basilisk PERFORMANCE

State Government Victoria · rea · 3LW · City of Ballarat · DMO · webex · Engineers Australia · Symscape

GKN Aerospace · ufs dispensaries · Bond Homes · Stamford Tyres · BEP · The Printer Wizards · Gold Bus Ballarat · KwikKopy · evoke imaging · BOCA Bearing · ALBINS Off Road Gear

behind the name

The reason we chose to use the Basilisk Lizard was because of the similarities we found in comparison to the F1 in Schools Challenge. This lizard has the capability to run across the surface of water, requiring efforts of strength and speed. Coincidently, the maximum distance that they can run on water is approximately 20 metres. As well as this ability, the name was unique and had professionalism. The three concepts we used for comparison to the challenge were speed, strength and distance.

team / testing manager - aidan cowie

Over the 4 years I have been involved in F1 in Schools I have learnt many designing skills and workplace relationships were developed. This has had a positive impact on my life, giving me more confidence and persistence to complete a task. After the challenge I wish to pursue a career in either computing, car designing or engineering.

sponsorship and marketing manager - ben kersten

I have been involved in F1 in Schools for the past 4 years and I have thoroughly enjoyed it. F1 in Schools has opened my eyes to a career in engineering. My role in the team has really improved my confidence and public speaking skills.

design / manufacturing engineer - brett sizeland

I have thoroughly enjoyed my journey in the F1 in Schools competition which started 4 years ago. Through out my journey I have learnt so many new skills and have come to love the engineering world. I hope to pursue a career in engineering once I have finished the competition.

graphic designer - keira schroeders

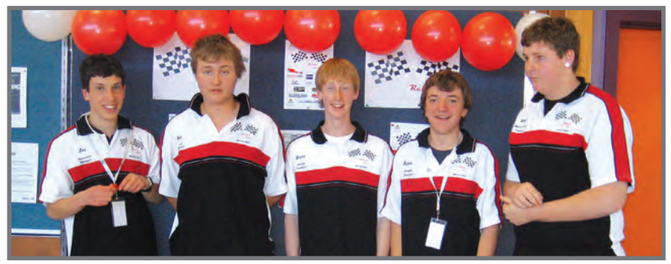
In the few short months I have been in the team I have improved on many skills, particularly in the area of public speaking and organisation and have also been able to pick up the use of new technology in order to help create the overall look of the team.

project supervisor - christof mulller

For the past three years I have witnessed the growth and development of the members comprising the Basilisk Performance team. My task is to provide an environment for the students, which allows them to excel in and develop skills in becoming World Champions in Singapore. Their thirst for knowledge, outstanding commitment and teamwork towards the 'F1 in Schools' program has formed Brett, Ben, Aidan and Keira into professional young adults who are inspiring and deserve to fulfil their dream of winning the title and continue on their educational journey with a scholarship.

the team

Basilisk Performance is a team of four graduated year 12 students with a combined experience of 13 years. Forming as Impulse Racing in 2008's season, we advanced to the National Final in Canberra, where we realised the true level of competition required to represent Australia at the World Finals. The team has experienced many challenges and difficulties that have been overcome. Each team member has their own view on the experience given to them.



rebel racing

Rebel Racing was formed in 2007 which was the first full year Sebastopol College competed in the F1 in Schools Technology Challenge. The team successfully made it through the Regional Final and came third at the Victorian State Final.

Regional Final
- 2nd Overall

State Final
- Third Overall

impulse racing

Two former members of Rebel Racing, Ben and Brett decided to continue on with the program and form a new team called Impulse Racing. They found that Aidan and Warren were interested in joining and they were introduced in the 2008 season. Impulse Racing went on to win the Regional Final and at the State Final came second, although the team gained a wild card into the 2008 National Final which was held in Canberra at Parliament House. Impulse Racing ended up 19th out of 24 teams.

Regional Final
- 1st Overall
- Fastest Car Award

State Final
- 2nd Overall
- Innovation Award
- Wild Card entry into National Final

National Final
- 19th Overall Professional Class

basilisk performance

After the experience from the 2008 National Final the team had seen the standard required to be successful at the National level. With no Regional Final held this season the team cruised straight into the 2009 Victorian State Final which Basilisk Performance won and proceeded into the 2009 Australian National Final. The team had high expectations heading into the event, although the team exceeded them by winning and becoming Australian Champions. Basilisk Performance has now won the right to represent Australia at the World Championship in Singapore to be held during the Singapore Formula 1 Grand Prix in September.

State Final
- 1st Overall
- Fastest Car Award
- Best Engineered Design

National Final
- 1st Overall Professional Class
- Fastest Car Award

World Championship (TBA)

SEBASTOPOL COLLEGE

our school

For over forty five years Sebastopol College has served the Ballarat community through the provision of quality education programs. The College is committed to ensuring that students are given every opportunity to achieve their potential within the College environment. Emphasis is placed on all students participating in the wide range of curricula and co-curricula activities offered by the College. The welfare of individual students is well supported through established structures within the College organisation. 4 years ago our school found out about this program, they found it so intriguing that they rushed a team together to be ready for the state final that was in 3 weeks time. Since then they have achieved remarkable results by winning a state final and the 2009 National Final.

project management

Project management is the discipline of planning, organizing, and managing resources to bring about the successful completion of specific project goals and objectives. The primary challenge of project management is to achieve all of the project goals and objectives while honouring the preconceived project constraints. Typical constraints are scope, time, and budget.

risk management

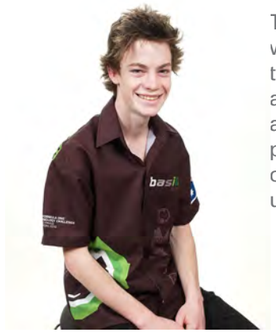
We realised that many things could happen over the season and created a list of our possible risks and how to manage and resolve them. The list included illness, grievance, extra-curricular activities and other tasks, as well as possible risks within the team, such as manufacturing difficulties, breaking the car or lack of preparation. Understanding how we could fix all of our problems created more of a relaxed environment, and we were able to focus on completing tasks.

1 - determine the risk (i.e. the expected consequences of specific types of attacks on specific assets)
2 - identify, characterize, and assess threats
3 - evaluate the vulnerability of critical assets to specific threats
4 - identify and manage ways to reduce those risks.

team management

In order for the team to work effectively the work load must be shared amongst team members. The work was split into four roles;

team/testing manager



The responsibility of this role was to effectively manage the team and control resources and expenditures, as well as evaluating and solving problems by the process of testing and eliminating unsuccessful concepts.

design/manufacturing engineer

The responsibility of Brett's role was to productively design and create the car from scratch using data collected from testing and research.

sponsorship and marketing manager

Ben's role included successfully promoting the project to a new audience whilst raising funds in order to support the team.

graphic designer

This role requires the person to create the overall look of the team theme.

communication

In order for the team to work effectively we needed to able to communicate at any time, we managed this by using forms of technology such as; email, text messages, instant messaging, phone calls, skype, but the two main forms of communication were webex and the popular social networking site, facebook.

webex

Webex is a company that provides on-demand collaboration, online meeting, web conferencing and video conferencing applications. This allowed the team to convene whilst separated, and allowed us to take control each others computers from another location if help was needed. An example of this was when Keira was learning Photoshop and needed assistance. Brett was able to help her online from a distance.

facebook

Facebook is a social networking site that allows instant messaging and private messages to be sent at no cost from the comfort of your own home. This was an affordable way for us to communicate since we were on such a tight budget. It also allowed us to communicate with other teams about the competition whilst also creating friendships with them prior to the competition. We created a personal page for Basilisk Performance that we kept regularly updated for our fans.

project management triangle

Like any person undertaking a project, it needs to be performed and delivered under certain constraints. Traditionally, these constraints have been listed as “scope,” “time,” and “cost” This is also referred to as the “Project Management Triangle”, where each side represents a constraint. One side of the triangle cannot be changed without affecting the others. The time constraint refers to the amount of time available to complete a project. The cost constraint refers to the budgeted amount available for the project. The scope constraint refers to what must be done to produce the project’s end result. These three constraints are often competing constraints: increased scope typically means increased time and increased cost, a tight time constraint could mean increased costs and reduced scope, and a tight budget could mean increased time and reduced scope. The discipline of Project Management is about providing the tools and techniques that enable the project team (not just the project manager) to organize their work to meet these constraints.

scope

The Scope of our project was to work as a team to create the best possible model F1 car. We had to define some set limits of time and cost to determine how well we could use our scope to determine the outcome of the team. This was especially helpful when it came to times where we needed to find out what we had to achieve. The scope was a common idea in which we could all rely on in times of need.

