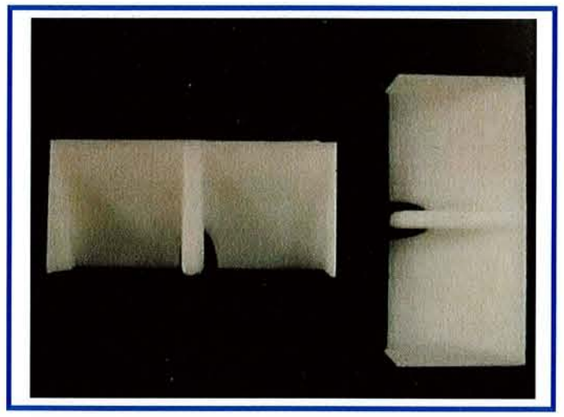
When you have high pressure you have very low velocity. In these drawings it explains velocity and pressure in variation of colors, dark blue to red. We were trying to get a velocity and pressure in yellow and green area. That means velocity is very high and has little drag. When you see red on the velocity drawing that is where your drag is. The wind is not flowing well and slows the car down which results high pressure. In one of the drawings you see a top view of the stream lines coming together. You want to ensure that the stream lines come together because if it does, your car will go a lot faster plus little turbulence is created.

S.E.M. RACING

-MAKE

We machined our front wing for our Phase Three car out of ABS plastic. To do this we used a 3-D printer that does stereo-lithography. The reason behind this was we wanted to prototype different wing designs and in this case, this was the quickest way. Plus we wanted a precise front end because the front end is what affects the car and every other aspect such as direction, down force, and airflow.

ABS Plastic Wing



The picture to the left is Eric sanding the car in preparing it for paint.

Sanding and Preparation

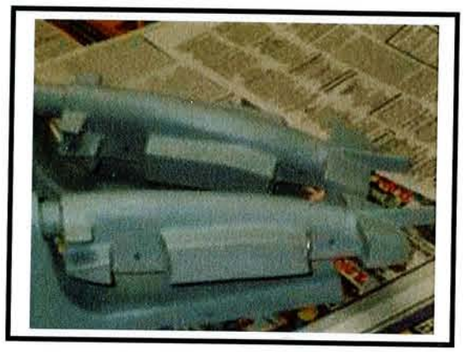
The top right picture shows Matt measuring parts of the car to make sure it's in spec before painting it. The bottom right is Matt sealing the car with fiberglass resin. We did this to make the car more durable for protection and to achieve a smooth finish when painting the car.

-ANALYZE

S.E.M. RACING -MAKE

ADDING THE PAINT AND GRAPHIC SCHEME

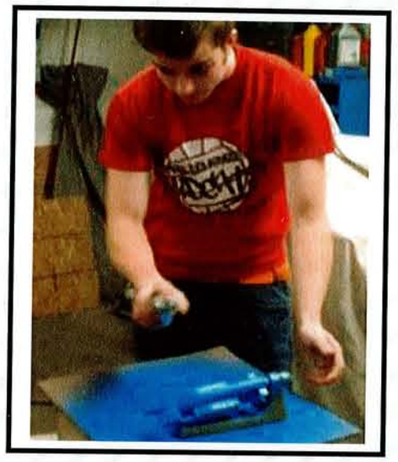
Matt is spray painting the front wing with enamel paint. But before paint could be applied over plastic it. had to be sprayed with Bulldog adhesion promoter.



These are the cars after we primed them with a filler primer to help fill any voids. We sprayed 2 coats.

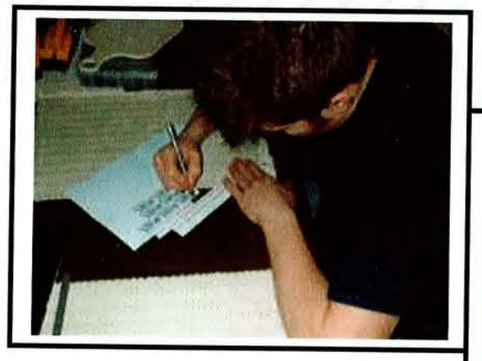
Sean is painting one of the three colors on the car. Yellow is the first due to it being a lighter color visible. Two heavy coats were applied.

