JAMES CAMERON

CHALLENGING THE DEEP

Teacher Resources

MUSEUM

AUSTRALIAN NATIONAL MARITIME MUSEUM

'James Cameron - Challenging the Deep', created and produced by the USA Programs of the Australian National Maritime Museum in association with Avatar Alliance Foundation, supported by the USA Bicentennial Gift Fund.

Education Resources

My problem is I'm curious and I need to go see for myself. I've seen some pretty astonishing things in the depths, things that fill your soul with wonder.

James Cameron

ABOUT THE EXHIBITION

James Cameron – Challenging the Deep traces the life-long dream of filmmaker James Cameron to explore the deep ocean. This fascinating journey takes us from his childhood love of science and art, through some of his most noted films and on to his achievements in the science and technology of undersea exploration – all the way to the Mariana Trench, the deepest place on the planet. At the forefront is the development and voyage of his submersible craft *Deepsea Challenger*, which he designed and then built in Sydney, Australia.

The exhibition uses cinema-scale projections, artefacts, plans, models, specimens and original movie props and costumes to take us on a unique journey that gives us an insight not only into Cameron's dedication, skill and spirit of exploration, but also into the fragile and fascinating world of earth's oceans. Explore the dark and mysterious abyss, visit the wreck of RMS *Titanic*, uncover new evidence about the sinking of the WWII German battleship *Bismark*, see fascinating specimens from the deep ocean, learn how *Deepsea Challenger* was designed and built to withstand water pressure of 1.2 tonnes per square centimetre, and meet the expert team involved on its journey to the deep.

There are four subthemes to investigate: **PIONEER**, **INNOVATOR**, **CATALYST**, **EXPLORER** and an **INTRODUCTION** section. Each subtheme examines a particular part of the story and features a large scale projection with real footage and interviews with key participants, as well as artefacts, personal items, information and things to do and discover. The exhibition itself is dimly lit to reflect the atmosphere of a journey to the deep, while inventive synchronised lighting effects showcase the areas you will visit. There is no set direction – students can visit the subthemes in any order as each one offers a unique and engaging experience.

We hope you enjoy your visit and are inspired by the dedication, commitment and curiosity of those who embarked on these journeys.

Image top: Mark Thiessen Nat Geo Creative

CURRICULUM INFORMATION

As the exhibition is travelling to several countries, specific syllabus references will vary. The following are broad curriculum areas with suggested syllabus references relevant to the exhibition and programs. The exhibition is suitable for school audiences of Grade 3 to Grade 12, although younger students can certainly engage with the material on a number of levels.

Please note that the exhibition is reasonably dimly lit to create a sense of immersion and to accommodate the cinema-style projections. Almost like going to the movies! It relies on lighting to illuminate the displays of artefacts and other material which is synchronised with the films and accompanying sound effects. Teachers may like to discuss this with some students beforehand.

Science & Technology

- Ocean ecosystems
- Species adaptation
- Buoyancy and forces
- Oceanography
- Innovation in technology & design
- Built environment systems
- Scientific collaboration

English

- Film studies
- Appreciating & interpreting texts
- Compopsing texts for purpose
- Analysing digital texts
- Language, form & structure

JAMES CAMERON
CHALLENGING THE DEEP
CURRICULUM OVERVIEW

Geography

- Ocean environments & forms
- Human interaction with the ocean
- Oceanography
- Environmental change & management
- Mapping & charting

History

- How historians & archaelogists investigate the past
- Contestability in investiating the past
- Representation & commemoration of the past
- Using evidence & sources
- How people lived in past times

A visit to the exhibition can be undertaken as part of a specific subject area or as part of an integrated curriculum approach. It could also be useful in subjects such:

Visual Arts: costumes, sketches, set design, videography

Personal Development: setting goals, personal commitment, team work

Mathematics: measurement, equations & calculations (number), scale

General capabilities: Critical & Creative thinking, literacy & numeracy, ethical understanding

Teachers should use the resources, activities and programs as a starting point and implement differentiation strategies suitable for their students. The activities target a particular curriculum area but often relate to others, so teachers can use the same activity for different subject areas.
A visit to the exhibition will provide specific and connected examples of syllabus points in both content and skills.

Introduction

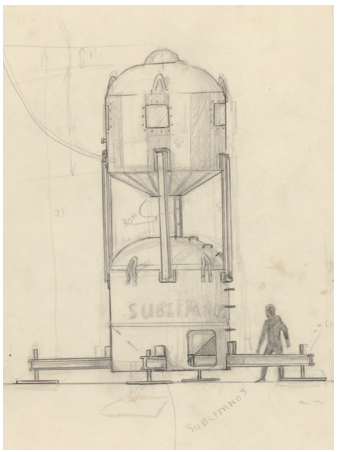
I was in love with the ocean before we ever met. It was watching all those great underwater explorers on TV in the 60s that got me excited about this alien world that was right here on earth, that was as rich and exotic as anything I could imagine myself.

James Cameron

At school in Canada James Cameron was interested in science, maths and art, and developed a fascination about exploring the deep oceans, particularly the story of the ill-fated *Titanic*. When he was 14 years old he saw Canadian physician-scientist Dr Joe McInnis' underwater habitat *Sublimnos* displayed outside the Royal Ontario Museum in 1967. It inspired him to design and build his own version of a bathysphere using his Erector Set, a pickle jar and tin can. He called it Sealab 3 and tested it in Chippawa Creek... and it worked!

Later in high school he became President of the Science Club which consisted of himself and one other student then later found others interested in similar things. He always had a vivid curiosity and wanted to explore what interested him. When his family moved to Los Angeles in 1971, he was not only close to the ocean but also to Hollywood where he set his sights on film making, a career that would combine his artistry with scientific curiosity and stimulate his spirit of deep-sea adventure.

Over the next five decades Cameron explored and revealed the mysteries of the deep oceans on the big screen and as leader of eight major expeditions that shone light into the least-known places on Earth.



Cameron's sketch of *Sublimnos*. Courtesy James Cameron.

Dr Joe MacInnis' *Sublimnos* outside the Royal Ontario Museum. Courtesy Dr Joe MacInnis.

Image top: James Cameron with *Sealab 3*. Courtesy James Cameron.

MAKING HISTORY – JOURNEYS TO CHALLENGER DEEP

1873-76

HMS *Challenger*

The steam assisted HMS *Challenger* undertook the first global marine research expedition. Its mission was to plumb, sample and map the world's oceans. With 243 people on board it covered 127,580 km (approximately 79,275 miles). Near the Mariana Islands in March 1875 the expedition discovered the deepest point of its survey, now named the Challenger Deep.

William Evans Hoyle, *Octopus Marmoratus*, from *The Voyage of HMS Challenger*.

