FORMULA 1 AUSTRALIAN GRAND PRIX 2021

STEM HUB

STEMHUB.COM.AU

BAE SYSTEMS POWERBOAT CHALLENGE

VICTORIA State Government

A TRANSFORMATIVE EDUCATIONAL EXPERIENCE

The Australian Grand Prix, BAE Systems Australia and STEM Hub present the BAE Systems Australia Powerboat Challenge. Students in grades 4 to 10 will use science, technology, engineering (STEM) disciplines in F1® racing to design a racing powerboat.

The Challenge aims to encourage young minds to think like engineers and scientists by engaging them in STEM skills, inspiring innovation, self-confidence, communication, and teamwork. The Challenge will also develop students' interest in STEM subjects as a means of expanding their curiosity and willingness to explore, ask questions about and speculate on the changing world in which they live.

WHAT WILL STUDENTS LEARN?

1. An understanding of the vision that science provides in everyday life and the nature of scientific inquiry, and the ability to use a range of scientific inquiry methods, including questioning, planning, evaluating concepts, and drawing critical, evidence-based conclusions.

2. To communicate scientific concepts and findings to a range of audiences, to justify ideas based on evidence, and to evaluate and debate scientific arguments and claims.

3. To solve problems and make informed, evidence-based decisions about current and future applications of science.

THE KEY CONCEPTS

This Challenge supports key aspects of the Science Inquiry Skills strand and contributes to developing students' appreciation of Science, Technology, Engineering and Mathematics.

Form and function

Students will explore the application of varying materials in different forms and how that form and the physical properties of the material influence the function.

Scale and measurement

Students will be challenged to work with magnitudes and scales that are outside their everyday experience such as what makes certain materials stronger or weaker. As students gain an understanding of relative sizes and rates of change of different magnitudes, they can conceptualise events and phenomena at a wider range of scales.

Matter and energy

Many aspects of science involve identifying, describing and measuring energy and/or matter. Students are introduced to the forces related to matter and to energy transfer and transformation. They use these understandings to justify their use of specific materials and solutions to meet the Challenge brief.

Systems

Science and Engineering involves systems thinking, modelling and analysis. Students will be utilising concepts of involving forces acting in opposing directions and that for a physical system to be in a steady state, these factors need to be in a state of balance or equilibrium.

Scientific investigations

Scientific investigations are activities in which ideas, predictions or hypotheses are tested and conclusions are drawn in response to a question or problem. Investigations can involve a range of activities, including experimental testing, field work, locating and using information sources, conducting surveys, and using modelling and simulations. Students will be required to use scientific investigations to justify their solutions to the Challenge.

Information Communication Technologies and Science

Information Communication Technologies (ICT) are powerful tools that can support student learning. It is also important that students know how to use these ICT efficiently and responsibly, as well as learning how to protect themselves and secure their data. This Challenge will require that students present their findings to a panel of judges and other event participants using varying multimedia tools.

THE CHALLENGE

1. Students are asked to address the following question:

   "If you were asked to design a winning powerboat what STEM principles from F1® racing would you use and why?"

2. Secondary school students are asked to address above question with the addition of the below question:

   "What design aspects would you change if you wanted to maximise the sustainability of your powerboat? Would it have a negative or positive impact on the performance of the powerboat? "

3. Create a slide-based presentation using a maximum of 10 slides.
4. Slide-based presentation should include (but is not limited to) the following:

- The team that was involved in the Challenge.
- What F1® racing and STEM principles the team considered when designing the powerboat? And why?

CHALLENGE DETAILS

Round 1: Selection

1. Schools are asked to address the Challenge question by creating a slide-based presentation deck (maximum 10 slides) using any format.
2. Schools may submit multiple applications.
3. Presentations must be submitted via the Australian Grand Prix website found at grandprix.com.au/event/driving-learning by 5pm on **Date to be determined.**
4. Schools will be notified of their success no later than 5pm **Date to be determined.**
5. Ten teams (5 Primary Schools and 5 High Schools) will be selected to orally present their solutions on **Date to be determined.**

Round 1: Resources

1. Teachers are advised to use the scoring rubric found on the last page, appendix A.
2. To assist students with their powerboat designs students are directed to the educational content in the succeeding pages.
3. Each team should consist of 2 to 5 school students.
4. Teams must have 1 team supervisor (teacher or parent).