Matt is taping up the yellow paint so that the blue color scheme can be sprayed.

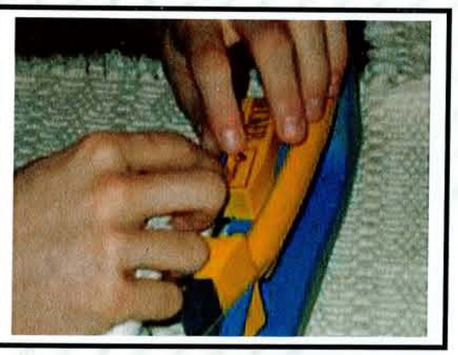


Sean is applying the blue paint. One coat was needed due to its dark tone.

This is the car with a finished paint job and all the masking tape peeled off it. Matt is applying the gold metal flack pin stripe to the car.



Sean is cutting decals out while Matt is applying them to the car. We made the decals by using water soluble decal paper. This is what model cars use. It is great because they are thin to avoid air resistance.



S.E.M. RACING -MAKE

G-CODE

Here we show the beginning (ON LEFT) and ending parts (ON RIGHT) of the G-code. It is too large to show all of 585 pages of G-code.

```
%
O100(INTERNATIONAL CAR)
(FACING RIGHT)
(1.23.08 BH)
T18 M6(.250 END MILL)
M3 S8000
G00 E5 X-0.7642 Y-0.2604
G43 Z2.3 H18
G00 Z1.3948
G01 Z1.1948 F80.0
X-0.6392
Y1.0247
G02 X-0.5243 Y1.1396 I0.1149 J0
G01 X8.7877