1960

Trieste

The first piloted dive to Challenger Deep was by US Navy Lieutenant Don Walsh and Jacques Piccard on Project Nekton aboard the vessel *Trieste*. After descending for 4 hours and 47 minutes they landed at a depth of 10,916m (approximately 35,813 feet). Petroleum was used in the float chamber because it was less dense than seawater and did not compress under the huge pressure. A Rolex watch strapped to the outside of the *Trieste* became famous for surviving the experience!

Walsh and Piccard inside the bathyscaphe *Trieste*. NOAA Ship Collection ship3224

2012

Deepsea Challenger

James Cameron became the third person and the first solo pilot to touch down on the seabed of Challenger Deep at 10,898.4 metres deep (approximately 35,754.6 feet) in the revolutionary *Deepsea Challenger*. Sediment collected there by Cameron contained more than 20,000 microbes. James Cameron also took a Rolex watch on his voyage to pay tribute to the pioneering *Trieste* crew. This watch also survived!

Mark Thiessen Nat Geo Creative

Pioneer

When I chose a career as an adult it was film making. And of course the stories that I chose to tell were science-fiction stories. So I made the movie called 'The Abyss'. At the core of it is this idea of going deeper and seeing what's down there ...

James Cameron

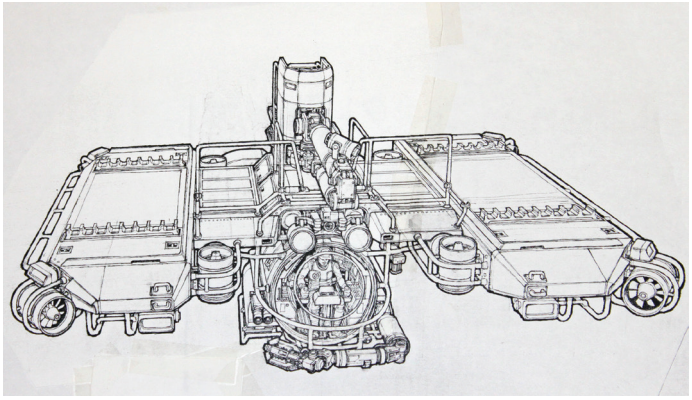
***Pioneer** - A person who is one of the first people to do something* Cambridge dictionary

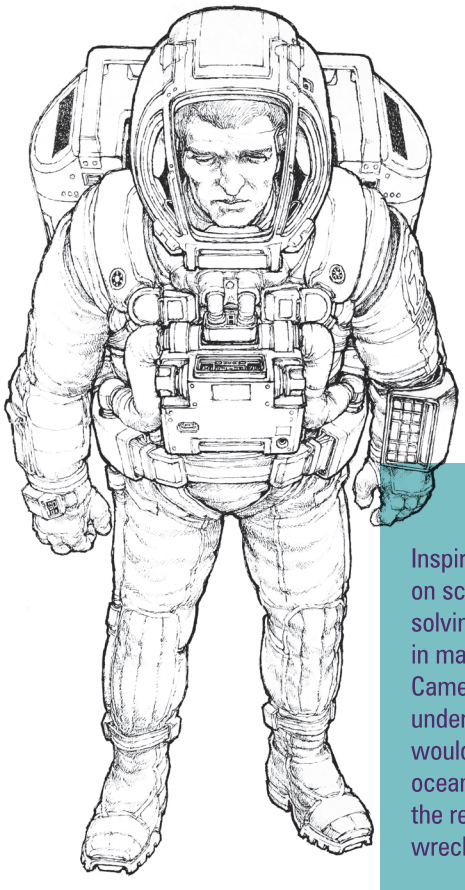
In his 1989 science-fiction movie classic '*The Abyss*', Cameron achieves a new level of authenticity for filmgoers by photographing actors on an underwater sound stage complete with sets, lights and sound – something never attempted before. Cameron builds the set in and then fills a giant concrete containment tank of an unfinished nuclear power plant in South Carolina with water. And so begins one of the most exacting, innovative, gruelling and dangerous film shoots in history.

More like an ocean expedition than a film production '*The Abyss*' presented logistical and engineering hurdles that were solved by providing new ways to light, record sound, communicate and film underwater (technologies that Cameron later refines and perfects to film his deep ocean expeditions).

Cameron and his brother Mike invented and patented the Sea Wasp for the film, a self-propelled camera 'dolly' that could zip a camera and cameraman around to film long tracking shots. New helmets were designed with large visors, internal lighting, microphones and side-mounted air regulators so that actors' faces could be seen and dialogue recorded. A star on his helmet was used to identify director James Cameron underwater and his helmet was wired so he could speak to all the cast and crew members.

The set was lit with 1200-watt metal halide SeaPar lamps and two ROVs called 'Big Geek' and 'Little Geek' were minor stars of the movie. Scale models were flown on wires and filmed in heavy smoke to create the illusion of being underwater. Tiny on-board film projectors shone pre-recorded images of actors into the cockpit to complete the illusion. The alien ship contained fibre-optic, neon and freeform hand blown glass plasma bottles to produce spectacular light effects.





Inspired by the hands-on science, problem solving and challenges in making *The Abyss*, Cameron's next underwater adventure would be his first deep ocean expedition … to the recently discovered wreck of RMS *Titanic*.

Image top: Courtesy James Cameron.

Sketches: Ron Cobb.
Courtesy Ron Cobb.

PIONEER ACTIVITIES

Do you know what a director actually does on a movie? Use your research skills to find out!

Imagine you are making a science fiction movie. Design your own space-craft and build a macquette (scale model or rough draft).

Imagine you are filming in a difficult environment such as underwater, outer space, the top of a mountain, inside caves, in a jungle ...or anywhere else out of the ordinary. Design and sketch a piece of specialist equipment that would assist you as a director (like James Cameron's special helmet). Make a report on how it will work and make some annotated sketches.

If you were writing a science-fiction story for a film, what would it be about? Would it be funny, scary, thought-provoking, mysterious, adventurous or a mix of different things? Think about your story then write a one-page summary of what it would be about. Include setting and the main characters.

Did you know the first film special effects were made in the late 1800s? Research how special effects have evolved in film-making and make a timeline. Start with the work of early filmmakers Alfred Clarke and Georges Méliès.

Choose a movie that you like and do a report on the special effects the director used then do a class presentation. (You might even do it as a film that uses special effects!)

Build a simple model movie set, or find some costumes or props and set them up. Experiment with different lighting to create different moods – you can use filters, colours, shadows, bright or dull lights and so on.

Note how the light works on different surfaces! Now try it underwater, like in a fish tank. Light works differently underwater than in the air. What do you notice?

Sound and sound effects are very important in films. **Watch a non-speaking part of your favourite film without the sound.** Now try it with the sound. What difference does it make? Try writing out a description of the sounds, and how they affect the action in the film.

