# Girls as Leaders in STEM Curriculum Package

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- Lesson Plans

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# Teacher Guide **Girls as Leaders in STEM**

There are many issues facing industries, individuals and the broader community that need STEM-related solutions.

## STEM design challenge

Your students will be challenged to choose a 'problem' that relates to one of the 'big issues' and develop a 'design solution' involving STEM (that is, a solution that uses Science, Technology, Engineering and/or Mathematics to help solve it). Your role as the teacher is to support the student through discussion, sourcing possible resources, and guiding the process.

For this project, we are considering the idea of a 'design solution' very flexibly so that students have opportunities to search out a broader response. The design solution can be an object, product, process, service, or anything else that helps to deal with their identified problem.

Please read the information supplied on the Student Guide, so that you are aware of what is being asked of the girls. While ambitious, we anticipate that girls will be able to complete the requirements with support. Should you require additional support or guidance, please do not hesitate to contact us via Jorja Mckinnon (jorja.mckinnon@deakin.edu.au).

## Problem Cards

Students will be working with a problem card in order to understand industry challenges. The *GALS Problem cards* present a number for problems relating to the issues of: marine waste, car accessory design, practices within the textile industry, occupational therapy, information and communication technology (ICT), or new materials. Page three of this Teacher Guide shows an example of problem cards and annotates the components. The problem cards have adopted the design to reflect the context-based approach as explained by Kuhn and Muller (2014). The context-based approach seeks to embed and connect teaching content and sequences beyond what is commonly taught in schools (Kuhn & Muller, 2014). One extension of the context-based approach is the Newspaper story problem. These are problems related to newspaper articles containing science related issues, and which are (up to minor modifications) unchanged in both text and layout (Kuhn & Muller, 2014). Each Problem Card maintains the same structure. They take the form of a newspaper article with content derived from 'The Conversation' – an online academic publication. Source information in relation to the content can be found at the bottom of this page under reference. Each of the Problem Cards presents a task for the student.

### Student task

1. Front page (Portfolio)
2. Team name and logo, Team structure
3. Team management and collaboration: What role does each person play? How have you be collaborating?
4. **The Problem:** What was the problem you examined, why is this important, how does it relate to a local industry or issue? Who will benefit from getting a solution to this problem?
5. **Collaborators**: Which industries, mentors and other people were involved? How did they contribute to the project? How did you interact with them?

6. **Designing:** processes of brainstorming (ideation) and planning, research informing the design, process of making changes to your design? What resources were needed to develop a solution, including materials and human resources?
7. **Data collection:** what parts of your design did you collect data on; how do you collect this, What type of data did you collect, how did the data help you re-design your solution
8. **Your design solution:** What does it look like or how is it implemented.
9. **Evaluation:** What criteria will you use to judge how well the design solution responds to the problem, what data was collected and what did it show about your design solution against these criteria
10. **How your design solution responds to the problem:** summary outlining the design solution and how it responds to the problem, drawings or representation of the design solution
11. **Budget (optional):** projected budget need for manufacturing or service delivery.

## Project Days

The first of the project days will provide girls with information about the project, strategies for designing and developing innovative solutions to human needs and time to work with mentors and teachers to identify a problem they wish to implement a solution for. It is not anticipated that students will get to the point of actually trying to 'construct' anything. Rather, they will use this time in talking, thinking, and developing an understanding of what they might want to do. They will most likely jot down ideas, perhaps sketch some design ideas and generally start to consider the design process. It is possible that they may work through the first 2-4 steps of the design process, but this is not a requirement.

**Design Process**

| |
|---|
| **Define the Problem -** What is the problem or need? Who has the problem or need? Why is it important to solve? |
| **Do Background Research:** Learn from the experiences of others —do background research in two major areas: Users or customers, Existing solutions |
| **Specify Requirements:** Indicate the important characteristics or criteria that your solution must meet to succeed. Eg consider an example of a similar product, noting each of its key features. |
| **Brainstorm Solutions:** Try to generate as many possible solutions as they can as there are always more than one way to do something. |
| **Choose the Best Solution:** Check which solution best meets your design requirements. |
| **Develop the Solution:** Refine and improve the solution. You may come back to this step more than once. |
| **Build a Prototype:** A prototype is an operating version of a solution, object, product, or service, made with simpler materials. It represents your key ideas. |
| **Test and Redesign:** Test your solution, find new problems, make changes, and test again before settling on a final solution |

The second project day will involve the students in further collaboration and refinement. It is anticipated that students will have made considerable progress with design solution, but will not have finished all aspects of the task. This day will provide students with time to work on their design solution, their portfolio or their communication strategy.

## Project outputs

**Portfolio** – written description of the project (see Student Guide). This is the main record of girls' design solution and the design **processes followed.**

**Video** – audio visual description of girls' design solution or how they arrived at their solution. This could be shared with the public, for example, the school may publish this on their website.