G02 X8.9026 Y1.0247 I0 J-0.1149
G01 Y-1.6814
G02 X8.7877 Y-1.7963 I-0.1149 J0
G01 X-0.5243
G02 X-0.6392 Y-1.6814 I0 J0.1149
G01 Y-0.2604
X-0.5392
Y1.0247
G02 X-0.5243 Y1.0396 I0.0149 J0
G01 X8.7877
G02 X8.8026 Y1.0247 I0 J-0.0149
G01 Y-1.6814
G02 X8.7877 Y-1.6963 I-0.0149 J0
G01 X-0.5243
G02 X-0.5392 Y-1.6814 I0 J0.0149
G01 Y-0.2604
```

```
X8.3646 Y-0.2072
X8.3792 Y-0.2405
X8.3774 Y-0.2413
Y-0.2468
Y-0.2526
Y-0.2575
Y-0.267
Y-0.2738
Y-0.2857
Y-0.2899
Y-0.2948
Y-0.3119
Y-0.3248
Y-0.3344
Y-0.5615
Y-0.7055
G00 Z2.3
M6
M1
T20M6(#22 DRILL)
S3000M3
G0G90E5X1.535Y-.768
G43H20Z3.
G81Z-.6R.7F20.G98
X5.744
G80
M6
M1
M30
%
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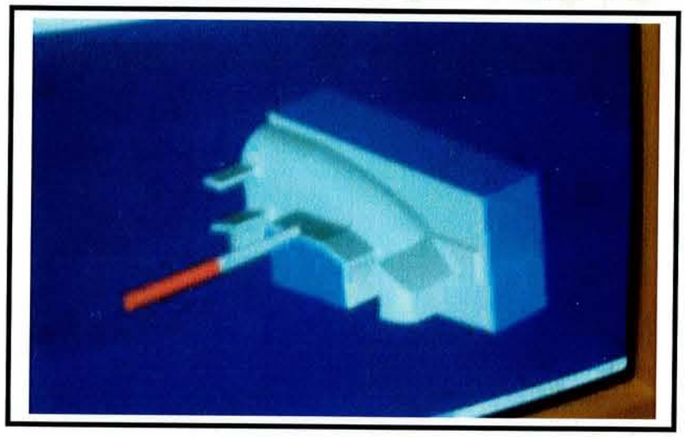
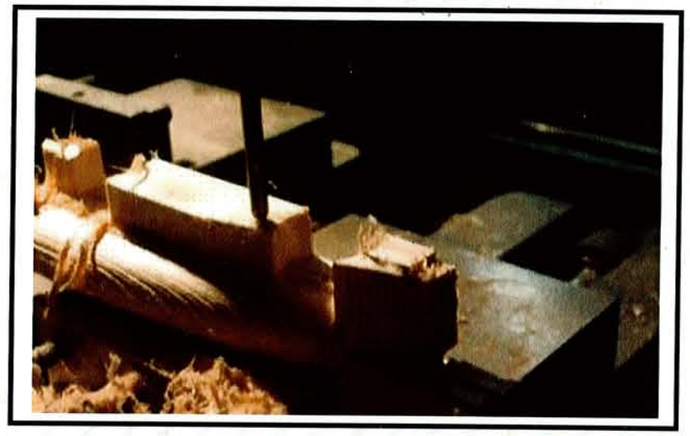
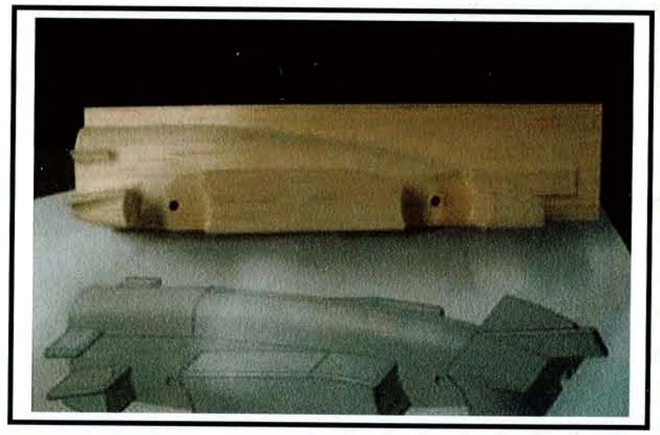
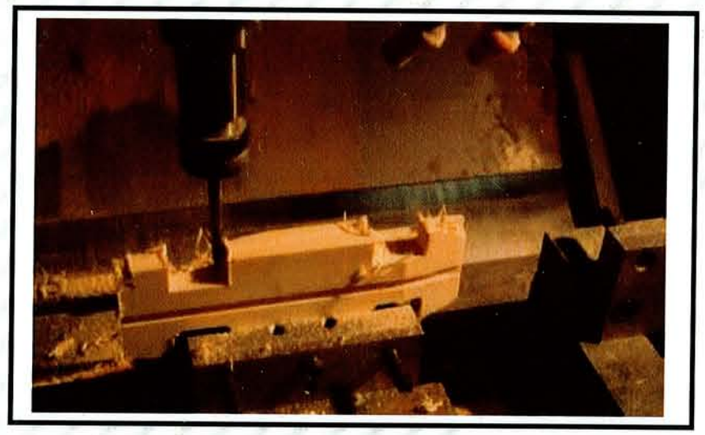




We used Surf CAM to produce our G-code shown in the top right. In the middle shows a Fadal CNC Mill that cut our cars. This was done at one of our sponsors company that does CNC work.