CHALLENGE DETAILS

Round 2: Presentation

1. Teams that have successfully reached Round 2 will be required to present their work to a panel of judges within the industry.
2. Teams will have 3-minute (timed) to present their designs and ideas, followed by 1-minute panel Q&A.
3. Presentations will be undertaken to a panel of industry judges from BAE Systems Australia.

The selected finalists will present on the following dates:

   a. Primary School: **Date to be determined**
   b. High School: **Date to be determined**

4. To assist teachers with getting their teams ready for oral presentations a member of the STEM Hub will be in contact once finalists are selected.

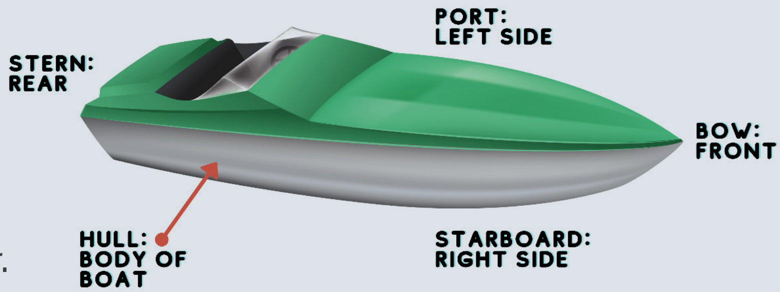
STEM RESOURCES: THE SCIENCE OF RACING

What do F1® racing and powerboat racing have in common? You'd be surprised to learn that they have a few things. Both F1® cars and marine vessels endure physical forces that race teams need to consider when designing their race vehicles. The following content outlines some of the things that engineers, and scientists focus on.

1. Basics of Marine Vessels

a. Parts of a Boat

When designing and building a powerboat, especially a racing boat, it's important to know the basic principles governing how marine vessels float and move through water.



b. Buoyancy and Archimedes' Principle

How do objects float? To answer this question, Archimedes of Syracuse, a Greek astronomer, scientist and mathematician (ca. 287–212 B.C.) came up with the Archimedes' Principle.

The principle states:

"Buoyant force on an object in a fluid equals the weight of the fluid it displaces".

In equation form this is written as $F_B = W_{fl} = pgV$

F_B is the **Buoyant Force**

W_{fl} is the **weight of the fluid displaced by the object**

p is the **density** of the fluid

g is **acceleration due to gravity**

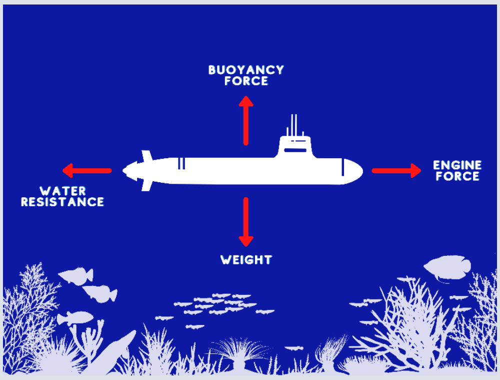
V the **volume of displaced fluid**. The unit of **Buoyancy Force** is **Newton (N)**.

Therefore, a **buoyant force** is an *upward force* that opposes the *downward force* of **gravity.**

- An object will **SINK** if the gravitational force acting on the object is *greater* than the buoyant force.
- An object will **FLOAT** if the gravitational force acting on the object is *equal* to the buoyant force.
- An object with **RISE** if the gravitational force acting on it is *less than* the buoyant force.

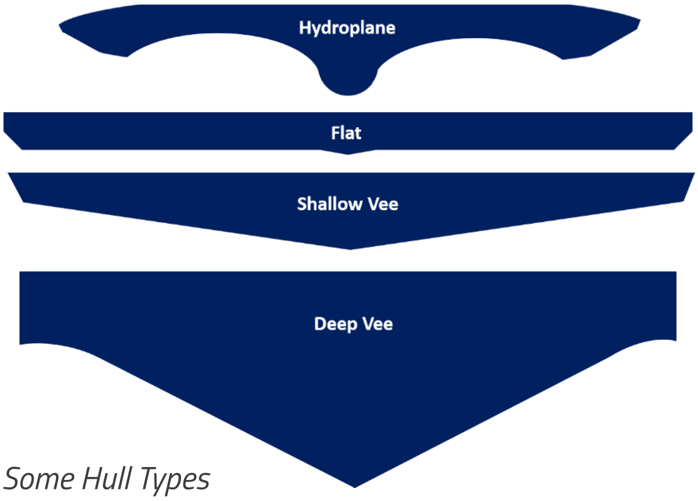
c. Water Resistance (Drag)