James and Mike Cameron invented the 'Sea Wasp' for *The Abyss*, which was a self-propelled camera that 'buzzed' around to get shots where the camera moves behind, in front or next to who or what is being filmed.

Look up some different camera angles used in movies then team up with some classmates and see if you can invent a piece of equipment that would get some really interesting angles for the audience to view the action.

Try making a short film (3- 5 minutes) where you use scale models that move. How will you organise the motion? Will you suspend them on wires, attach a little motor or remote control, move them manually by a concealed person...or use some other clever method?

Innovator

I'm an explorer at heart, a filmmaker by trade.

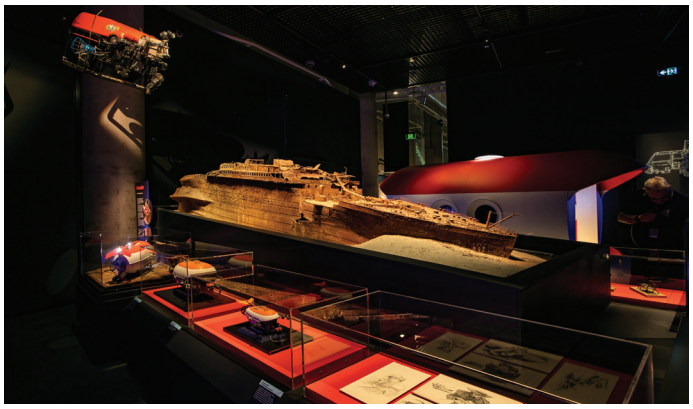
James Cameron

Innovator - Someone who introduces changes and new ideas Cambridge dictionary

The discovery of the wreck of RMS *Titanic* by Robert Ballard in 1985 and its exploration by the Woods Hole Oceanographic Institution's deep diving Human Occupied Vehicle 'Alvin' re-awakened Cameron's teenage fascination with the tragic story. Mounting an expedition to see *Titanic* with his own eyes became Cameron's rationale for writing a love story set on board the ill-fated liner and turning it into the 1997 movie blockbuster *Titanic*.

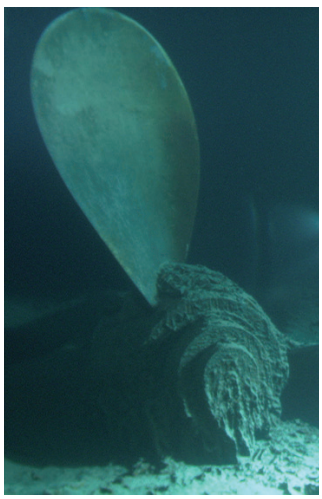
In September 1995 Cameron took the first of twelve dives in MIR submersible vessels launched from a Russian research vessel. They were fitted with unique externally-mounted 35mm film cameras that could survive the immense water pressure, and the custom-designed Remote Operated vehicle (ROV) 'Snoop dog' to explore the wreck close up. Footage from these dives was woven into the movie plot. The use of extremely high quality footage from the expedition added context and authenticity to Cameron's screen recreation of the doomed ocean liner and the night it sank on the 15th April, 1912.

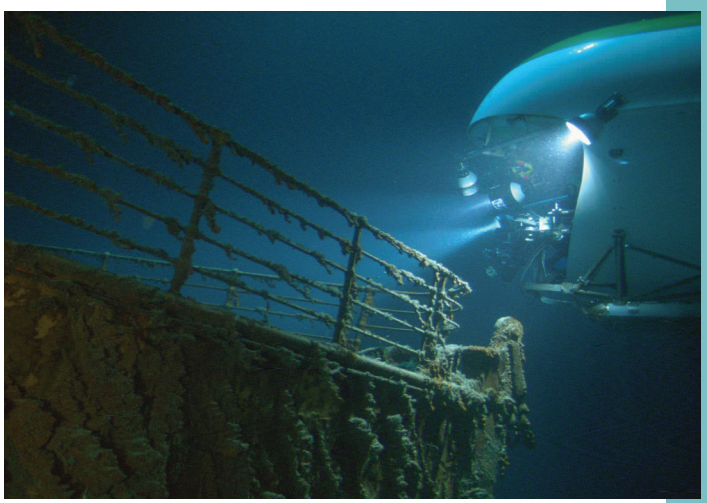
Driven by his curiosity to understand more about how and why RMS *Titanic* sank, Cameron mounted two further expeditions to the wreck, again using two Mir submersibles equipped with cameras and ROVs. He used a 1/20th scale model to precision plan each dive, meticulously 'storyboarding' every take ahead of time.



Over time innovations in ROV technology decreased their size and a fine 610m long fibre-optic tether invented by Mike Cameron let the robots go much further into the wreck. In 2005 innovative expedition technology achieved a world-first live sea-floor to surface video link.

The 'Ghosts of the Abyss' expedition in 2001 used miniaturised ROVs 'Elwood' and 'Jake', small enough to film inside the wreck for the first time and answer questions about the last moments of the ship. Returning in 2005 on the 'Last Mysteries of Titanic' expedition, even smaller ROVs penetrated deep inside the wreck to record unknown details of the opulent interior of the ocean liner and its catastrophic fate, while creating a detailed archaeological record and database.





Images: Courtesy James Cameron.

RMS *Titanic*

With the loss of more than 1500 passengers and crew the sinking of Titanic ranks among the worst maritime disasters in history. Adding to the intrigue was a lack of evidence and conflicting eye-witness accounts. Over the years the story of *Titanic* became the subject of speculation in the media.

James Cameron's expedition not only brought the wreck to the big screen, it also shed new light on its condition and how the ship had broken up and then collapsed on impact with the seafloor.

INNOVATOR ACTIVITIES

Look at the exhibition label 1 in the Appendix. James Cameron used 1:8 scale models when making space craft in *The Abyss* so they were 1/8 the size of what they would be in real life. His *Titanic* dive model was on a 1:20 scale.

Try making a scale model of something out of cardboard or balsa wood. Start with a plan of how big the real thing is then 'scale' it down or up in size. Work in pairs or threes if you like.

Now apply the maths calculations to something large at your school – measure or research the actual size and decide what size scale to use. **Write your own label about it.**

Investigate the latest technology in maritime (underwater) archaeology eg infra-red scans, ROVs and write a report.

Look at latest ROV image (see Appendix) and some of the footage. What additions/changes would you make for the next model? Discuss it with your classmates.

https://www.sea.museum/drone

Do you remember the Styrofoam cups in the exhibition? (see Appendix). **Write an explanation of why** we sometimes use ROVs and not a diver. Can you think of another reason besides water pressure?