**School Showcase** - see below

**Public Showcase** - see below

## School Showcase

After the second project day, there should be opportunity for the girls to present their projects to a 'whole school' assembly or other public forums to acknowledge the project they have been involved in. This relates to the need to raise awareness of girls in STEM and particularly their leadership in providing models to other girls as STEM ambassadors.

## Public Showcase

Towards the end of June, a public space, such as a shopping centre or library, will be located for the display of the projects, prototypes and/or posters of the design solutions. It is envisioned that the girls will attend for a specified time (2 hours), if possible to present or respond to queries from the public. Depending on the location for the public showcase, it may be possible to safely and securely leave projects on display for a period of time.


References:
Context-based science education by newspaper story problems: A study on motivation and learning effects - https://doi.org/10.1016/j.pisc.2014.06.001

**Problem Card 1:**
https://corporate.ford.com/articles/propulsion-choices/new-generation-electric-vehicles.html
https://corporate.ford.com/articles/winning-portfolio/f-150-body-of-work.html
https://www.autoblog.com/2014/11/07/how-and-why-automakers-work-hard-to-camouflage-their-cars/

**Problem Card 2: Content Warning – this card mentions content related to cyber bullying. Content may trigger distress some students**
https://au.reachout.com/articles/what-is-cyberbullying
https://theconversation.com/banning-kids-from-using-technology-is-counter-productive-37173
https://theconversation.com/we-need-to-take-responsibility-for-our-own-safety-online-38368
https://theconversation.com/thumbs-up-facebook-might-actually-be-good-for-you-11889

**Problem Card 3:**
https://www.deakin.edu.au/research/research-news/articles/rating-system-targets-motorcycle-safety
https://www.deakin.edu.au/research/research-news/articles/grant-smooths-way-for-silk-eardrum-trials
https://theconversation.com/from-science-fiction-to-reality-the-dawn-of-the-biofabricator-45309

**Problem Card 4:**
https://soe.environment.gov.au/theme/marine-environment/topic/2016/marine-debris
https://www.csiro.au/en/Research/OandA/Areas/Marine-resources-and-industries/Marine-debris
https://ocean.si.edu/conservation/pollution/teaching-your-students-about-marine-debris-classroom-activity
https://theconversation.com/the-future-of-plastics-reusing-the-bad-and-encouraging-the-good-87001
https://blog.csiro.au/how-to-create-wealth-from-waste-and-reduce-our-landfill/

**Problem Card 5:**
http://www.stagetwo.com.au/
https://www.choice.com.au/shopping/everyday-shopping/clothing/articles/clothing-size-irregularities
https://www.geelongmanufacturingcouncil.com.au/
https://wwd.com/business-news/business-features/sucharita-mulpuru-think-tank-returns-10939339/

**Problem Card 6:**
https://www.education.vic.gov.au/school/teachers/learningneeds/Pages/ables.aspx
https://www.geelongaustralia.com.au/parks/item/playspace.aspx
https://theconversation.com/its-designers-who-can-make-gaming-more-accessible-for-people-living-with-disabilities-107594
https://theconversation.com/wheelchair-technology-in-the-paralympics-and-its-spin-offs-8924
https://theconversation.com/3d-printers-a-revolutionary-frontier-for-medicine-83031

**Problem Card 7**
https://theconversation.com/recycling-the-unrecyclable-a-new-class-of-thermoset-plastics-26594
https://www.ellenmacarthurfoundation.org/circular-economy/what-is-the-circular-economy
https://www.goodnet.org/articles/5-companies-that-embrace-concept-circular-economy
https://www.npr.org/2019/09/10/759376113/unfurling-the-waste-problem-caused-by-wind-energy
https://en.wikipedia.org/wiki/Composite_material

**Problem Card 8**
https://www.1millionwomen.com.au/blog/what-most-abundant-form-plastic-pollution/
https://heiq.com/
https://www.patagonia.com/blog/2017/02/an-update-on-microfiber-pollution/