SCOPE

QUALITY

TIME

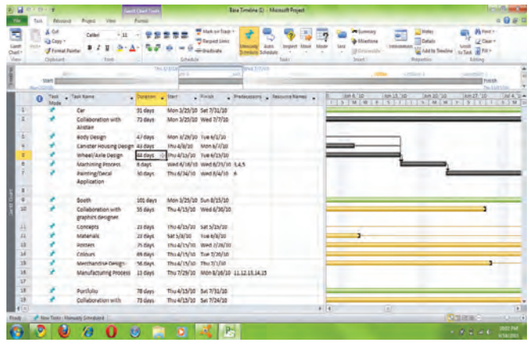
COST

our goal

our goal is to become F1 in Schools champions and produce the fastest car ever.

time management

When we advanced through the national final, we created a basic time schedule to follow during the rest of the season. We included all aspects of the car, graphics, uniforms, presentations, sponsors and content of our portfolio and booth. This was a good schedule to fall back on as we prioritised all of the tasks and used this to determine how much time each item would take to prepare and complete.



finance management

In order for the to team participate at the 2010 World Finals, we needed to form a proposed budget before seeking financial support from industry.

As a team we managed to raise a total of AUD$12,000 through sponsorship and fund-raising events. We were privileged to have REA the head body of F1 in Schools in Australia helping us in our effort to raise the money, they managed to raise AUD$20,000 for our team. Therefore we ended up with a total amount of AUD$32,000 to cover all of our costs.

From previous experience we have learnt that in having a budget helped us keep track of where we had to spend the money, we split the budget up into 9 categories; entry fee, accommodation, flights, freight, uniform, merchandise, display, car development, promotional. This also gave sponsors an idea of where we were spending the money that we raised.

casual uniform

Casual uniforms were designed to provide the team with comfort whilst travelling and for extra activities during the competition.
The Australian flag is presented on the shirt sleeve with the team name and platinum sponsors on the front, while the team name is located on the rear. The shirt is accompanied by green and black sport shorts, white socks and white sport shoes.

competition shirts

The competition shirts were created strictly to be worn during the competition phase. The shirts were designed by the team and manufactured by an Australian company called Kombat, which have helped us out previously.
The design of the shirts consisted of the F1 in Schools logo, the Australian flag to show which country we are proudly representing, along with the team name on both front and back as well as platinum sponsors. This is worn with plain black slacks, black socks and black leather shoes.

formal outfits

Formal outfits were included in the team uniform to give the team a smart look for presentations. It consists of a plain black fitted suit with a white shirt, green tie, black socks and black leather shoes for the males, and a black dress and shoes for Keira.

car graphics

A simple green skirt is put along the bottom of the car with darker green rays along with black rays on the canister housing and the lizard icon placed on the top of the deck. This is accompanied by our major sponsors which are shown in a light grey. We have put the logo's in this colour so that they don't compete with our car graphics.

The graphics were applied to the car as a water slide transfer as these are light-weight, very thin, and easy to apply. This was a simple and effective way to display our car graphics rather than using stencils or masks to paint them on.

Logo

This year it was decided that the team would go for a new look. Once we had the look we sought advice from 3LW on how to further improve on our ideas for a new logo. In doing this they eliminated the concepts which were least appealing and from here the team came up with the present logo. It was decided to keep it simple as the name Basilisk is a unique word which makes it easy to remember. They then created an image of the lizard head which is used to link the name of the team to the basilisk lizard. The icon shows a sharp, front-on image of a basilisk head, and by doing this the lizard developed a more confrontational look which makes it appear more aggressive.

Logo

basilisk PERFORMANCE

Icon

Mock up Pit display

We Created a mock up of the pit display using the program CATIA and from here we placed strategically placed items with in the booth and then later on also created a physical mock up of the booth out of cardboard so we were able to move things around in order to achieve the most maximal potential out of items placed with in the display pit.

Pit display

The plan was to maximise this small area and make it as visually appealing as possible. We wanted to keep it simple, clean and organised, whilst still being highly detailed and professional.
To make the pit display unique to the team we had a custom table made to make full use of the length of the pit display. This allows more space for items to be displayed without being cluttered, while also allowing custom graphics to be displayed on the table.
The table consists of an aluminium frame with a printed material banner that covers the front and is attached by Velcro and topped with green perspex sheets. With a combined weight of 14kg, we can pack this into our luggage on the plane rather than sending it by freight.

In addition to the table, custom wall banners were created in order to show the unique information that needed to be shown in the pit display and also allow larger graphics to be displayed. Items that were displayed in the booth were placed in a manner that optimised their visual potential.

local news television broadcast

WIN News, an Australian Television Company's local News branch, offered to cover a local news story on the team and their success. They visited the school and witnessed us working on the project and took some footage of the cars racing and the manufacture of our car. This promoted both the team and the F1 in Schools Challenge, and from the feedback we received, many schools around the local district were interested in the program.

local radio broadcast

ABC Radio covered a story on the team, and also provided promotion for our trivia night. As this station reaches a large audience, the program was promoted into remote areas around the Ballarat district. There was also an article published on their website.

fund raising events

We held many fund raising events over the year, including a trivia night and an election day barbeque. Not only did these events raise much needed funds, but also promoted the challenge. The public who participated in these events were keen to know about the program and why they should donate towards the team. These were also great opportunities to provide us with public speaking confidence, and promoted our own knowledge about the challenge as we were teaching others about the program.

newspaper

The Courier, the local Ballarat newspaper, wrote an article on the team and their success at the National Championships. This promoted the team and provided a positive image of our school. We also felt this was an effective way to gain potential sponsors as many Ballarat citizens read The Courier.

social networking

We had many opportunities to present to the community about the program. This was done to inform businesses of what we were doing and how we could be assisted. The two major experiences were a National Insurance Conference and Commerce Ballarat meetings. These promote local businesses and what they were doing in the community. We were able to obtain money from many different groups at both these events, and they had a positive impact on our confidence as we were able to talk to all the people and find out how they would expect a group to contact them about sponsorship and what they could offer.

kyabram trip

The team were involved in a trip to Kyabram P-12 to promote the challenge to students who were interested in competing. We were able to set the track up, teach them how to create a car, and let them ask questions about our experience with the competition. Each student had their particular interests in the program, so we split into groups to teach them about our own roles and what we did to complete tasks and overcome challenges. Every student who was involved showed great interest in the program, and many were eager to get started on the program straight away. We offered to mentor the students, and provide them with any assistance they would need.

ballarat careers exhibition

We were invited by Engineers Australia to participate in the Ballarat Careers Exhibition to promote engineering to students who walked through the display. Many of the students who were interested came to ask us about why we were there and what we do. Of the students we talked to, most asked about how to get involved in the program and what work is required to do the challenge .