Find an image of real objects from a particular place or sea/space craft and **try to build some miniatures** of things found there, for example, from a spaceship, an ancient civilisation monument, a 19th-century ship, or a modern submarine.

Look at the costumes from the film *Titanic*. How are they true to the time? How do they suggest the age and social class or the characters? **Design costumes for 2-3 people in your story above.** What will you have to take into account?

Have you ever really wanted to visit a place? Imagine you were making a film about it and **write a screenplay using real events** mixed with fictional people and their part in the story. Read about how to write a screenplay in our workshop notes.

Read exhibition label 2 in the Appendix to **see how modelling can help with theories.**

Mark on a map the coordinates of where RMS *Titanic* sank. Did you know it was only about two days from port?

Investigate the science and engineering technology that went into building RMS *Titanic*. It was cutting-edge at the time but what made an 'unsinkable' ship actually sink?

Source and collect newspaper articles, images, quotes and other interesting material on the sinking of *Titanic* and **make a physical or digital scrapbook**. Try to show what makes this story so popular and intriguing.

Catalyst

[After Titanic] 'I really got bitten by the bug of deep ocean exploration, it was adventure, it was a curiosity and it was an experience that Hollywood couldn't give me ... my next target would take us even deeper.'

James Cameron

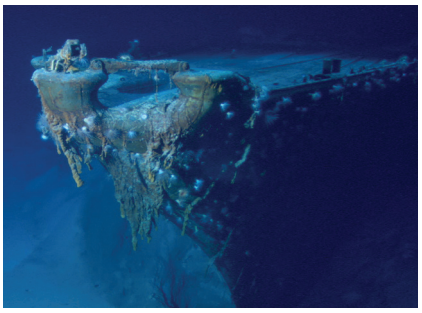
Catalyst - An event or person that causes great change Cambridge dictionary

Bismarck - new evidence

On 27 May 2002, Cameron uses two MIR submersibles launched from the Russian research vessel Keldysh to dive 4790 metres (approx.15, 715 feet) to the wreck of WWII German battleship *Bismarck*. ROV 'Elwood's' 3D cameras capture never before seen details inside the wreck. Cameron concludes there was insufficient damage from British shells and torpedoes to immediately sink the ship, indicating that it was scuttled by its crew to avoid being boarded. He attributes large gashes seen along the hull to a 'hydraulic outburst' when the ship hit the bottom. On board the Keldysh as they watch 'Elwood's' discoveries, Kriegsmarine veterans Karl Khun and Walter Weintz, who survived the sinking, relive the events of 27 May 1941 that killed 2107 of their shipmates.

'Aliens of the Deep' project

Between 2001 and 2005 Cameron spent a cumulative seven months at sea taking forty one dives on deep ocean expeditions. In 2003-2005 he assembled a team of young scientists to join the team of his ambitious 'Aliens of the deep' expedition to study ecosystems around hydrothermal vents on three expeditions in the Atlantic and Pacific Oceans and the Sea of Cortez (west coast Mexico). Examining the life that thrives here in complete darkness can inform theories about life forms beyond Earth. Europa, a moon of Jupiter, is suspected of having water-filled oceans beneath its ice crust which may contain organisms living in similar conditions.



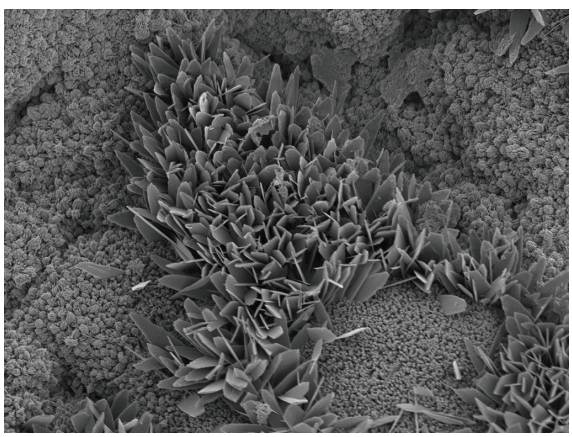
Images: Disney Enterprises, Inc/Walden Media LLC

Kevin Hand, a member of Cameron's expedition is now a project scientist on NASA's 'Europa clipper' mission which is scheduled to send a spacecraft to Jupiter's moon in the next decade.

Rusticles on wrecks

Film from James Cameron's dives to RMS *Titanic* and the German battleship *Bismarck* show that both of these large iron composite (steel) ships are covered with what looks like rust coloured icicles. These are called rusticles and were identified and named by Robert Ballard during discovery of the Titanic in 1985. They were first studied by corrosion scientist Roy Cullimore, a member of James Cameron expeditions to *Bismarck* and *Titanic*. Rusticles are made up of proteobacteria, products of corrosion, fungi, microbes and sediment together in a structured symbiotic colony. They form when iron composite corrodes in water, but are only icicle-shaped in seawater. They grow, mature, and fall to the seafloor in cycles. Rusticles play a role in the microbial corrosion of iron composite shipwreck sites. Some scientists think that wrecks will eventually completely disappear.

Image top: Courtesy James Cameron



SEM images of rusticles from the wreck of HMAS *Sydney* (II). Courtesy Curtin Corrosion Centre, Curtin University.

CATALYST ACTIVITIES

Imagine you were one of the young NASA scientists on James Cameron's Aliens of the Deep project. **Create a series of log or diary entries showing your thoughts and discoveries while on the expedition.**

Why do you think James Cameron called his expedition to the sulphur vents ecosystem 'Aliens of the Deep'?

Choose a fascinating ocean ecosystem and **make a report or do a presentation** on what we know and what we don't know about it. How has plant and animal life adapted to the physical conditions of the ecosystem? What is the latest scientific research on your choice?

Research more about the *Bismarck*. Imagine you could interview one of the *Bismarck* survivors that went back to the site with James Cameron. How do you think they were feeling? What questions would you ask?

What was the popular theory about how the *Bismarck* sank? Why were James Cameron's findings important to how we view history?

Find the latest progress on NASA's 'Europa clipper' mission. **Create a report or visual presentation** on Jupiter and its' moons.

Research what causes corrosion, particularly in sea water? Remember, different metals corrode at different rates. What are some of the more corrosive metals and what are those that corrode slowly? This is an important consideration when investigating shipwrecks.

Not all ships sink in the same way – it depends on what caused it to sink in the first place. Some will break up and some will go down intact. **Make a comparative 'scatter-map'** of how *Titanic* and *Bismark* settled on the ocean floor and suggest what we can learn from this?

Visit a marine environment and see if you can find evidence of metals corroding. What measures have been taken to slow down the corrosion rate?

Create a piece of persuasive writing that argues the case for more deep sea exploration.

Explorer

'Surface, DEEPSEA CHALLENGER, I am on the bottom, depth is thirty-five thousand seven-hundred fifty-five feet ... over.'