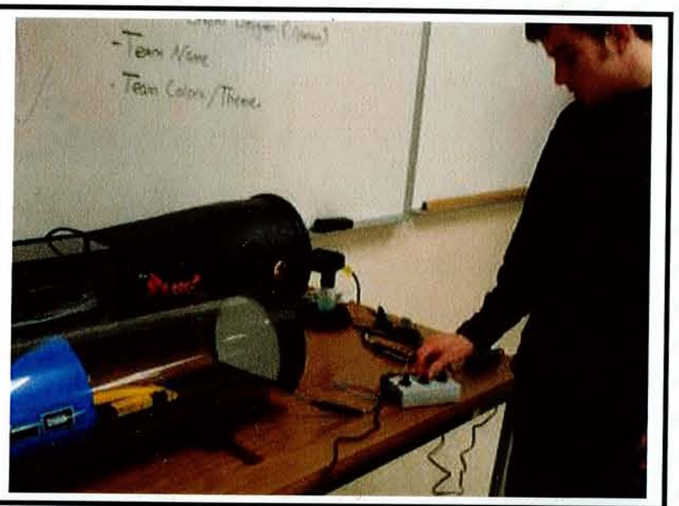
S.E.M. RACING -TEST

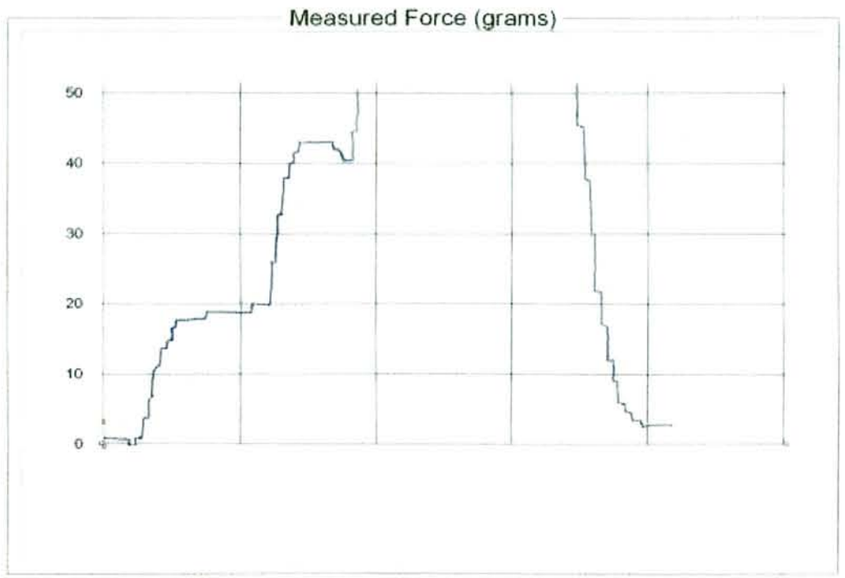
At the Track Comparison

The picture above shows us testing our new design with our previous designs. The car on the left is our International car which is running a time of 1.04 seconds. It is much faster than our Phase Two car (1.09 seconds) in the middle and our Phase One car on the right of 1.14 seconds.

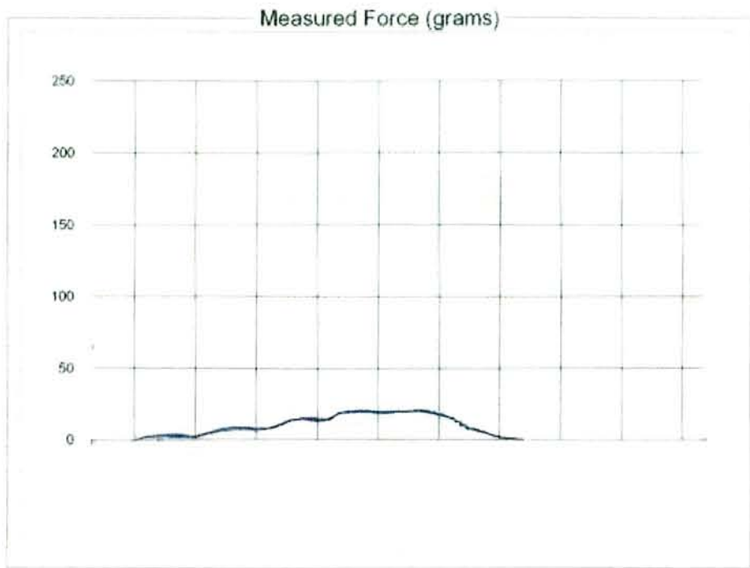
Fog Tunnel Testing

The picture below shows our Phase One car in the fog tunnel. Here we saw that streamlines were breaking apart creating turbulence behind the car. We corrected it in our International car by adding a rear airfoil and rounding the edges on the rear wings shown in the bottom right.





Airtech Xstream Wind Tunnel Data



Airtech Xstream Wind Tunnel Data

Balsa block test

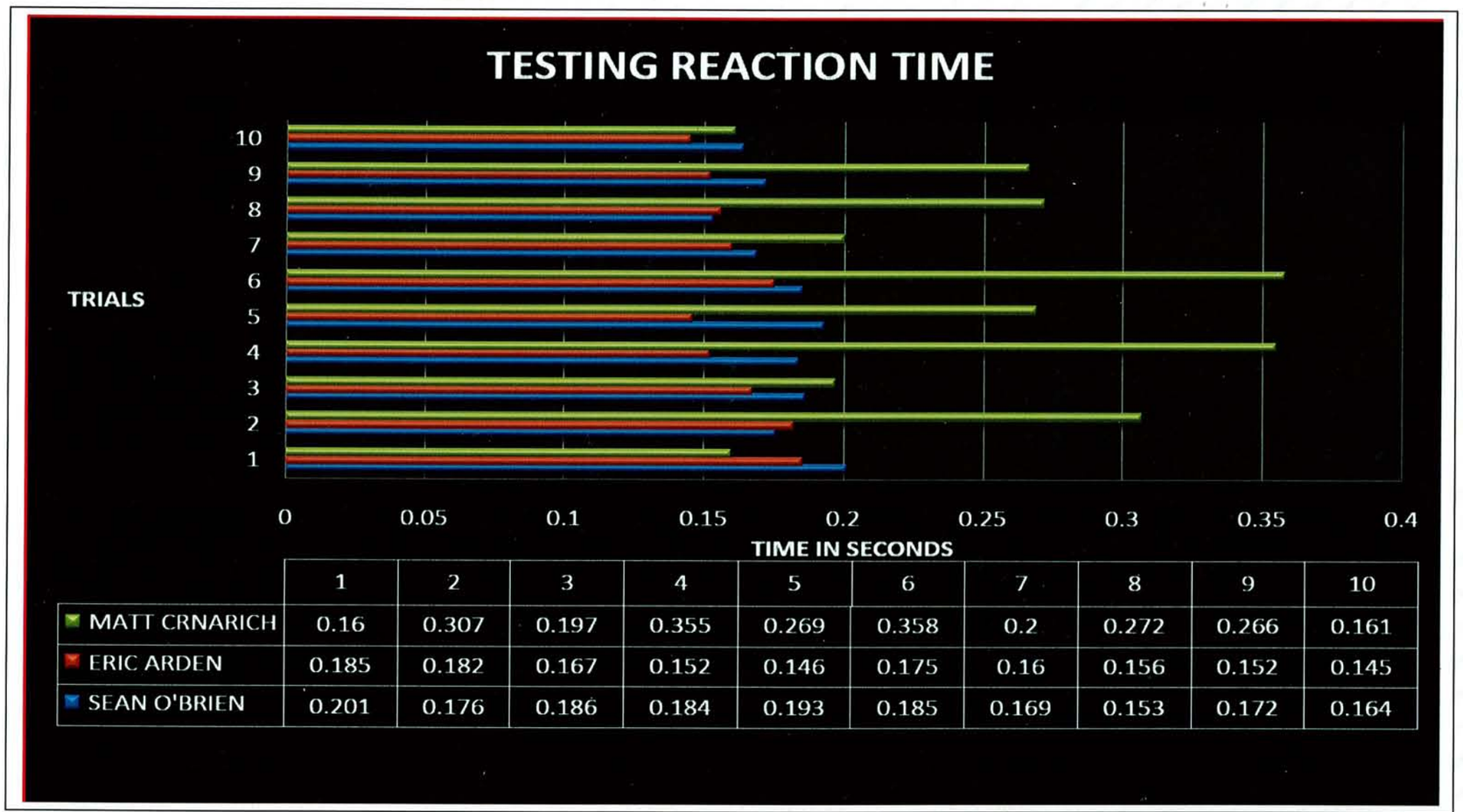