# Student Guide **Girls as Leaders in STEM**

## There are many issues facing industries, individuals and the broader community that need STEM-related solutions.

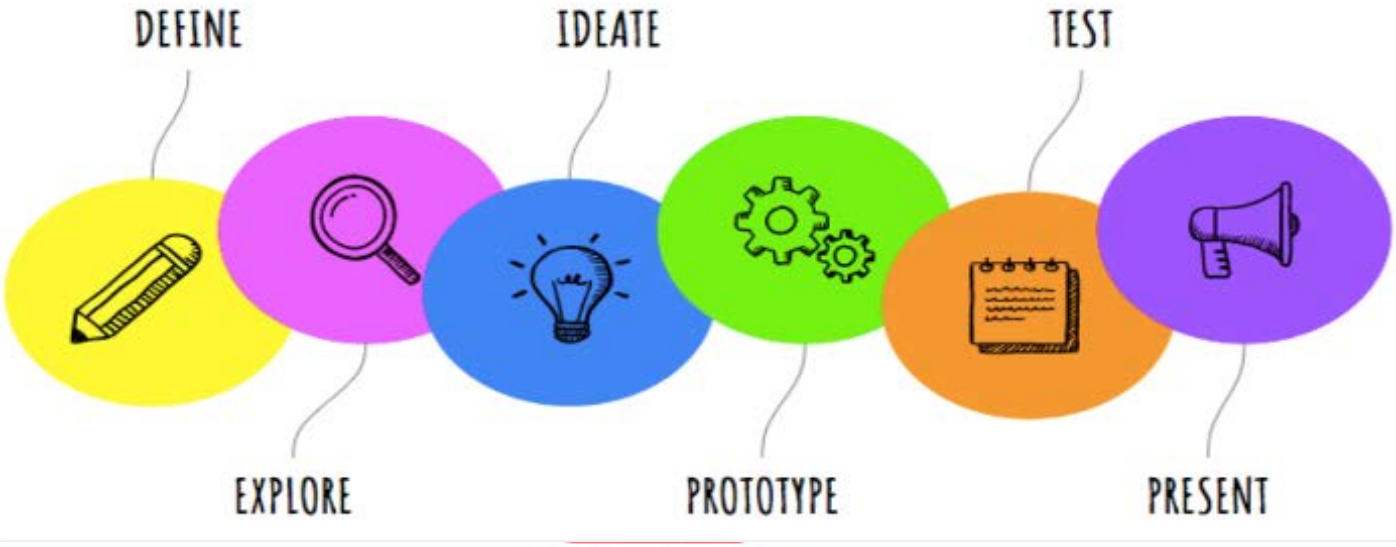
### STEM design challenge

Your challenge is to choose a 'problem' that relates to one of the 'big issues' and develop a 'design solution' involving STEM (that is, a solution that uses Science, Technology, Engineering and/or Mathematics to help solve it).

A 'design solution' can be an object, product, process, service, or anything else that helps to deal with this problem.

The *GALS Problem cards* present a number of problems relating to the broad issues of: marine waste, car accessory design, practices within the textile industry, occupational therapy, information and communication technology (ICT), and new materials. Perhaps you and your teacher can think of other problems relating to these big issues? What problem would you like to tackle?

### The design process




The design process for Design technology and Engineering are very similar. The diagram represents one way of thinking about this and may help you in working through the process.

| |
|---|
| **Define the Problem -** What is the problem or need? Who has the problem or need? Why is it important to solve? |
| **Do Background Research:** Learn from the experiences of others. Do background research in two major areas: Users or customers, Existing solutions |
| **Specify Requirements:** Indicate the important characteristics or criteria that your solution must meet to succeed. Eg. consider an example of a similar product, noting each of its key features. |
| **Brainstorm Solutions:** Try to generate as many possible solutions as they can as there are always more than one way to do something. |
| **Choose the Best Solution:** Check which solution best meets your design requirements. |
| **Develop the Solution:** Refine and improve the solution. You may come back to this step more than once. |
| **Build a Prototype:** A prototype is an operating version of a solution, object, product, or service, made with simpler materials. It represents your key ideas. |
| **Test and Redesign:** Test your solution, find new problems, make changes, and test again before settling on a final solution |

**Communicate Results:** Communicate your results to others in a final report and/or a display board.

## Communication Strategy

Industries and scientists use a 'communication strategy' to tell different groups of people about new products or services. During GALS you will have the chance to tell others about the problem you were looking at, your design solution, and how you know that it will work. You will do this in a number of way and to different people:

1) Portfolio – written description of the project (see below). This is the main record of your design solution and the design process you followed. It will be help you communicate during 2), 3) and 4).

2) Video – audio visual description of your design solution or how you came up with your solution that you can share with the public, for example, your school may publish this on their website. Where else might you share this video?

3) Report at your school – such as at your school assembly where you tell your friends and family about your design solution and how you worked with STEM mentors and industry representatives. What will your friends and family like to hear about the most?

4) Public display – such as at a shopping centre or town library where your design and the portfolio may be presented to the public. How might the general public benefit from your solution? How will you communicate this?

## Portfolio requirements

Your portfolio can be in the form of a printed report or poster (size A0). Below is a suggested structure with some questions to guide your thinking. Your teacher and mentors can help you to think about how to show your thinking.

An example of a portfolio: Entries to the "F1in Schools" competition are examples of very high quality portfolios. These can give you some ideas of how to put together your own, but remember that they are completed by older students with help from sponsors. Here is an example from the 2012 competition:
https://online.flowpaper.com/7747073c/TeamSpectraWorldFinalsPortfolio/#page=20