One of our main goals from the start of F1 in Schools was to gain sponsorship. Without sponsorship you can't run a successful F1 in Schools team. We had some great advice from marketing experts who showed us how to make a successful sponsorship proposal and the reasons behind particular sections of the proposal.

how we obtained sponsors

We had many hours of contacting potential sponsors and were able to find some businesses that were prepared to provide a great amount of assistance. Many techniques were used to contact sponsors. The main methods were phone contact, meetings and emails. Many sponsors were prepared to give assistance. This came in forms of monetary donations and assistance with the production of our graphics and car.

sponsorship proposal document

We created a sponsorship proposal document, in which we specified the benefits of sponsoring the team. The four packages of sponsorship we offered were Platinum, Gold, Silver and Bronze. Each level of sponsorship would receive different benefits; from a mention in the portfolio to receiving a signed shirt and car. Here is a list of our major sponsors and some basic information about their businesses.

three little words, platinum sponsorship - graphic assistance

Three Little Words, a local graphic designer in Ballarat, were prepared to assist us with all areas of graphic design, including explanations and concepts for our designing. They also had contacts in the industry and were able to organise printing and manufacturing of our products. Keira spent many hours collaborating with Ross and Saeed, where Keira was able to learn many techniques in the industry. Keira was able to consult with them about the advantages and disadvantages about the designs that had been created and used this feedback to create the most effective design possible.

victorian state government, platinum sponsorship - monetary

The Victorian State government provided us with a donation of $10,000. This donation went into our transport costs. Just like the Ballarat City Council, the Victorian State Government specialises in assisting the Victorian Community. This donation was a milestone in our sponsorship goal, as this confirmed we would be competing in Singapore.

gkn aerospace, gold sponsorship - engineer assistance

GKN Aerospace is a company that specialises in the designing of aircraft and aerodynamics. We were able to contact Stuart Pearse through many connections and he offered to provide us with assistance. He was able to help us design our car and introduce us to new techniques in regards to aerodynamics and CATIA work. Many hours were spent emailing Stuart and meeting up to have productive lunches.

city of ballarat council, gold sponsorship - monetary

The City of Ballarat council provided the team with a monetary donation. They provide assistance to the Ballarat community and make many decisions to benefit the community. Their assistance went on to the creation of our graphical properties, including our booth, uniforms and portfolio.

ufs dispensaries, gold sponsorship - monetary

UFS Dispensaries is a local chemist in the Ballarat and Bendigo community. They provide good value medication and put all of their profits into the community. They have been a faithful sponsor over the years and have shown great interest in our goal of becoming World Champions.

engineers australia, gold sponsorship - monetary

Engineers Australia were interested in the work we were doing and were happy to provide funds to the team. We were also invited to participate at the Ballarat Careers Exhibition. Engineers Australia is a group who specialise in all forms of engineering, and the Ballarat Region is one of the largest groups in Australia.

3lw

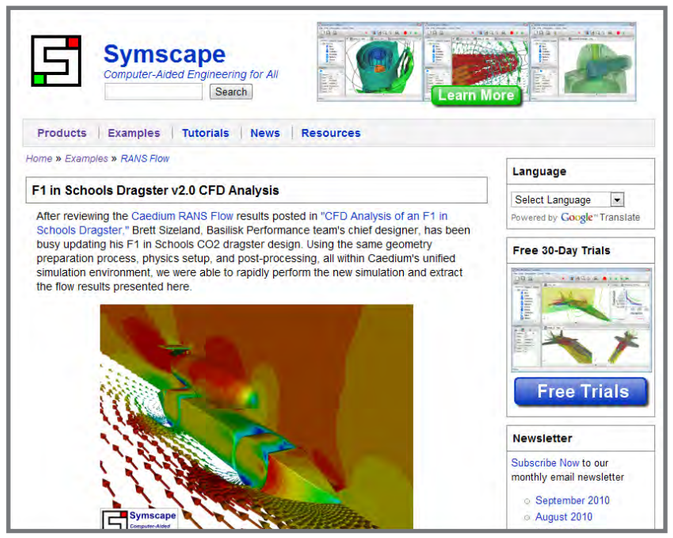
Because Keira only possessed skills in the form of sketching, which was useful during the first few weeks, her involvement in the team wasn't enough to produce the graphics we needed, so we called many design firms in Ballarat seeking help until we came across Three Little Words. They seemed very enthusiastic about the project and were more than happy to sponsor us by donating their time and facilities to teach Keira about the industry and how to transform sketches on paper to a computerised format. Through their mentoring Keira learnt how to correctly use programs such as Adobe Photoshop, Illustrator and Indesign. Keira spent many hours collaborating with them learning the advantages and disadvantages of the various concepts that were produced. Keira used this feedback to effectively eliminate concepts to give the most successful design possible.

university of ballarat

The university of Ballarat allowed us to use their humidity chamber for testing purposes. We spent many days working with Rod Hall to set the humidity chamber to different conditions, testing what we would be facing if we were competing in different areas of the world. This research provided us with results of car time differences, weight differences and also prepared our bodies for the conditions.

Symscape

Symscape, an American company, provided us with their expertise in the area of Computation Fluid Dynamics, and offered to not only test our car, but promote the team and the challenge on their website. They also analysed our own results from our Virtual Wind Tunnel and provided feedback as to what the results meant. This was very helpful and we obtained a lot of knowledge from our relationship with Symscape.



Lorraine Hayes

Aidan spent many hours working with the Sebastopol College Business Manager, Lorraine Hayes, to learn how to successfully run a business and some effective techniques. This was to ensure that he was correctly doing his job, and to spark an interest in a possible career in management. She was able to teach him how to consult different people, how to manage finances and how to solve issues within the team. This was a very efficient technique of learning as Aidan quickly realised the work that had to be put in for success.

gkn aerospace

Through contacts with judges from the Australian F1 in Schools Competition, we were able to establish a connection with an engineer from GKN Aerospace named Stuart Pearse. We were able to ask him many questions in regards to CATIA use, car design and kinematics. He spent many hours assisting us with the design of the car, and teaching Brett many new techniques from his work on CATIA. Over the hours he assisted us, we established a strong connection with this expert in engineering. He was very helpful in our pursuit to become World Champions.

factors during the race

Control Factors

These are the factors that we have control over:

Car Geometry
Wheel Design
Car Set-up on Track
Weight of Car
Car protection during stopping
Reaction Times
Noise Factors

These are the factors that we have no control over:

Track Set-up
C02 Canister differences
Starting Mechanism variability
Atmospheric conditions

car shape

We researched many car designs. These were from previous competitions and we determined what aspects we approved of and what could be changed to make them better. Through many hours of research, we found a completely innovative design, that looked aesthetically appealing and was fast down the track. Due to our complex shape, we were required to create a completely new machining technique, incorporating 13 different sides, including the canister housing, as this had to be altered due to position and original size dilemmas.

wheel design

Many hours were put into the design and research of our wheels. Many designs were tested and we came to a conclusion that if we can get the caps to stop rotating, the turbulent air around the wheels is reduced dramatically. This idea was researched after we noticed the wheels caps on the Ferrari F1 cars were not rotating. Many designs were tested after this and we determined that our current wheel design had little friction, was made out of a slippery material and provided the car with a fast, respectable time.

beam breaker myth

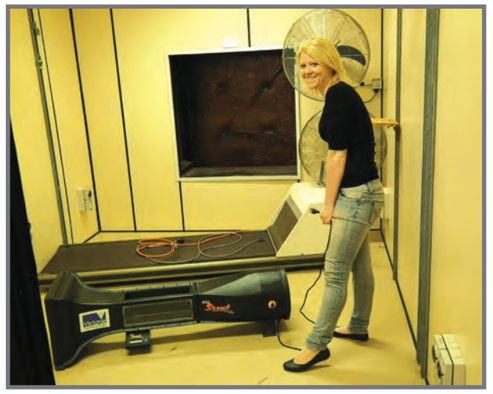
The beam breaker is the part of the car that has been designed so that when the car crosses the line it breaks the beam immediately. Teams have been using them for the past 4 years ever since Brisk in Pink invented the idea. We had originally used the beam breaker on our previous designs until Stuart from GKN Aerospace pointed out that if we did a simple calculation we would find that you only save 0.001 seconds, so it isn't worth having a beam breaker if it affects the aerodynamics of the car.