Just like an F1® racing car, boats are also under the influence of **drag (air friction)**. In the marine environment vessels are subjected to an additional friction referred to as **water resistance**. Engineers must think about ways of reducing this to ensure their racing powerboats are faster than their competitors. Regardless of the type of marine vessel - sailboats, barges, ocean liners or powerboats - all marine vessels are affected by **drag**.



When an object is immersed in a fluid stream, **friction** and **waves** occur. **Drag** is a **force** acting opposite to the relative motion of any moving object. Therefore, boat designers must take into consideration drag because it takes power to overcome the drag force. The greater the speed, the greater the drag.

Some ways that drag can be reduced is by varying the shape of a boat's hull; the shape variation affects the ratio between underwater and above water surfaces, and the shape of the waves generated. Here are some examples of boat hulls but you should do your own research. Have a look at **runabout** and **hydroplane hull** types!



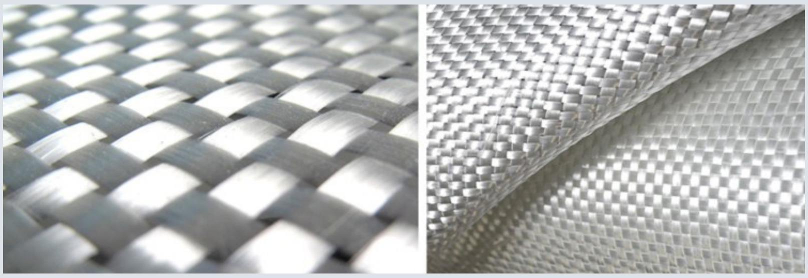
Some Hull Types

Challenge Design Hint!

When designing your winning powerboats think about which hull shape you'd use to produce the least water resistance.

d. Materials Used for Boat Building

To build a boat there are so many different materials that boat builders could use. Traditionally boats were built using wood but in recent years the shift in boatbuilding has been to mostly fibreglass which is a fibre material set in resin. For many years' fiberglass construction has been from cloth, mat, roving and resins but more recently it's included more advanced materials like Kevlar and Carbon Fibre.



Here is an example of fibreglass cloth.

Boat designers need to take into consideration ways to make boats lighter without the loss of strength which means they'll be more fuel efficient.

F1® MEETS BOAT RACING

Did you know that Formula E has announced the formation of an all-electric powerboat league called the E1 World Electric Powerboat Series to officially kick off in 2022? Here's a sneak peak of a concept powerboat. Why do you think their hull and keel are designed the way they are? To help you with your design for the Challenge have a look at this video: https://youtu.be/CTRAU-zRd8k

SINGLE PILOT POWERBOAT

Battery Capacity: 30kW/h
Charging Time: 30min
Boat Length: 4.8m
Max Speed: 60knots
Boat Mass: 380kg
Body: 100% Carbon Fibre
Boat Efficiency: 80% to 90%

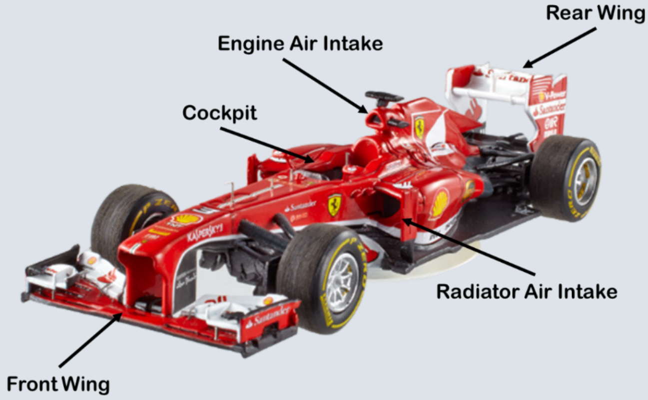
These powerboats will be racing in the worlds-first electric boat series called the E1! Up to 12 Teams will compete in races on seas, rivers and lakes around the world, to be the first ever E1 World Champion. Want to learn more go to www.e1series.com