## What to include

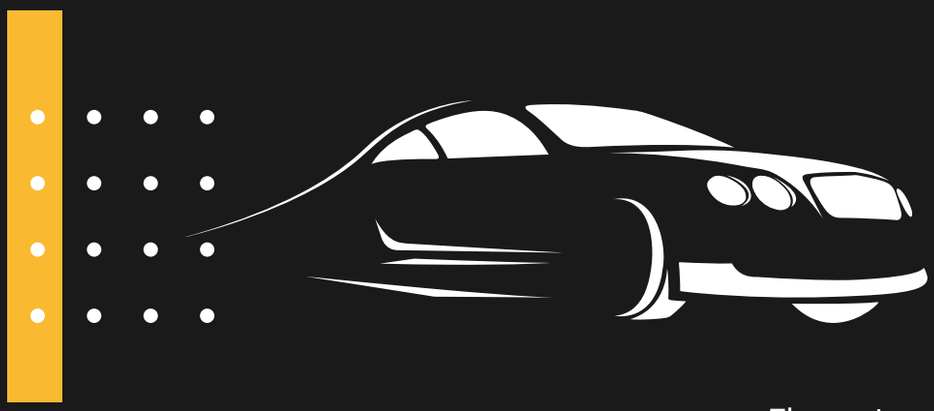
1. Front page (Portfolio)
2. Team name and logo, Team structure
3. Team management and collaboration: What role does each person play? How have you been collaborating?
4. **The Problem:** What was the problem you investigated, why is this important, how does it relate to a local industry or a local issue? Who will benefit from getting a solution to this problem?
5. **Collaborators**: Which industries, mentors and other people were involved? How did they contribute to the project? How did you interact with them?
6. **Designing:** processes of brainstorming (ideation) and planning, research informing the design, process of making changes to your design? What resources were needed to develop a solution, including materials and human resources?
7. **Data collection:** what parts of your design did you collect data on; how do you collect this, What type of data did you collect, how did the data help you re-design your solution?
8. **Your design solution:** What does it look like or how is it implemented?
9. **Evaluation:** What criteria will you use to judge how well the design solution responds to the problem? What data was collected and what did it show about your design solution against these criteria?
10. **How your design solution responds to the problem:** a summary outlining the design solution and how it responds to the problem, including drawings or representation of the design solution
11. **Budget (optional):** projected budget need for manufacturing or service delivery.

# Problem Cards

1. Automotive Industry
2. Information and Communication Technologies
3. Future Materials
4. Managing Waste
5. Innovation in the Fashion Industry
6. Achieving an Inclusive Society
7. Circular Economy
8. Microthread Pollution
9. Dairy Industry
10. Hydrogen Futures industry
11. Floodplain management
12. Bee Pollination
13. Grain research climate changing crops

# PROBLEM CARD 1: AUTOMOTIVE INDUSTRY

How can we, as engineers, tailor cars to suit different consumers? Innovation, creativity and testing is needed when designing cars in order to think about things in new ways! Engineers need to speak to people to make sure they design cars that are suited to a large variety of wants and needs, but certain aspects of design remain the same. But do they have to? What would your dream car be like?



**INNOVATE**

**DARREN PALMER -TEAM EDISON**

You'd think after 28 years of working for the same company that nothing would surprise me. I've been fortunate enough to work for Ford across many amazing teams on many exciting assignments.

Earlier this year I received a call that would challenge everything I thought I knew about Ford and our future. My team was asked to design and focus only on "electrified vehicles. To be successful, we must be willing to think of completely new ways to design and make cars.

The world is changing, and we have to listen more to what people want, so that we understand our customers and how their wants and needs are evolving.

The automotive industry in Australia is worth $37 million dollars per year – that's a lot of money! Australia used to be a leader in car manufacturing, but over the past 50 years due to cheaper production costs over the past 50 years more cars are being made overseas. Even though the cars are no longer being built in Australia, we still design and make car parts and test how well the cars perform at Ford in Geelong.
The Ford factory gives a lot of people jobs and training. Geelong Ford is well known for creating new ideas and products that are tested right here.

**How do we customise cars so that they are suitable for different cultural and employment needs?**

On a recent trip to Shanghai, Ford looked at how big families use their cars. Engineers started to understand how families use cars by watching them.

They brainstormed, researched and listed different needs for families of different sizes.

Ford can take these insights and ensure they are really designing vehicles in a way that is human-centered and right for each unique market.

**CREATE**


How could we design a vehicle that is suited to different purposes?

What sort of jobs need to be mobile?

And how do these different jobs use their vehicles?

Mobile hairdressers and mobile dog washers have very specific needs for car designs. But can the same cars be used to pop down to the supermarket to buy the groceries?

Who would benefit from a vehicle that can be used for multiple purposes?

We live in an online world. The internet is a powerful tool for communication, connection, entertainment and information, but with such access to the world at our fingertips comes a need to be careful and responsible. How we behave online, who we communicate with and what information we share can have lasting consequences. Learning how to use technology includes; keeping personal details safe, thinking about the types of photos that you post online and how to speak to one another in a friendly way.

# PROBLEM CARD: 2 INFORMATION AND COMMUNICATIONS TECHNOLOGY

Should kids be banned from tech for their own protection?
or...
Is it possible to have the good that comes with this technology without the bad?

Check the website for more info!

## NETIQUETTE – ETIQUETTE FOR THE NET!

As you become involved with online discussion groups, you will find that each group has its own accepted rules of behaviour. Here are two important rules to remember:

1. Don't get involved in personal abuse.
2. Remember that your posts are public. Your friends, your siblings, your parents, your teachers, or your future employer can read them.