$$\text{Time} = \frac{0.020\text{m (20mm)}}{20\text{m/sec}} = 0.001\text{seconds}$$

ie. The time it takes the car to travel 20mm at 20m/sec

humidity

After some research on the conditions of Singapore we found that the humidity would be high so we wanted to test what effects humidity has on the car. The main purpose of this testing was to see how much drag the humidity added to the car. We did this by going to our local university and putting our wind tunnel in their humidity chamber and changed the humidity to find what difference it made. Previous teams had also said that when they headed overseas their cars gained weight, after researching why this would happen we found that it would be due to high humidity and the cars soaking up moisture through the canister hole where there is bare balsa wood.



canister heat

We did some research on the canister heat to determine whether this would provide an advantage or disadvantage. We determined that when the canister's temperature is increased, the carbon dioxide expels from the canister more rapidly. Though we will have no control over canister heat, we felt this was some effective research.

balsa strengthening

As our cars had broken at our previous competitions, we researched into a material that could harden the balsa and strengthen the car on a whole. We researched and discovered a material called dope, that has been used on model planes and cars for many years now. After we applied the dope, the car strength increased and the car was more resistant to breakage. The design was also made thicker so that the car would be more solid in the design structure.

materials

We have researched a lot of different materials for the components of our car, the main focus was on the material for our wheels because we found that the material of our wheels affected the speed of our car. We originally used aluminium for our wheels but found that if we used a plastic it's lower coefficient of friction improved the speed of the car. This lead us into further research to find the best plastic which had the lowest coefficient of friction but still strong enough to handle the forces the car goes through on its run down the track.

wheels

We have tested many different wheel designs trying to perfect them. We found that having each wheel spin independently improved the cars speed because it reduced the rotating mass which allows the car to get up to speed faster.

wheel 1

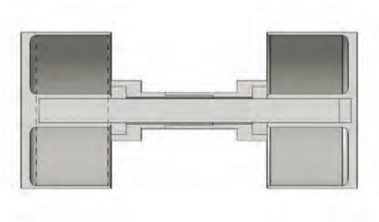
This initial idea has the two wheels fixed to the same axle and the axle is fitted to a bearing in each side of the car body.

advantages

- strong and sturdy
- simple design

disadvantages

- high rotating inertia
- rotating axle system



wheel 2

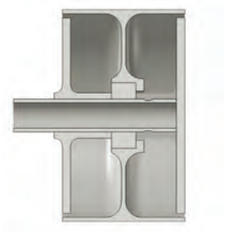
This wheel uses a fixed axle system which means that each wheel spins independently. It incorporates a single bearing in each wheel.

advantages

- stationary caps
- simple design
- low rotating inertia

disadvantages

- expensive



wheel 3

This idea uses 2 thin discs that run on a 1mm stainless steel axle. Due to the small surface area touching the axle it gave the wheel a low rolling resistance.

advantages

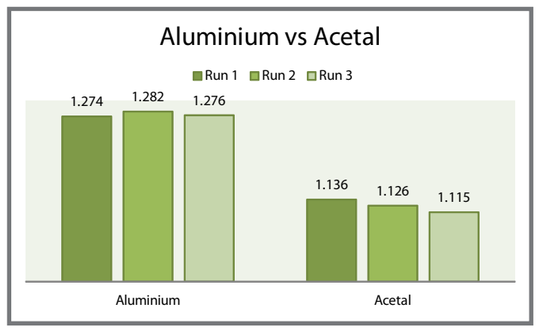
- cheap
- low rotating inertia

disadvantages

- complex to get working correctly
- using the stationary caps added rolling resistance

material

We tested many different materials to find which worked best and why. We originally made our wheels from aluminium but found that other teams had started making their wheels from plastic. This spurred us on to try plastic and after some research into different plastics we found that the wheel with the least coefficient of friction would work best because the wheels aren't trying to move the car, so they don't need any grip with the track surface. After this research we went and asked Ballarat Engineering Plastics (BEP) for their advice and settled on a plastic called Acetal. Acetal is lightweight, has a low coefficient of friction and is strong enough to be machined to a very narrow wall thickness to reduce the rotating mass of the wheel. To test our theory we produced 2 sets of wheels, one out of aluminium and the other out of Acetal. We then tested them on the track and found that the set made from acetal were on average 0.150sec faster which is a massive improvement. This is why we have chosen to use acetal for our wheels.



wheel design

For the past 2 years we have used wheels with a single bearing in each of them. This was a simple but very effective design. Once we'd won the Australian Championship we felt that we should try and improve on our wheels. We decided we would try a wheel that incorporated 2 thin discs that run on a 1mm stainless steel axle. Because of the small surface area that touches the axle, this design has a low coefficient of friction. We found that they worked well when given enough clearance, but were prone to wobble. Adding stationary caps unfortunately added a lot of friction due to the caps having to push up against the discs. For this reason, design number 2 has proved the most effective due to its reduced rolling resistance.

impulse racing

IR3 National Car - 2008

We produced this car for the 2008 Australian Championship. Some of the main features on the car were vortex generators to reduce the wake of the car and the beam breaker at the front of the car to break the timing beam as early as possible. We also introduced our new wheel system with non rotating caps to reduce the formation of eddies around the wheels and incorporated a single bearing in the centre of each wheel.

basilisk performance

BP1 state final - 2009

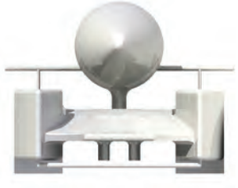
We spent a 10 month break after the 2008 national final evolving our car design using the experience that we had gained from our first national final. This design continued to use a beam breaker and the same wheel system, although we moved on to using the split profile body to greatly reduce the drag of the car. It also has a bulbous cartridge chamber to direct the airflow behind the car back together smoothly as well as having cut outs in the sidepods to reduce the pressure behind the front wheels.