F1® RACING

Just like racing powerboats, F1® racing cars have some pretty amazing science behind them that design teams must take into consideration when they're constructing their winning vehicles.

a. Parts of an F1® Racing Car

Wings on an F1® car work the opposite way to the wings on an aeroplane. Aeroplane wings create lift which causes flight but in an F1® car they produce downforce which makes the car stick to the road. The wings on an F1® car are adjustable so they can move the wings to different angles to help with aerodynamics.



The wings around the keel of the powerboat, like the wings of and aeroplane, create an upward lift that allows the hull of the powerboat to elevate above the water and reduce drag to a minimum.

b. Aerodynamics

Aerodynamics is the science that studies objects moving through air especially how air flows around objects like cars and aeroplanes.

When engineers study aerodynamics to improve the speed and safety of race cars they have 2 main concerns:

1. Creating downforce, which helps push the car's tyres onto the track, and improves cornering performance, and
2. Minimising drag, which can slow the car down (and is a result of air resistance).

DID YOU KNOW?

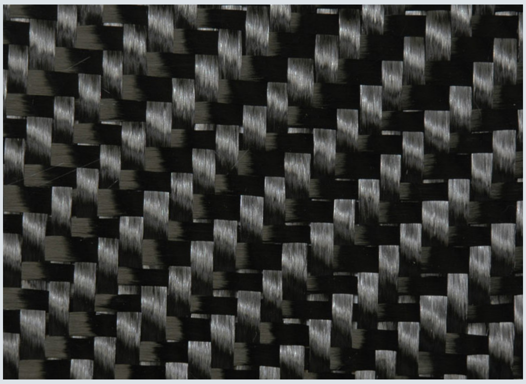
- Without aerodynamic downforce, racing cars would flip over and crash once they go faster than 160km/h. F1® cars race at over 300km/h.
- Race car wings can produce amazing aerodynamic down force. When a car is traveling over 160km/h it can generate enough downforce to hold itself to the ceiling and drive upside down. Now that's awesome!

c. Racing Materials

F1® cars are put under huge physical strain during a race so the cars need to be made using the most cutting-edge materials. Race cars are now even lighter and faster than ever before, but they also must be super strong and safe. Special materials are used to build the F1® cars that keep them light, strong and safe. One of these materials is called Carbon Fibre. Most of the chassis, monocoque (the body of the F1® race car), suspension, wings and engine covers are made with carbon fibre.

This special material has 4 advantages over other kinds of material for racing car construction:

- It is lightweight.
- It is extremely strong.
- It is super stiff.
- It can be easily moulded into all kinds of shapes.

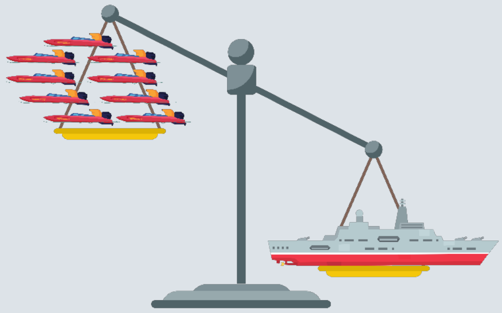


WANT A CAREER IN THE MARINE INDUSTRY? HOW ABOUT SHIPBUILDING?

Australia is currently developing one of the largest naval shipbuilding programs in the world: The Hunter-Class anti-submarine frigate program.

Just like powerboats and F1® racing cars, these frigates are cutting–edge technology, designed using state-of-the-art digital tools and able to fulfil very complex missions in support of Royal Australian Navy (RAN) operations. Just like powerboats, Hunter-Class frigates are designed to operate in the ocean but there are some noteworthy differences:

1. A Hunter-Class frigate is predominantly built out of steel, instead of carbon fibre.
2. A Hunter-Class Frigate is over 30 times longer than a E1 Powerboat.
3. A Hunter-Class frigate displaces 8800 tonnes (full load) which is the same as 20,000 E1 powerboats put together.