James Cameron

Explorer - Someone who travels to places where no one has ever been in order to find out what is there Cambridge dictionary

By 2012, as a veteran of more than 80 submersible dives and leader of seven deep sea expeditions, James Cameron is an esteemed underwater explorer and inventor. More than forty years after he built his first miniature submersible 'Sealab 3' as a high school science enthusiast, Cameron realises his ultimate challenge, to visit the deepest place on earth as solo pilot of the *DEEPSEA CHALLENGER*.

Cameron's design for the revolutionary Kawasaki racing green piloted 'submersible science platform' defies engineering convention with its torpedo shape, syntactic foam core and advanced lighting, battery and propulsion technologies.

Ten years from concept to completion, the vessel was engineered and built in relative secrecy in Sydney and California. The first test dive, under cover of darkness on 26th January 2012, off Garden Island navy yard in Sydney Harbour, was to a depth of one metre, revealing significant faults in communication, controls and life support systems. These were ironed out before Cameron took a series of deep dives up to 8,221m (approx. 26, 971 feet] into the New Britain Trench.

On 26th March 2012, after a 2 hour and 37 minute descent, Cameron touched down 10,898m (approx. 35,754 feet) deep at the bottom of the Mariana Trench, the first person to go there alone.

Image: Disney Enterprises, Inc/Walden Media LLC

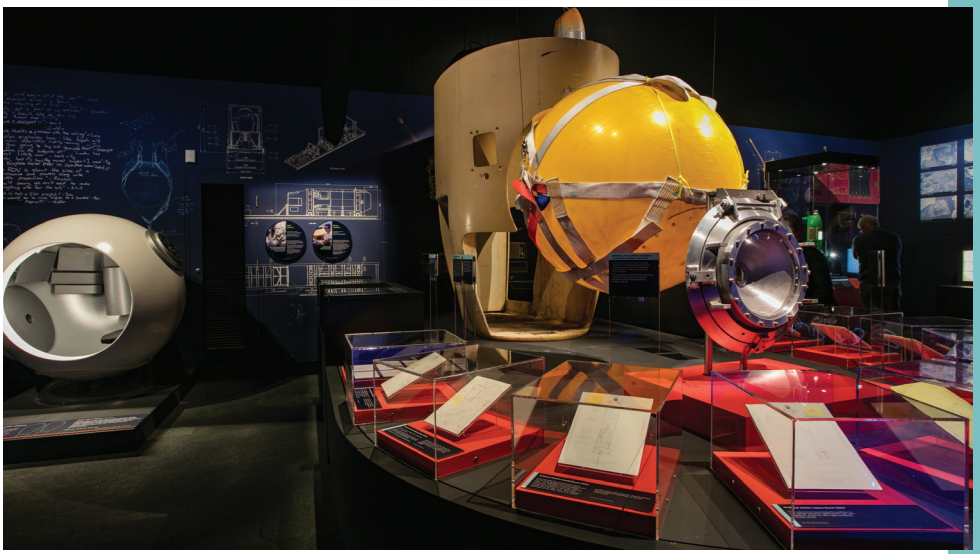


Image top: Courtesy James Cameron

Even though James Cameron piloted *DEEPSEA CHALLENGER* solo, he had a team of experts working on different aspects of the expedition behind the scenes. When he returned from the successful dive, he stated "… we all did it".

Team work is very important to any major project and each team member needs to know their responsibility and how it fits into the total scheme of operations.

EXPLORER ACTIVITIES

20 July 2019 marks the 50th anniversary of one of the greatest feats of exploration ever ...do you know what it is?

Humans have always wanted to explore. What do you think are the **Top 10 exploration expeditions** of all time? Make a list and compare with your classmates then take a class vote on the most significant one of all time.

For the expeditions in your list above, **how many needed special machinery to get them there?** What role did science, maths, engineering and technology play in those expeditions?

Imagine what it would have been like going solo to the Mariana Trench. **Think of 5 words to describe how he might have been feeling.** Would you use the same 5 words for yourself, or different words?

If you could visit any place on earth where would it be? **Give a class talk** about why you want to go there and what you want to explore. Devise what special equipment you would need and make some 'concept sketches' (see exhibition label 4 in the Appendix)

Look at exhibition label 3 in the Appendix. **Why was it important to do test dives** under different conditions?

Look at exhibition label 4 in the Appendix. **What does the word 'prototype' mean?** Why is it important?

Find out all you can about *DEEPSEA CHALLENGER*. What made it such a remarkable vehicle? Why do you think it sat in the water vertically rather than horizontally?

Look at the *DEEPSEA CHALLENGER* components. What do you think is the most interesting feature? Research the science and technology behind your choice.

Team work was very important to the *DEEPSEA CHALLENGER* mission. If you were going on a scientific research mission **make a list of the team members you would assemble as your team.**

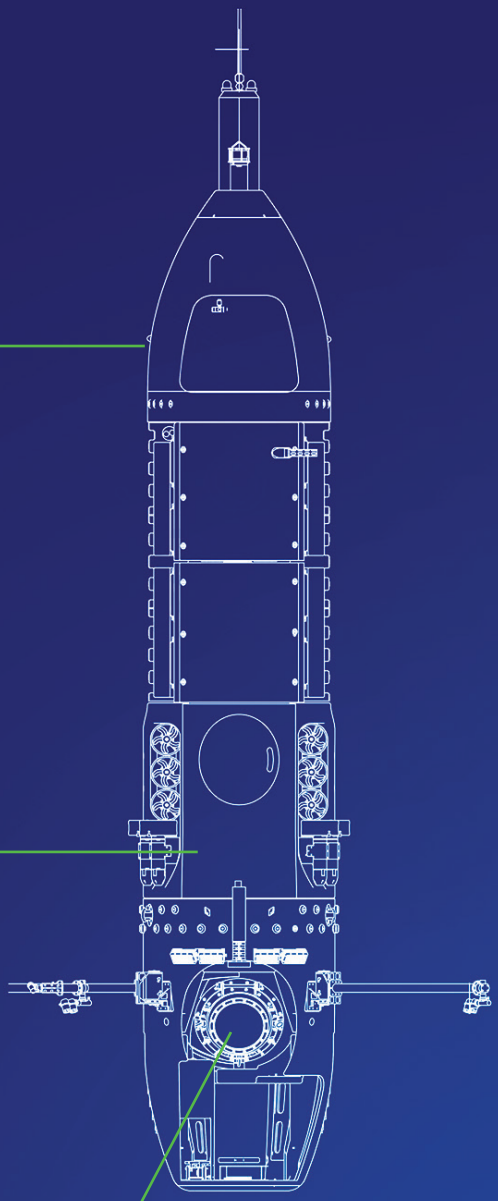
What is buoyancy? **Make a diagram/infographic** to show how this concept works.