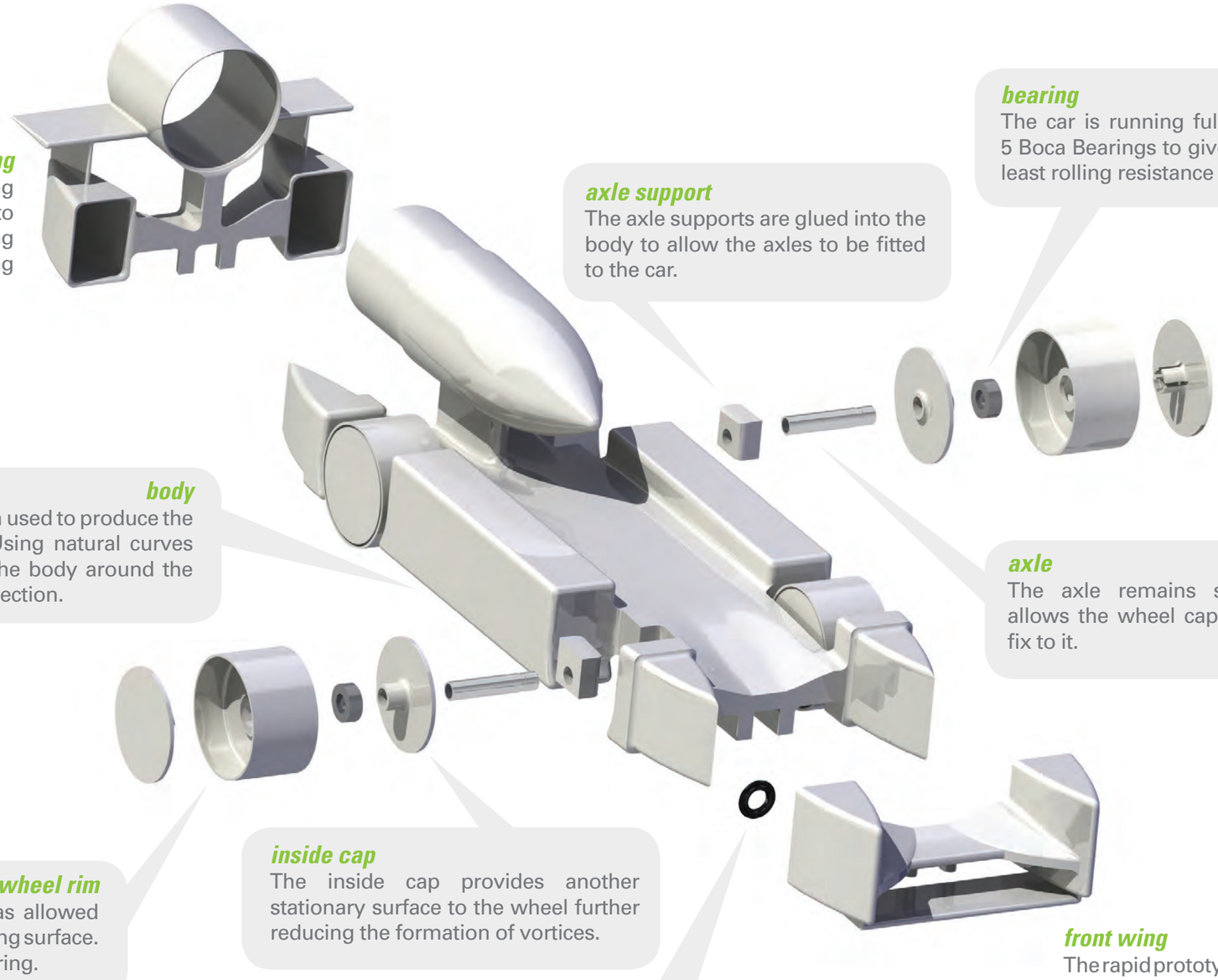
BP2 national final - 2009/10

We won the Australian Championship with this design. The car featured a simple, sturdy structure and a hollowed out centre shaft. This vehicle produced fast times and incorporated our old wheel design. The tapered canister housing provided an effective and aesthetic design, and the consistency through the car design allowed the air to move smoothly and quickly past the car. The beam breaker was removed as we realised this increased the time of the car, not reducing it as has been previously discussed. This car had to be completely redesigned with the release of the new regulations.

BP3 world final - 2010

This is the newest car that we have produced, and the last as Basilisk Performance. This design aims for the car to lie low and keep towards the track. The section in the middle complies with the rules and regulations and provides an aesthetic enhancement to the car. The canister housing has been raised to allow for our complex machining pattern, and the design resembles the fierceness of the Basilisk lizard. Once again, this design uses our old wheel system, though it has been upgraded to full ceramic bearings to provide the least friction and most speed possible. This car has been made to follow the rules and regulations completely.





rear wing
The rapid prototyped wing provides structural support to the rear of the car. The wing tapers down smaller to trailing edge.

body
The high canister housing has been used to produce the minimum frontal cross section. Using natural curves we were able to gradually form the body around the minimum 30x50x10mm required section.

axle support
The axle supports are glued into the body to allow the axles to be fitted to the car.

bearing
The car is running full ceramic ABEC 5 Boca Bearings to give it the absolute least rolling resistance possible.

outside cap
The outside cap stays stationary to reduce the formation of vortices from the rotating wheels. It has a snap fit design so that it stays on the axle.

axle
The axle remains stationary which allows the wheel caps and bearing to fix to it.

wheel rim
The wheel rim is as small as allowed with a smooth and slick running surface. It also encompasses the bearing.

inside cap
The inside cap provides another stationary surface to the wheel further reducing the formation of vortices.

tether line guides
The guide is a ceramic fishing rod eyelet which is glued into the tether line slot in the body.

front wing
The rapid prototyped wing is attached to a supporting structure that slides onto the body which provides structural support to the front of the car. The wing tapers smaller to the trailing edge.

testing

There were many forms of testing used to determine the design of our current car. Through virtual wind tunnels, physical wind tunnels, track testing and many other forms of testing, we were able to design an effective, aesthetic and aerodynamic design.

stopping material testing

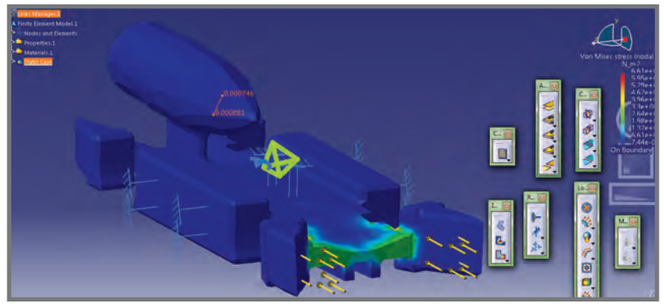
While we were testing, the car broke multiple times during the testing due to the high density of the material used to stop the car. To overcome this we have tested a variety of different materials to make sure the car stopped quickly without having any damage. Having satin as the material the car first hits provides a soft entry, while a double polar fleece brings the car to a complete stop.

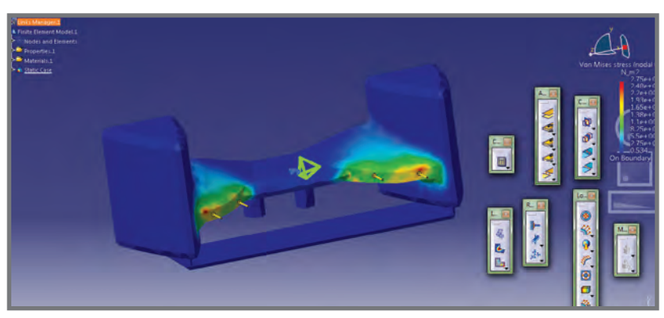
track testing

We used track testing to determine our choice of wheels and as an approximate measure of the times we could expect from the car. We needed to track test as we were interested in changing our current design which we have used since 2008. Testing of the new wheel we believed would be effective, proved that this was not as proficient as our old/current design. The track testing confirmed that the world championship car was capable of running faster times than our national final design.

finite element analysis

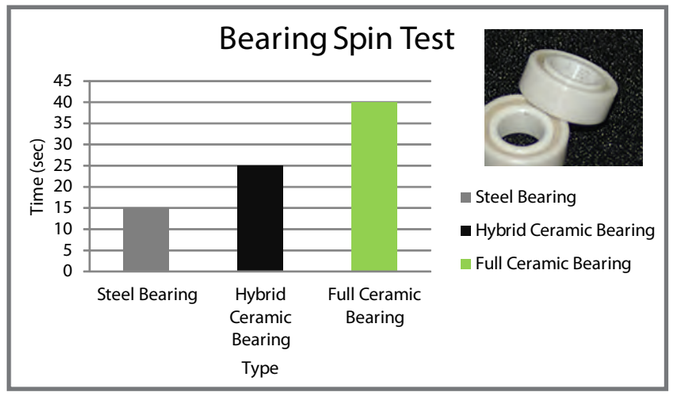
Using the inbuilt FEA function in CATIA, we were able to test the strength of the car and show where the weak spots would be. From this testing we determined that the front of the car where the front aerofoil attached would be the most vulnerable spot of the car, and the most likely to break. Researching materials, we came across cellulose dope, a wood strengthening lacquer, and discovered that this would enhance the strength of the car, reducing the risk of breakage.