WIND TUNNEL TESTING

To see how much drag we can reduce off the car, we performed a balsa block test. This test had a result of 120 grams of drag on the block. When we tested our International car in the wind tunnel it had only 18 grams of drag.

International car test

S.E.M. RACING -TEST

Selecting Our Driver



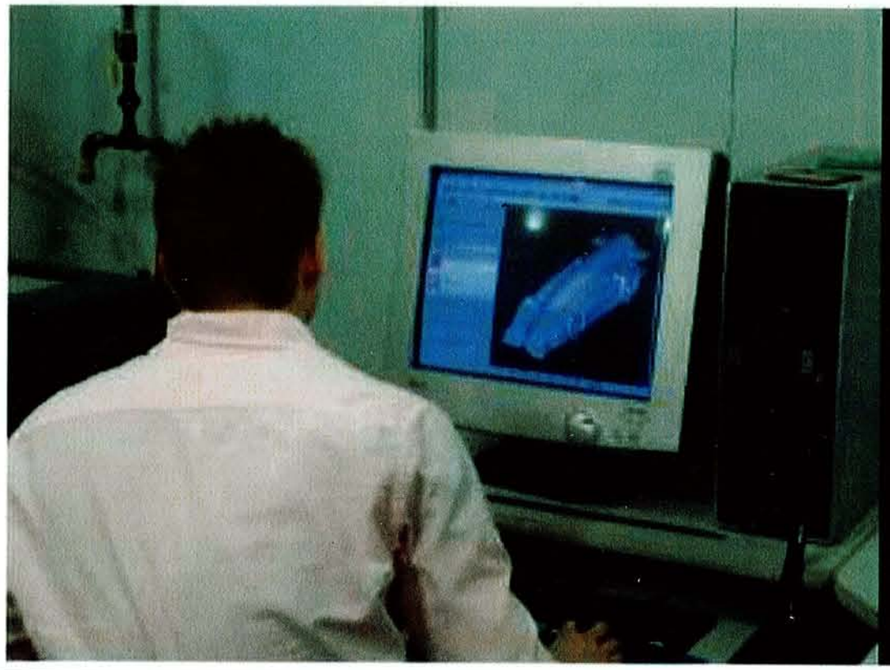
	1	2	3	4	5	6	7	8	9	10
MATT CRNARICH	0.16	0.307	0.197	0.355	0.269	0.358	0.2	0.272	0.266	0.161
ERIC ARDEN	0.185	0.182	0.167	0.152	0.146	0.175	0.16	0.156	0.152	0.145
SEAN O'BRIEN	0.201	0.176	0.186	0.184	0.193	0.185	0.169	0.153	0.172	0.164

Top picture- Sean and Eric

Bottom picture- Matt and Eric

To select our driver we collected reaction times from each of the team members to see who has the best reaction time. As you can see in the graph Eric (in red) has the overall best reaction time, and it is somewhat consistent toward the last few tries. It looks like he would get better with more practice. Eric will be our driver.

Inspection of Car using a Coordinate Measuring Machine (CMM)



When it came time to inspect our car to make sure it met specifications we used a CMM. This machine measures the car by probing points from different spots on the car. The far left picture shows Matt setting a base alignment using Calypso Software. The middle picture and the right picture are showing the Zeiss CMM measuring the car.

S.E.M. RACING -RACE

Media Coverage

Having success at our State and National competitions led to media coverage from various newspapers. We also got recognition from our state senator. This helped us out when seeking sponsorship to raise the funds needed to go to this International competition.

State Competition

Here we won 1st place, and Fastest Car.

National Competition

At Nationals we won 1st place, Judges choice and Fastest Car.

S.E.M. RACING

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