Through his exploration of the oceans James Cameron came to realise the importance of protecting them. Working in groups, **design your own ocean conservation project** and do a set TED talks on it!

Why racing green? **Investigate why it stands out** and design an experiment to test it against other colours in a dark underwater environment. Think of how colour is related to light!

For seniors - the specimen smaller samples (*Hirondellea* and *Lysianassidae*) were recovered from the Middle Pond of the Mariana Trench. Investigation has revealed that they contain scyllo-inositol, a compound being tracked as a possible treatment for Alzheimer's disease. **Research this.**

DEEPSEA CHALLENGER



GREEN OUTER CASING

Cameron nominated his favourite 'Kawasaki racing green' as the colour of the fibreglass shroud surrounding the flotation beam or core of the *DEEPSEA CHALLENGER*. It was practical because it was easily identifiable for recovery of the submersible if something went wrong.

ISOFLOAT™ CORE

DEEPSEA CHALLENGER has a structural flotation core of white syntactic foam – a composite material of air-filled glass microspheres set into epoxy resin. Existing foams pressure tested to full ocean depth warped, cracked, compressed, lost buoyancy and structural integrity. Australian lead project engineer, Ron Allum spent 18 months designing a new type of foam with twice the tensile strength of existing foams and able to withstand the pressure. It was named and patented as ISOFLOAT™.

VIEWPORT LENS

Lead engineer Ron Allum also tested and manufactured the thick conical lens integrated into the pilot sphere access hatch through which Cameron would have his only view to the outside. Glass imploded into dust-sized particles when pressure-tested. The section from a test lens of solid acrylic reveals tiny surface fractures under the same pressure and is a prototype of the lens installed in the *DEEPSEA CHALLENGER*.

CLEAN AIR

Apart from oxygen for the pilot to breathe, carbon-dioxide and water exhaled into the sphere by the pilot has to be removed from the air. Scrubber units absorb carbon-dioxide, while water vapour from breath and sweat condense on the sphere's cool steel interior and trickle down to a sump at the bottom. In an emergency, the pilot can drink it using a special straw designed to filter out contaminants.

CRADLE

Woven polyester webbing was commissioned especially for the project and made in Australia. It is heat set and undyed for maximum strength and polyester thread was used to provide maximum stretch and quick recovery. The harness held the 1.5 tonne life support sphere to the syntactic flotation beam, which shrank roughly 65mm (approx.2.5 inches) when at the greatest depth. The harness system acted like an elastic band holding the life support sphere tight into the body.

DSC LED LIGHT ARRAY

Every part of the *DEEPSEA CHALLENGER* is built to withstand the crushing pressure of the deep. LED lighting arrays are inserted into egg-crate like holders in the side of the sub. Each array has a diaphragm compensating system, which allows silicon fluid to fill any air pockets inside the array.

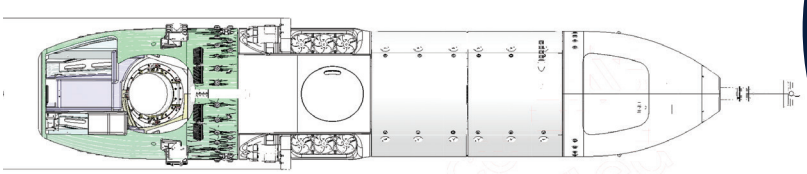
The LED lighting system on *DEEPSEA CHALLENGER* is 2.4 m (approx. 7'10") tall, enabling Cameron to light his way across the seabed and capture detailed 3D digital footage as he went.

BATTERY MODULE

The *DEEPSEA CHALLENGER* carries enough batteries to power two or three electric cars. 70 oil-filled plastic battery packs are mounted into the sub's sides where they are spaced just far enough apart not to be affected when the foam core in which they sit shrinks by about 1% under the ocean's pressure.

Image: The Archeron Project Pty Ltd. Courtesy James Cameron.

LIFE IN THE PILOT SPHERE



The Australian made steel pilot sphere of the *DEEPSEA CHALLENGER* is 6.4cm (2.5 inches) thick with an internal diameter of just 109 cm (approx. 43 inches). It was tested to pressure of 1.25 tonnes per square centimetre (16,500 pounds per square inch or 1,138 bars). Strain gauges attached to the sphere during testing indicated that the sphere could withstand up to 140 percent of the test pressure.

The pilot sphere is equipped with two compressed oxygen cylinders with enough oxygen to sustain life for up to 56 hours. Cameron prepared for the dives by running and free-diving regularly to increase his lung capacity and his body's oxygen efficiency.

Everything inside the sphere is as fire resistant as possible, but even a small electrical fault could make the air toxic. To be prepared, Cameron trained in holding his breath while quickly switching to a full face mask attached to a self-contained re-breather unit.

At the start of the dive the combination of the tropical waters of the western Pacific and the electronics inside the pilot sphere made it hot and Cameron was sweating. As he descended he added layers of clothing, a beanie and warm slipper boots to stay warm as the temperature dropped to around 3°C (37.4F) at the bottom.

The space is so crammed with equipment that 187cm (6 ft 1 inch) tall James Cameron kept his legs bent with arms barely moving on dives. He stayed like this for the 6.75 hours of his Mariana Trench dive plus the time taken to launch and retrieve the sub.

As well as the pilot, the sphere contains 120 complex operating systems, thruster joy sticks, computer screens, a life support system, cameras, re-breather scrubber unit, a fire extinguisher, sleeping bag, and emergency batteries under the seat.