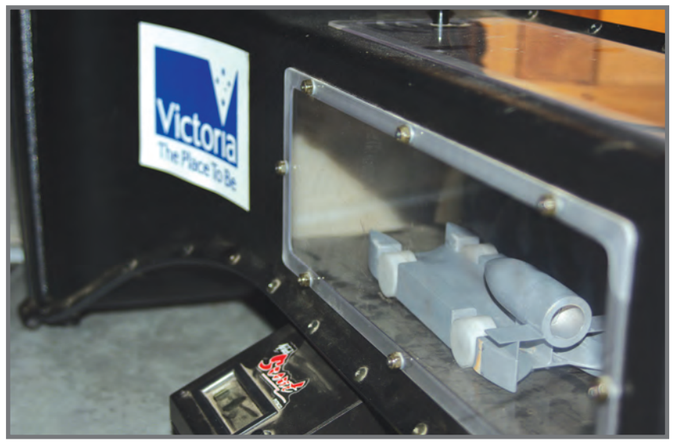
bearing testing

We tested our bearings and modified them to provide the least rolling resistance as possible. We achieved this by removing the seal of the bearing and cleaning the grease and lubricant out of them with acetone. We ended up choosing full ceramic bearings as these provide less friction than hybrid and steel bearings, and also produced faster car times. We also conducted spin tests on each bearing to see which spun the longest. This determines the bearing with the least rolling resistance. We were also able to compare the bearings with the accelerometer to see which bearing slowed down the least. The ceramic bearings ended up winning all tests which is why we have decided to run full ceramic ABEC 5 bearings.



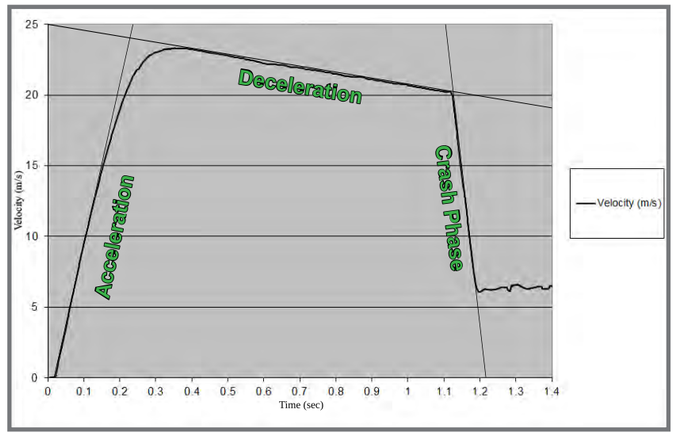
physical wind tunnel

The physical wind tunnel provided a more accurate reading in regards to the drag, we were able to reduce the drag from 19g to 17g over many months of testing. Having access to this allowed us to test the different models that we had machined and compare the differences in drag. We were able to determine an aesthetically pleasing yet aerodynamic design, and chose the design that was the lightest and had the least drag.



accelerometer

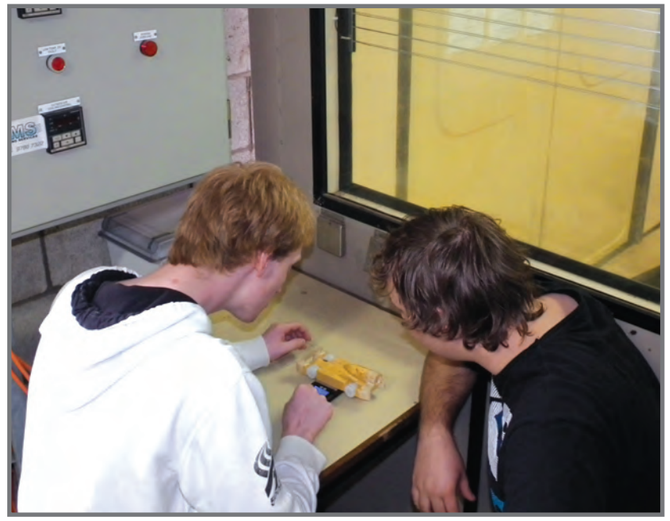
An accelerometer measures proper acceleration, which is acceleration relative to freefall and is the acceleration felt by people and objects. We were able to acquire an accelerometer from Vast Motion who specially make these accelerometers for hobby applications, although it was originally design for an F1 in Schools car. The VAST Motion F1 Puck Accelerometer was used to allow us to record the acceleration of our car so that we could then examine the data to see exactly what the car does as it shoots down the track. It is able to record at 1000 samples a second which gave us a very detailed insight into what the car is doing. From this data we found that the car reaches a top speed of 23m/s in just 0.3 seconds.



The small size of the accelerometer allows you to insert it into the canister hole, which also allows you to use it in nearly every car design. This helped us test our wheel configurations because the less rolling resistance the wheels have the less deceleration you will see in the data.

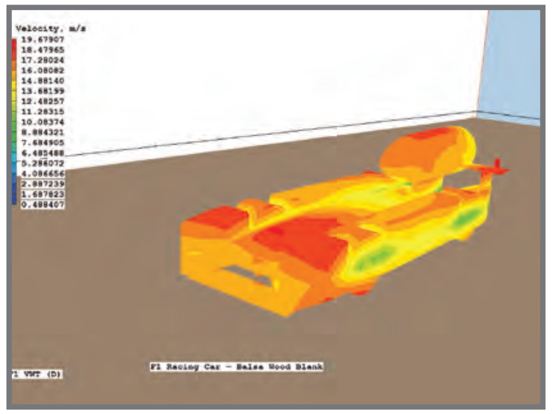
humidity chamber

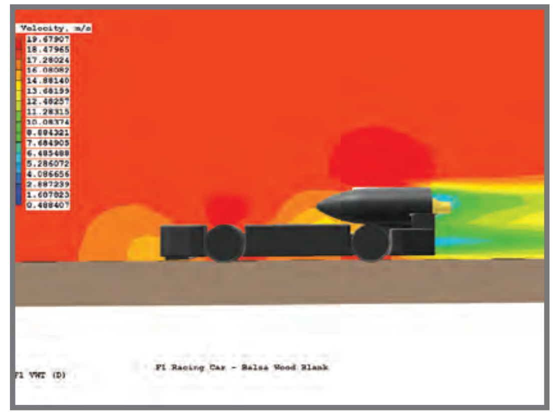
A humidity chamber at the University of Ballarat was used to determine what different humidity will do to the car. We increased the humidity to match the climate of Singapore and put the physical wind tunnel inside it so we could see how much drag was added to the car. We found that on average the cars had an extra 2 grams of drag at 90% humidity. We were able to determine that the more dense the air, the slower the car will go. We also left the car in the humidity chamber for 12 hours to see if the car would gain any weight due to humidity, and we found that the car increased in weight by 0.3 of a gram, a large amount of weight for this type of competition. We changed the design of the car to compensate for this and moved to make an aerodynamic design that will move through the thick air as smoothly as possible.

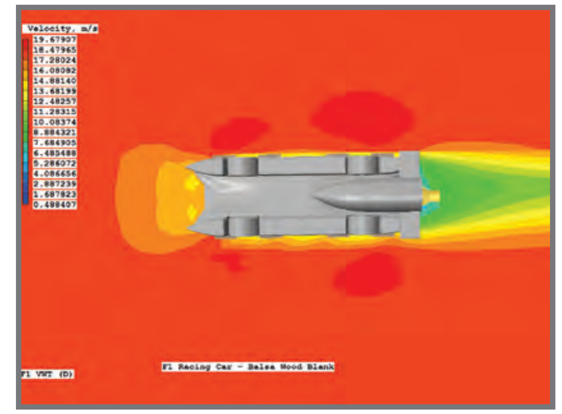


virtual wind tunnel

VWT was used extensively to test the design of our car, measuring the drag, lift and side pressure of the car at a speed of 20 metres per second. Using these results, we were able to reduce drag and lift to an absolute minimum. This was a simple yet effective method as we were able to test cars without spending many hours machining different designs. We wanted a design with virtually no lift or drag, so we could get the fastest design while staying within the limits of the rules.