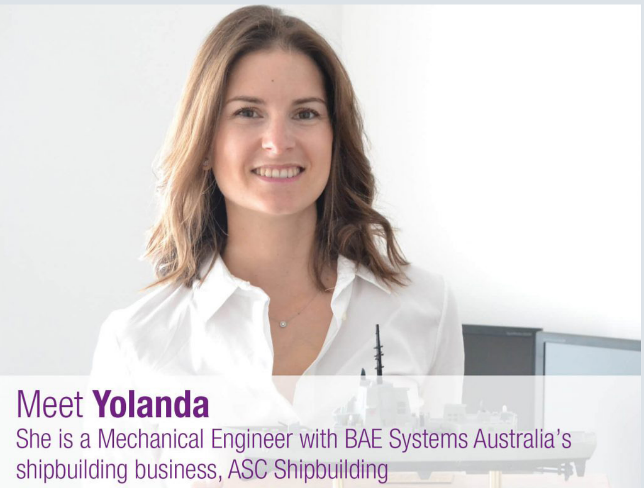
4. A Hunter-Class frigate is operated by a crew that has over 200 times the crew of an E1 powerboat.
5. A Hunter-Class Frigate's top speed is only 27+ knots, approximately half that of an E1 Powerboat whose top speed is 60+ knots.

BAE Systems Maritime Australia have embarked on an exciting program to design and build nine Hunter-Class anti-submarine frigates for the Royal Australian Navy (RAN). They're also transforming the shipbuilding industry by creating a digital shipyard for Adelaide with 3D experiences, augmented reality, automation, cyber-physical systems, smart factories, and robotics. Here's a sneak peak at the digital shipyard:

WORKING AT BAE SYSTEMS MARITIME AUSTRALIA

BAE Systems Maritime Australia are looking for young Australians to join them in this technological challenge. They have 1,000 apprenticeships and graduate roles in engineering, steel works, mechanical, electrical and technical trades and other jobs to fill. Find out what the apprentices and graduates have to say.

Meet **Melissa Weston** and **Nicola Higgins**
Melissa is a Mechanical Engineer with ASC Pty Ltd and Nicola is studying for a Bachelor of Engineering (Mechanical)



Meet **Yolanda**
She is a Mechanical Engineer with BAE Systems Australia's shipbuilding business, ASC Shipbuilding

Meet **Nicola**
She is a Principal Engineer on the Hunter Class Frigate Program with BAE Systems Australia's shipbuilding business, ASC Shipbuilding

AN INTERVIEW WITH VALENTIN ZARKHIN BAE SYSTEMS' AUSTRALIA MECHANICAL ENGINEER

1. **What's your role?**
   I work as an engineer supporting the Royal Australian Navy with resolving issues with their Hobart-Class destroyers.

2. **What kind of things do you do day to day?**
   Go on-board the ships and assist sailors with identifying and ultimately solving issues they are having. On any given day I work with a large number of people in different professions, including electricians, fitters, sheet metal workers, technicians, project managers as well as contract managers, warehouse staff and safety supervisors.

3. **What did you study and what was your career pathway?**
   I studied mechanical engineering at university, then I was employed as a graduate engineer at BAE Systems Maritime Australia where I worked for 6 years in the mechanical and structural departments during the build of the Hobart Class destroyer vessels. I then spent a year working in maintenance on the Collins Class submarines before taking my current role supporting the destroyers in service with the Navy.

4. **What did you want to be when you were younger?**
   I wanted to be an astronaut.

5. **Any advice for students wanting to work in Shipbuilding?**
   Like most engineering professions, shipbuilding is a very complex industry and requires an enormous amount of people with different skills to make it happen. While it is important to have a good knowledge of engineering principles, it is just as important to have good communication skills so that you can understand everyone's point of view and get a good idea of the best way to solve the many problems you will face.

APPENDIX A

Scoring Rubric

Enter School Name Here	**Score**				
	Very Weak or Missing	**Weak**	**Ok**	**Good**	**Excellent**
	1	**2**	**3**	**4**	**5**

Please enter a score for each category below

Content	**Score**
Originality of idea	
Creative presentation deck	
Concise information	
Content Total	**/15**

Alignment with Challenge and Science	**Score**
Presentation addresses the problem	
Challenge solution aligns with science	
Alignment with Challenge and Science Total	**/10**

Grand Total	**/25**

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