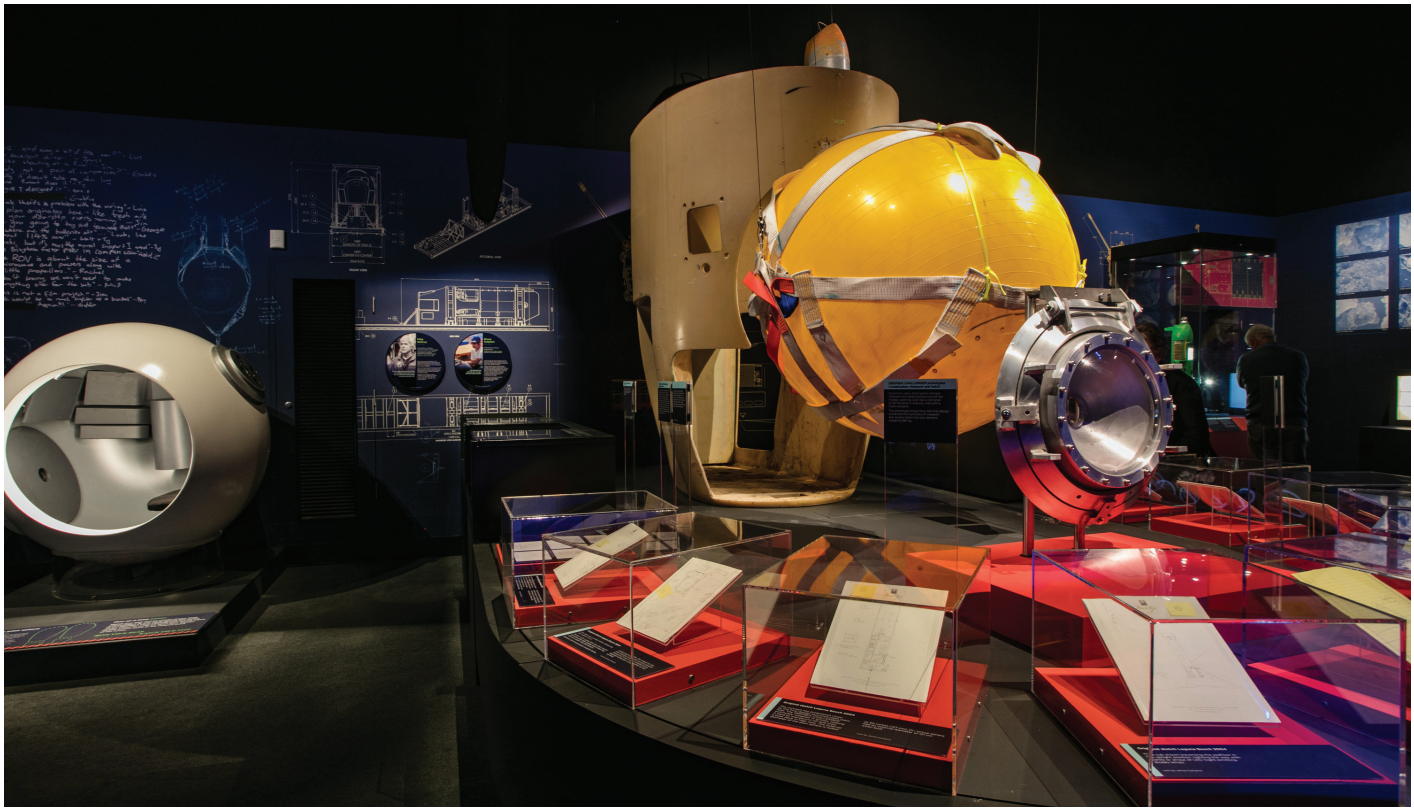


Image top: The Archeron Project Pty Ltd. Courtesy James Cameron.

Image top: Mark Thiessen Nat Geo Creative.

APPENDIX

A: EXHIBITION LABEL 1

Filming miniatures *Titanic*

Details of *Titanic* and the wreck were painstakingly reproduced from original drawings, photographs of sister ship RMS *Olympia*, and based on expedition footage.

Scale models of *Titanic* used in filming required components like this anchor, section of railing and engine turbines to be made at the same small scale.

B:

Polystyrene cup

C: EXHIBITION LABEL 2

Grand staircase cherub lamp

The Deck A landing of *Titanic's* grand staircase featured a bronze cherub holding an electrically lit 'flame'. This full-scale reproduction made for the film was damaged when the set was flooded by 3.5 million litres of water to simulate the ship sinking. The force of the water tore the entire set from its foundations.

This has led to the theory that as the real Titanic sank, the grand staircase blew out, explaining why it hasn't been found in or near the wreck.

APPENDIX

D:

Latest ROV

Image courtesy OpenROV

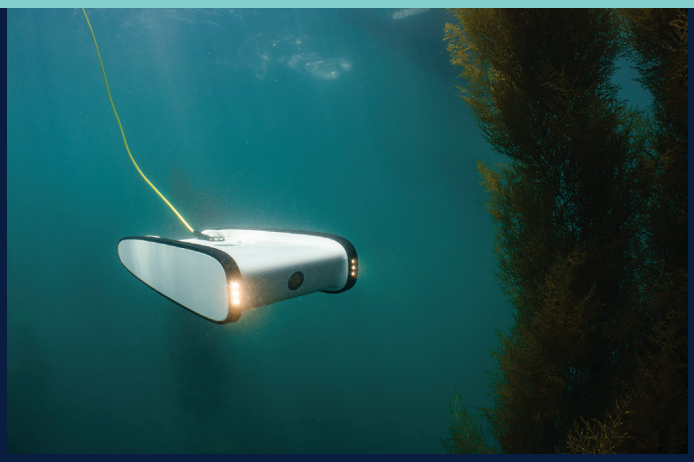


Image courtesy OpenROV

E: EXHIBITION LABEL 3

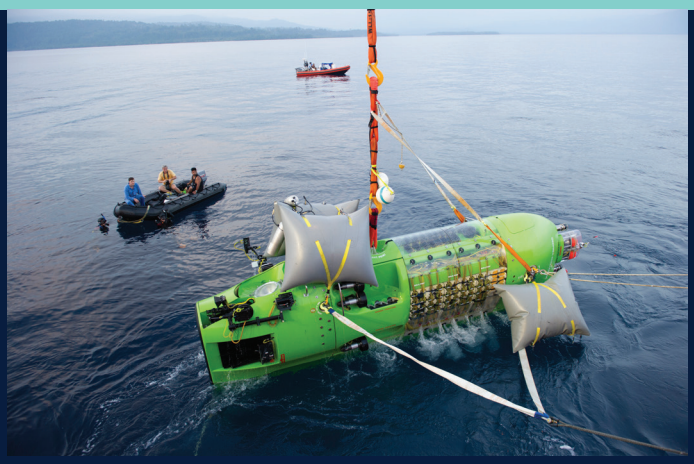
Test dives

Dive 1, Garden Island Sydney Harbour, test dive, 1 metre, 25-26/1/2012

Dive 2, Jervis Bay, NSW, test dive, 20 metres, 2/2/2012

Dive 6, PNG, test dive, aborted, 4/3/2012

Dive 10, Challenger deep, 26/3/2012

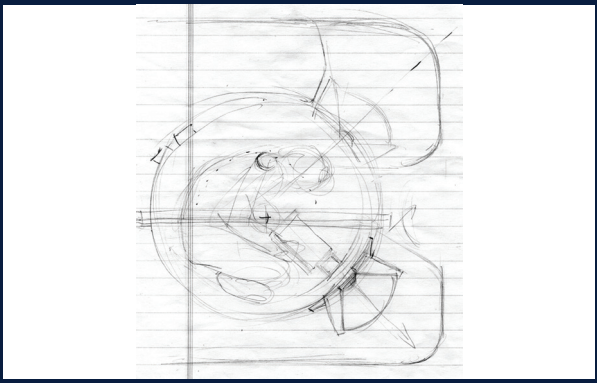


DEEPSEA CHALLENGER: Courtesy James Cameron.