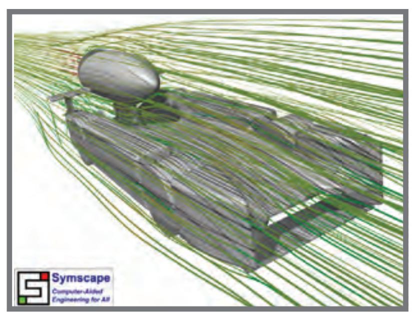


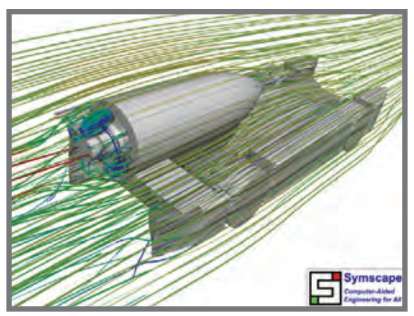


symscape

Symscape is an American company who specialises in CFD testing and were able to provide their services using a program called Caedium. This provided us with a greater amount of data because they were able to simulate the gas releasing from the canister and have the wheels rotating. This gave us more accurate results which allowed us to make the required modifications to the car. They offered to provide the services on the proviso that we were able to be published on their website. This was a simple yet effective way of also providing more information about the F1 in Schools challenge to a new audience.

streamlines

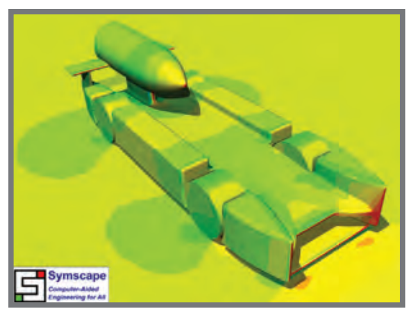


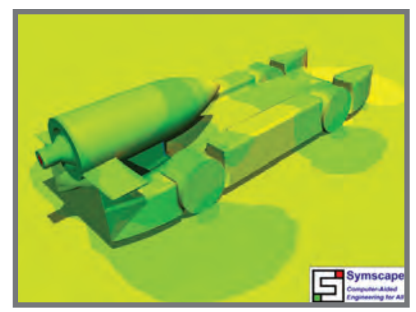


aerodynamic concepts

An initial idea we had was to measure our aerodynamics in another possible fashion. When viewing our results on a virtual wind tunnel, we realised that if air was water it would be spiralling as the car cuts through the air. Therefore this allowed us to "see" air and determine what the car would look like passing through air. We decided after this that a smoke tunnel would be the most efficient way to see how the air moves around the car in a physical dimension.

pressure

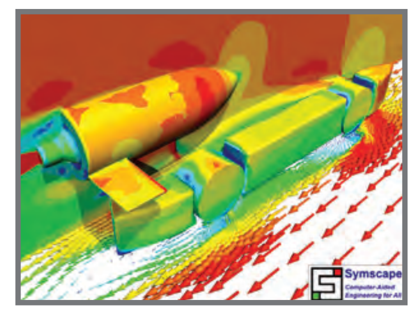


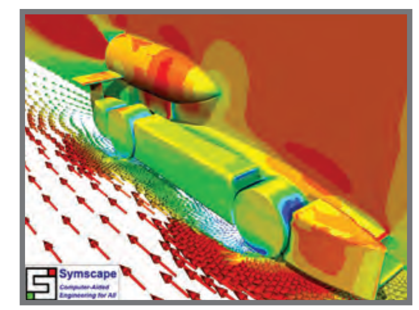


front aerofoil aerodynamics

The front aerofoil assembly is constructed of Rapid Prototyped plastic and is the first part of the car to meet the air mass. The flow field here is better than other parts of the car because the air here has been disturbed the least. The aerofoil is designed to guide the air as it moves toward the body and rear of the car. The turbulent air moving toward the rear of the car will impact the efficiency of the rear wing. Therefore the front aerofoil was created in a way that split the air and guided it in the smoothest motion possible. This reduced drag and increased speed, as well as reducing turbulent air towards the rear of the car.

velocity





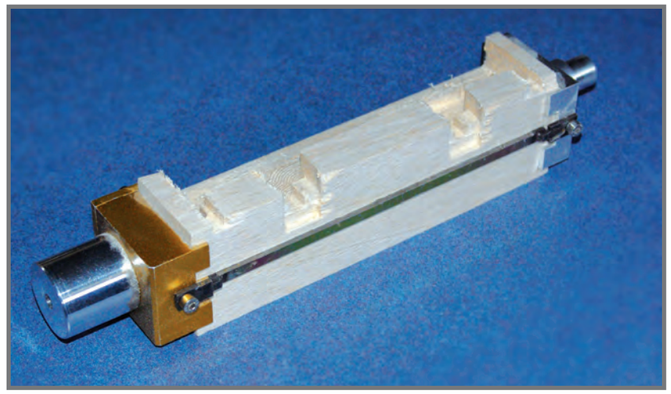
rear aerofoil aerodynamics

The rear aerofoil is the last section of the car that will break the airflow. This had to be designed in an aerodynamic shape, so we tapered the edge down to create a shape similar to that of a tear drop, the most aerodynamic shape possible. The design was created to reduce lift and provide support to the canister housing. This proved very effective as the car was strengthened and the aerodynamics improved dramatically, reducing the turbulent air behind the car and allowing a smoother path through the air.

car body

Due to the complexity of our car body we have had to machine our car from 12 sides, the 4 normal sides and then a further 8 sides in order to machine underneath the chamber housing. We achieved this by using the 4th axis fixture in our Denford router. This allowed us to rotate the car to any desired angle.

We had to alter the fixtures to allow us to machine the car body in the 4th axis fixture, and because we weren't able to use the spigot anymore, we had to drill a new hole in the front of the balsa blank. We also found that the balsa blank bowed when secured tightly in the 4th axis fixture, so we made a brace that fits in the tether slot of the balsa blank. This allowed us to grip the blank tightly in the fixture without it bending.



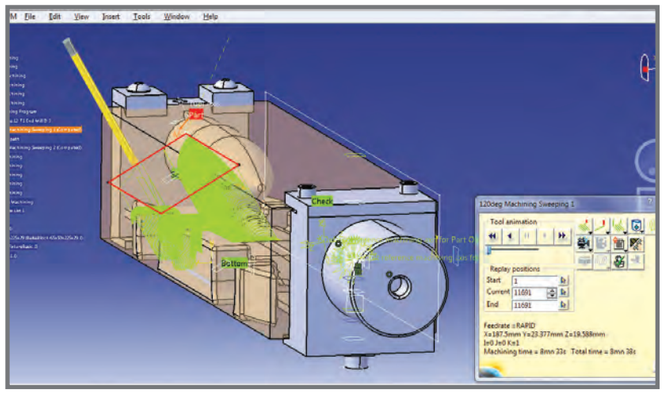
To be able to fit the 3mm ball nose cutter underneath the canister housing we had to raise the canister hole up to the maximum height according to the 2010 rules and regulations. This caused the hole in the official balsa blanks to be too low. To get around this problem we drilled a new hole into the front of the official balsa blank. To comply with the rule 1a., which states that your F1 car must be manufactured on a CNC machine, we had to drill the new hole with our Denford router. To do this we altered the Denford router so that it machined horizontally rather than vertically. This allowed us to achieve the required distance to be able to drill the new hole.

machining process

To ensure we got the best possible surface finish on the car body after machining it, we used a 3mm ball nose cutter for the whole car. To do this we had to use a roughing operation to firstly remove unnecessary material in thin layers in order to reduce stress on the cutter. We also added a 1.5mm offset to stop the associated chipping from affecting the final quality of the car body.

To eliminate scalloping on the vertical faces we ran a Z-Level operation before the sweeping operations. This gave us a much better surface finish in the wheel arches.

We then ran 2 sweeping operations with a 0.2mm step over. One ran at a 45 degree angle and the other at a 315 degree angle which made the tool paths criss cross to minimise the scalloping.