These rules are only as good as the users who follow them. What can be done about the people who don't follow the rules?

Often these people are called 'trolls' and their behaviour is never acceptable. Social media platforms like Facebook and Twitter have ways of monitoring trolls and their anti-social behaviour by identifying words that are considered offensive.

Some gaming platforms use bots to alert a user that someone commenting on their stream is being offensive. It is then up to the gamer to decide how to deal with the individual. This might be asking them to stop, or in extreme cases the troll can be blocked.

## Cyberbullying – what's so special about cyber?

Ilan Katz – University New South Wales

Australian and international studies on the amount of cyberbullying, estimate that around 20% of children and young people a year are involved in cyberbullying.

With more children having access to internet and mobile technology, cyberbullying is on the rise and it is right that the schools, families and government should attempt to do something about it.

There are specific dangers for young people online that are not found in traditional bullying – in particular cyberbullying is often publicly and permanently visible, is available 24/7, and can be conducted anonymously even by adults from overseas. The home is no longer a safe haven from the bullying.

These dangers make cyberbullying hard to deal with. Sometimes the bullying feeling is overwhelming and never ending. Combatting cyber bullying is a challenge lots of people are trying to solve. New laws have been brought in to punish cyber criminals including cyberbullies, which can result in up to 10 years in jail for serious cyber bullying crimes.

## FACEBOOK MIGHT BE GOOD FOR YOU!

Rachel Grieve– University of Tasmania

A study was completed to find out if social "connectedness" could be experienced from being on Facebook. In the first study, we asked 344 Facebook users to rate their level of social connectedness in the real world, as well the social connectedness they experienced from their Facebook use. The results show that social connectedness isn't a "one-size-fits-all" idea.

Instead, Facebook connectedness was different from the connectedness people experience face-to- face. This research does suggest Facebook can be an alternative way to engage and connect with others, and that Facebook can act to facilitate better mental health and well-being, particularly for those who find it difficult to connect face-to-face.

## We need to take responsibility for our own safety online

Shanton Chang – University of Melbourne

Going online without understanding the basics of how the internet works is like getting behind the wheel without knowing the road rules: you might still get where you are going, but you could be a danger to yourself and those around you. At a certain point, we need to take personal responsibility and educate ourselves about how to use the internet safely.

There is a general lack of understanding about how the internet actually affects us. This is particularly the case since users have started posting user-generated content to the internet, some of it of a private nature.

While some of us are aware of the dangers of the internet, the idea that "it won't happen to me because I am not doing anything'dodgy'" is a common one. There is also a generally low level of digital literacy, including basic things like knowing how a web browser works, what sources to trust and where uploaded information is stored. This can mean that people give away personal information without realizing it. This is what criminals rely on and they go to great lengths to make it easy for you to give away information.

## HOW CAN WE HELP KIDS LEARN ABOUT INFORMATION TECHNOLOGY AND COMMUNICATION AND KEEP THEM SAFE ONLINE?

*What could happen if you accidently give away personal information?*

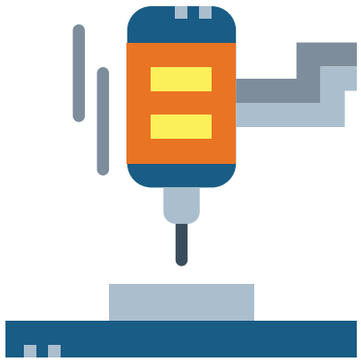
*Imagine if there was a mascot who made it easy and fun to learn how to behave online. What would it look like and say?*

*Can we use digital technology to create something that teaches others and protects them online?*

*What do you find engaging to learn from?*

*How does online communication impact our community?*

# Problem Card 3: Future Materials

For many years our society has been using steel and other strong metals to make aeroplanes, trucks and bridges. These metals are strong but heavy – innovation in materials means that items that were once very heavy could become much lighter, but still maintain their strength.

By innovating materials, we also start to think about other uses for materials found in nature– could there be unexpected uses for what already exists in the environment?

New materials means new uses – this could improve safety, reduce product waste or mean humanity could make something entirely new!

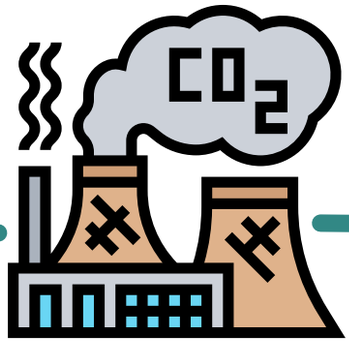
## NATURAL WONDERS

The innovators of future materials focus on improving weight and performance and developing new materials and structures that are cheaper to make, as well as being better for the environment. This includes creating materials that are easier to recycle and those that can be used to harness new energy sources.

Scientists called biofabricators are now working with doctors to make new materials to solve medical problems.

They are designing and building new human body parts using computers and 3D printing. Who knows what our future replacement organs could be made from?!

A solution to the problem of middle ear disease which is being explored, could be healing the eardrum with silk (a strong, thin fibre made from silkworms larvae).