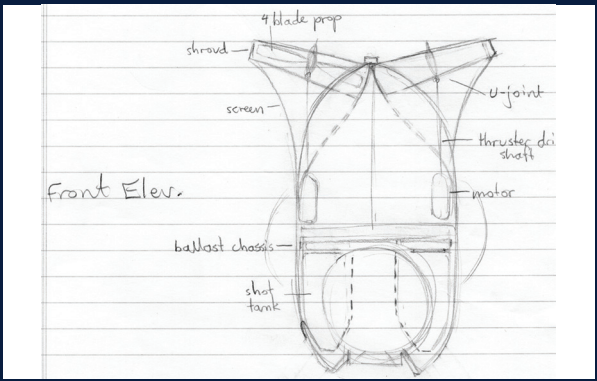
APPENDIX

F: EXHIBITION LABEL 4

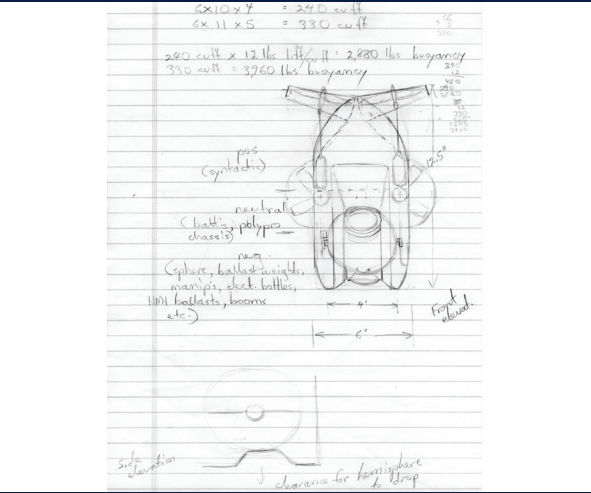
The first six concept sketches 2003



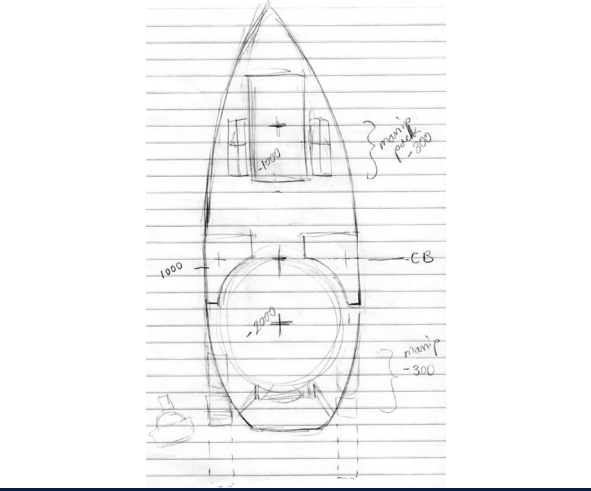
1. Pilot sits cross-legged, camera at the view port (close to the final design).



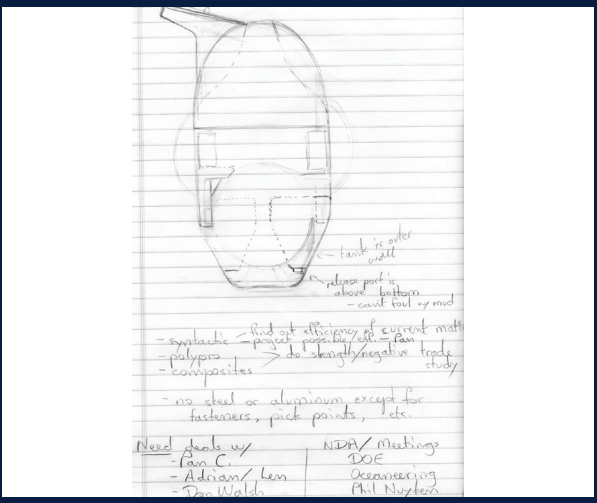
2. What looks like an ROV with a pilot sphere attached.



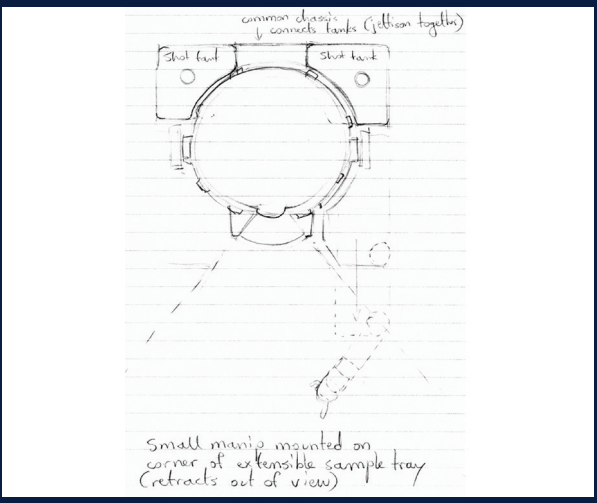
3. Pilot straddling view port with camera pointing straight down (rejected).



4. Plan view shows teardrop shape, retained in the final design.



5. Notes mentioning materials, manufacturers and Don Walsh who with Jacques Piccard was first to visit Challenger Deep in 1960.



6. Pilot sphere in two parts shown bolted together; the final sphere was welded together.

Sketches: James Cameron. Courtesy James Cameron.

EXTRA ACTIVITIES ON THE EXHIBITION AS A WHOLE

Make a board game based on the exhibition. Divide the class into four groups and take one subtheme each!

Hold an exhibition 'mastermind' or 'super quiz'. Write questions and film the quiz show!

Write a newspaper report on one of James Cameron's expeditions. Use quotes from the exhibition in your article. Think carefully about your headline. How will you capture people's attention?

Imagine you were with James Cameron on any ONE of his deep sea exploration expeditions. **Create 'Wordle' that captures how you would have felt** about the experience (electronic or draw it).

Students write a quick sentence or even one word on a post-it note on what they learned/felt by visiting the exhibition. **Make a display of the notes** and allow students time to read each one and discuss them with classmates.

What are some other uses for an ROV?

James Cameron set his love story against the backdrop of the *Titanic* tragedy. **Choose another well-known historical event** and write a background fictional story that captures the essence of the time.

If you could investigate one unsolved mystery what would it be? Why are you fascinated by it?

A well-known saying suggests that **"We know more about outer space than we do about our own oceans"** What do you think about this? Around 71% of the earth is covered by ocean but a majority of that is unexplored by humans. Why do you think this is so?