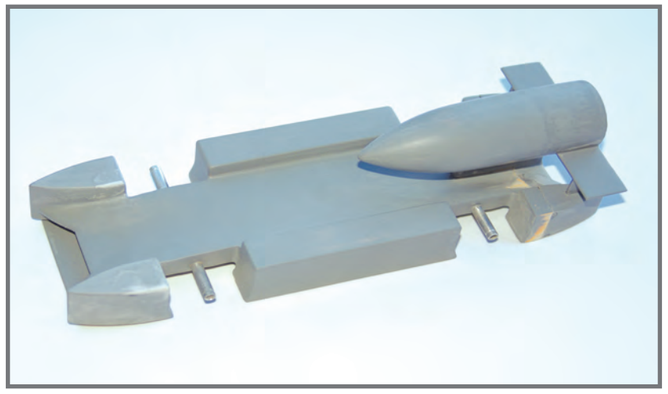


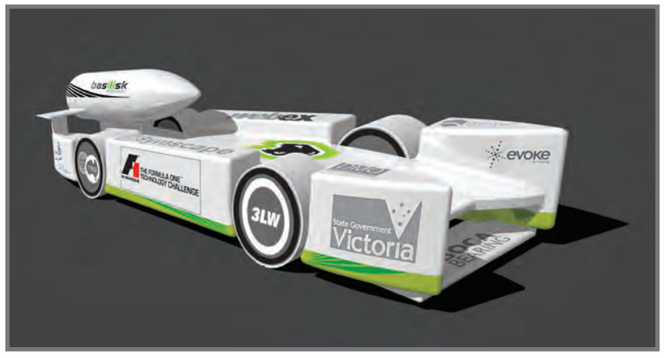
surface finish

Balsa Wood is very porous. To paint it without first sealing the surface causes the wood to keep soaking up the paint, which causes the grain in the wood keep showing up. To fix this problem, we first applied 2 coats of cellulose dope which seals and tightens the balsa wood and also adds strength.

We then gave the car bodies a light sand before applying a coat of primer filler, which we then sanded almost all the way back to balsa. A final coat of primer filler was applied, which we lightly sanded with 800 grit sand paper to create a smooth surface for the top coats of paint.

Two coats of white paint were then applied to give the car body its colour. Once the paint had dried we then applied our decals.





aerofoils

The use of Rapid prototyping has helped us produce our car to such a high quality and comply with the rules and regulations at the same time.

We have produced our aerofoils, axle supports and wheel caps from ABS using the Rapid Prototyping process, this allowed us to have thinner parts due to the added strength from the plastic. It also allowed us to easily test different aerofoil configurations to determine the most aerodynamic one.

The rear aerofoil support structure also doubled up as a support to the canister housing which was required due to the small amount of material in the canister housing support.

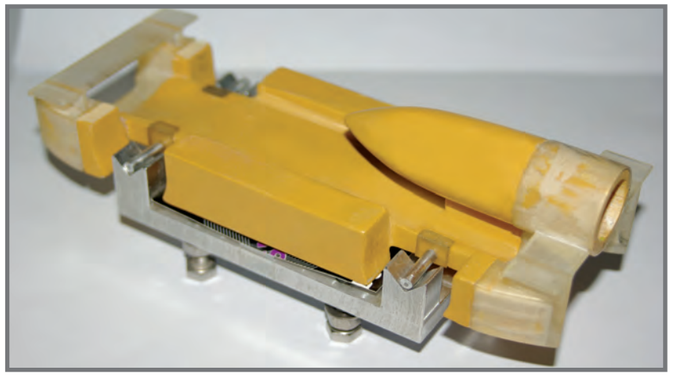
wheels

Albins Off Road Gear were kind enough to produce our wheels for us using their state of the art CNC lathes, we have tried to produce our own wheels on an old lathe that one of our fathers had but we were not able to get them accurate enough due to the lathe being worn. This helped us with getting the wheels balanced, as they were almost perfect when we received them.

wheel balancer

Our wheel balancer was manufactured to ensure that our wheels were as precise as possible due to the fact that our wheels rotate at up to 20,000rpm so any imperfection will cause them to vibrate.

The wheel balancer is made up of 2 magnets either side of an axle with the axle only touching one of the magnets, this minimises the friction between the axle and the bearing giving us more accuracy when balancing our wheels.

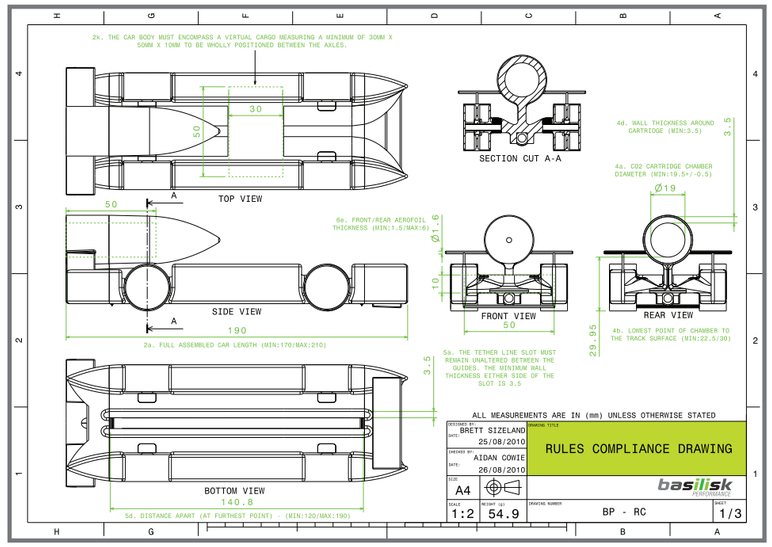


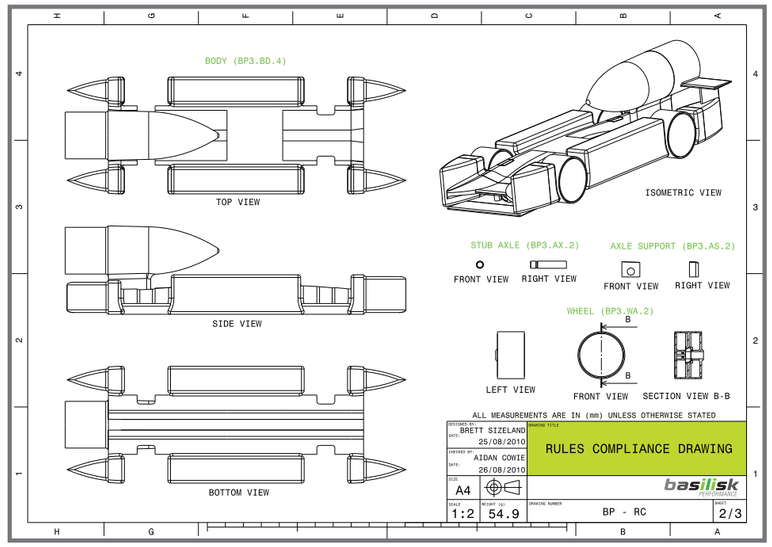
chassis jig

In the past we have had problems with getting our axles straight in the car, so we have produced a chassis jig to make sure our axles are straight. We use it when we glue our axle supports into the car body, once we have applied the glue we put it in the chassis jig and sit the weight onto the axles to hold them in place. This ensured that our wheels were straight and didn't have any toe-in, toe-out or camber.

The technical drawings were generated using the drafting tools in CATIA V5 R19. We have not only created the rules compliance drawings but also created Geometric Dimensioning and Tolerancing drawings to give further details on the car and ensure greater accuracy when producing the cars. We were able to use these drawings when it came to the manufacturing of the car and sanding and painting to ensure we got it to the right dimensions.

rules compliance drawings





geometric dimensioning and tolerancing drawings