# MAN MADE MAGIC

Often combining materials in different ways can create a different result.

A by-product of petrol is coal tar, which can be used to create strong and light materials known as carbon fibres.

Carbon fibres combine carbon with other chemical atoms under a lot of heat and pressure to make a super strong, flexible, lightweight, and stretchy fibre.

In aerospace, automotive, oil and gas industries, carbon fibres are replacing traditional materials such as steel and aluminium. These new fibres have helped to make huge improvements in sports equipment such as bikes and golf clubs.

Carbon fibres can also be used to improve safety and create clothing. In the past leather (a natural material created from cow skin) was the only clothing material strong enough to provide a safe option for motorcyclists to protect themselves in the case of accidents. Leather is ultra-strong, but also heavier and hotter than most clothing materials.

Carbon fibres have now an even safer clothing option...Kevlar. This incredibly strong manufactured plastic fibre can be woven into fabric to create comfortable clothing strong enough to protect in an accident, and even to stop a bullet!

## How can we innovate the use of new material?

Imagine if you had a set of clothes that could always keep you dry – what sort of material would do that?

How do different jobs require different properties of workwear? How could clothing designers use this for their designs?

Or would you like your Ipad cover to be made out of something natural and not plastic? What would it need to do?

What type of inspiration can be taken from nature?

Anything is possible if you have the right material!

Many natural materials have useful properties. For example a duck's oily feathers are water resistant to keep the duck warm and dry while on water.

How could something like this be used to innovate and design for human use?

# Problem Card 4: Managing Waste

What do you do with an empty bottle? Does your school encourage Nude Foods?

Plastics have become a part of nearly every aspect of our lives. Most people know that inappropriate disposal of plastics threatens marine animals and are aware of the importance of recycling, but is recycling the only option for dealing with waste? The phase Reduce, Reuse, Recycle has been updated to Refuse, Reduce, Reuse, Recycle. Have we thought about how much energy is needed to turn one bottle into something else?

Waste is a big problem and it's just getting bigger – so what are the options?

CSIRO research has shown that approximately three-quarters of the rubbish along the Australian coast is plastic, with some city coastlines containing more than 40,000 pieces of plastic per square kilometre!

Our oceans and beaches are choked with debris from both the land (litter flushed out to sea through stormwater drains) and marine industries (loss of equipment, often from fishing). Floating plastics are a major threat because they don't breakdown.

Northern Australia is especially vulnerable because of how close it is to intensive fishing operations and ocean circulation and wind patterns that make it easy for floating debris to collect.

How does this debris impact marine animals? What happens when they ingest these plastics or become entangled in them? What are ghost nets and why are they a threat to our marine wildlife? Research this topic to find out more.

Is plastic *all* bad or can it also be **good** for the environment?

Check out the website for more info!

# THE SOLUTION IS LESS POLLUTION


Australia's is one of the highest waste producing nations per capita in the world.

Consider e-waste, that is the old TVs, DVDs, computers, household appliances and other electrical goods that we throw away. This type of waste has emerged as one of our fastest growing waste streams but only about 10% is recovered or recycled.

By 2008 we had already sent some 17 million televisions and 37 million computers to landfill.

But e-waste devices also include valuable metals such as copper, silver, gold, palladium and other rare materials that are ending up in landfill.

Can we do things differently? Can we make money from what we currently throw away?

## Let's Create a Plastic-free ocean

**How can we innovate the waste and recycling industry?**

**What sort of impacts are plastics and waste having on our society?**

**How can these impacts be minimised?**

**There are lots of things to consider – why did our society turn away from natural fibers like animal skins, wood and plant material?**

**Is there a way to balance the good and bad aspects of plastics?**

**How can we educate people about what happens to plastics after they leave their house?**

**If we didn't have plastic what would change?**

# Problem Card 5:
# Innovation in the fashion industry

How do you know if the clothes you buy online are going to fit? How can clothing manufactures get their clothes from a warehouse to the store or your house in the best condition? When buying clothes online customers can pick the size and colour of the product they want. This means designers must make a purchasing system that customers can use to ensure what they order is what they need. The product ordered is then delivered through the post to your home or delivered in bulk by trucks to stores.

**What is a 'normal' Australian body?**
Kate Browne – Choice Magazine

There is no such thing as normal! It is easy to go to a store or buy online for kids because their bodies don't have as many differing factors as an adults body.

There is no Australian standard for adults' clothing sizes, and designers and clothing manufacturers base their sizes on their sales history. A size 12 in one brand is not neccessarily the same as a size 12 in another.

While this may suit the designers, who can manipulate sizing to give an instant "feel-good" factor or deter the "wrong" body shapes, consumers usually have to try a range of sizes to find the right fit.

The fashion industry experts that CHOICE magazine spoke with, all agreed that, in an Australian industry worth billions,, sizing irregularity is a major issue.

This is not the case overseas, where massive surveys have been conducted and the data has been used to help clothing manufacturers improve fit and identify new markets. This research has led to developing better-fitting uniforms and safety wear, reduction in waste and improved ergonomics and comfort in seating for cars and public transport.

## Who's making the clothes on your back?

Geelong was founded on the strength of its textiles, clothing and footwear industries, with the region's long association with the wool industry resulting in the establishment of a number of wool and textile-related industries.

Some examples of these are Australia's best known surfwear Rip Curl and Quicksilver and carpets from Godfrey Hirst that are now shipped and sold internationally from Geelong.

## Online Return = Real World Rubbish

Sucharita Mulpuru, a retail industry analyst, explains:

Within the online retail industry, clothes have a very high return rate. On average, 22% of clothing sales are returned!

While clothing retailers have improved significantly in the last decade, particularly focusing on fixing photography, sizing and fabric and quality control around shipments, clothing returns continue to be a significant problem.

What happens to the clothes after they are returned?
When you return clothes, the manufacturers don't just dust them off and put them back up for sale. In far too many cases, clothes returned find their way to landfills.

### Transport Troubles

When transporting clothes by truck, they are often carried as hanging garments, while other clothing items are generally transported folded flat in boxes.

Care needs to be taken to protect the clothes from exposure to sunlight, heat and moisture.

Clothes require certain temperatures, moisture and ventilation conditions to maintain strength and colour, and avoid shrinking, brittleness and pests.

***How can we innovate the clothing industry?***

***How can the process of transporting clothes change? Is there a packaging solution to clothes on hangers?***

***There is a lot of packaging that comes with clothes – what impact does that have?***

***How can online customers needs be better met?***

***Would meeting customers' needs better reduce waste?***

# Problem Card 6:
# Achieving an Inclusive Society

Disabilities impact many Australians in lots of different ways– but in assisting these individuals we need to be careful to not underestimate their ability. Understanding what an individual needs is the focus of achieving an inclusive society with disability technologies.
Is your school inclusive? How does it cater for students with disabilities?
Assessing school safety for all students should be a focus.

**Community Play Space**

The Play Space is accessible and offers the opportunity for families to enjoy social interaction and activities for children of all abilities.
It is an attractive natural space for everyone to use and is unique in design, considering different ability levels and providing an activity space for a wide age range.

In 2001, it was identified that there was the need for a regional play space that could cater for children with disabilities, providing a model of inclusive design for the region.

## Disability and Sport

Wheelchairs and prosthetics (artificial limbs) assist disabled people to be mobile, but what if simply being able to move isn't enough?

In the endeavour to go higher, faster and longer, athletes with a disability have found these standard devices can inhibit their sporting performance. How can innovation assist disabled athletes to be all they can be?

Traditional wheelchairs have been modified over time to meet the requirements of the need for rapid acceleration and sudden changes of direction in sports. Understanding the needs of wheelchair athletes assists in the design of disability technology.

# Video games for people with disabilities

Ben Egliston – University of Sydney

Anyone can play video games, right? It's true that more people are now able to play games without much gaming knowledge– thanks to Nintendo Switch or Sony's Playstation. However, all video games are technologies of the body. We scan movements on the screen with our eyes, grip controllers with our hands, rapidly tap buttons with our fingers, and so on.

Some things need to change with the design of games and gaming controllers to make them more accessible for people living with disability.

The video game industry needs to improve in this area. Can you think of how to make your favourite game accessible to someone who doesn't have the ability to grip a controller?

Want to see the 10 coolest recent inventions to assist the blind?

Check out the website!

**How can we innovate to encourage all abilities?**

Imagine if schools could anticipate what students with disabilities needed so the school could be prepared for all students?

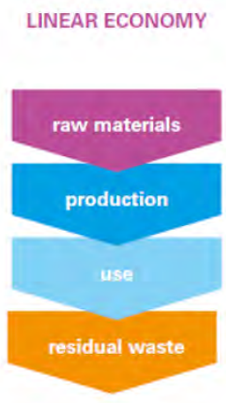
Or if the needs of a disabled user were thought about during the design of equipment?

Designing a tailor made wheelchair for athletes by understanding the needs of their sport could literally change the game!

# Problem Card 7: Circular Economy

When we think about circular, we can think about a circle or a loop. When we think about economy, we can think about products that are made, bought and sold. Therefore, the meaning of a circular economy is one where products that are made and sold are done so that there is limited waste.


Circular economy, wastes nothing. Materials are recycled or reclaimed.




A Linear Economy takes raw materials and transforms them into products that are used until they are finally discarded as waste. There is no recycling or reusing.

## Why some plastics are not part of the circular economy.

Qipeng Guo - Deakin University

Plastics make up around 10% of solid waste in Australia. While we can recycle certain types of plastic, there is a group of particularly stable plastics called thermosets, common in electronic devices, which can't be broken down and recycled.

Thermoplastics – such as plastic milk bottles, Lego bricks and guitar picks – can be melted and reshaped repeatedly. If you hold a flame to a plastic milk bottle, it will warp and melt.

But thermosets – found in kitchen utensils (think of a plastic spatula)and in electronics such as circuit boards which are intended to be used in hot environments– retain their strength and shape even when heated.

This means that any product made from a thermoset plastic can't be recycled and enters the waste stream of the linear economy.

If companies are making products from thermoset plastics, they are not part of the circular economy and generate that 10% of solid waste in Australia.

**Composite Materials**

Composite materials come from a combination of two or more materials used together to form a much stronger material. Many things are made from composite materials such as Novak Djokovic's tennis racket, Mark Webber's F1 car, wind turbines and the new Boeing 787.

The problem with composite materials is that they are difficult to recycle meaning the products end of life enters the waste stream of the linear economy. Many industries are working on a way to recycle composite materials.

Timberland produces footwear using recycled tires!

Johnson Controls has managed to design a battery that is 99% recyclable, an incredible feat for a product so chemically complex and hazardous. Do you recycle your batteries?

## How do we create a circular economy?

In reading these stories we can see that lots of industries and products need to think carefully about the 'end of life' of their product. It's great that wind energy is helping to generate clean and renewable energy but that is not very good if all the used turbines go to waste! There are many uses for plastics and composite materials but we need to think about where they will end up before we start production.

If materials cannot be recycled (melted and changed) when they are finished with, is there a way they can be repurposed?

# Problem Card 8: Microthread Pollution

What type of plastic is most commonly found in our oceans? Plastic bags?Plastic wrappers? Guess again. You are wearing it.

Over 60% of the plastic debris found in the marine environment are from microfibres from our clothing. 3/4 of all clothes produced contain synthetic (man made) fibres such as polyester, Lycra, nylon etc...otherwise known as plastics.

This global issue has increased by over 450% since the 1960s. Scientists have discovered plastic waste from microfibers is six times greater than the plastic from other sources, like bottles, bags and wrappers.

## How does what we wear affect aquatic life?

As we shed skin and hair, our clothing fabrics also shed fibres. When we so innocently place our dirty laundry into our washing machines, tiny synthetic fibres from our clothing begin a journey themselves.

The waste water from our washing machine carries these microscopic fibres straight through washing machine filters and past sewerage system filters on the way to rivers, lakes and oceans.

Plastics are entering the world's oceans at an alarming rate. It is estimated that there are at least five trillion plastic pieces on the surface of the oceans with eight million tonnes of plastics leaking into the ocean every day—that is the equivalent of one garbage truck of plastic every minute of every day of the year.

Scientists have looked inside the stomachs of different fish from lakes and oceans around the world and have found plastic in 1 out of every 4!

For more information on the microfibre issue and ideas, check out the website!

**How could we prevent microthreads from polluting the environment ?**

**Can clothing manufacturers help solve the problem with what materials they use to make clothing?**

**Can synthetic materials be changed to stop them shedding microthreads?**

**How could washing machine manufactures help solve this problem?**

**Is there something Governments and councils could do to protect our oceans from these tiny fibres getting through our sewage system?**

**Who would benefit and who's responsibility is it anyway?**

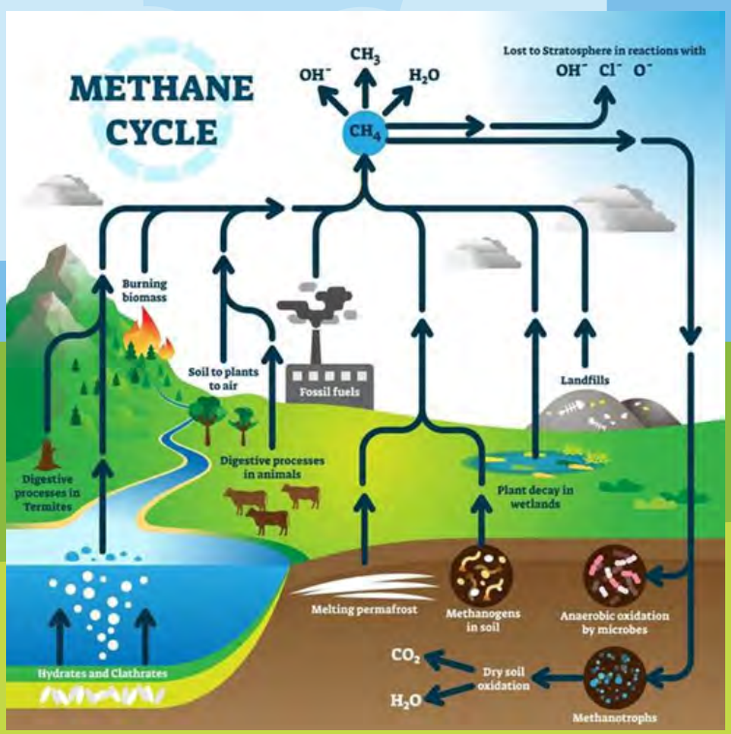
# PROBLEM CARD 9: DAIRY INDUSTRY

Western Victoria has around 1,170 dairy farms producing 2 billion litres of milk a year! But have you ever wondered what impact these cows and this industry have on the land? A by-product of milk production is a powerful greenhouse gas called methane. Methane is a problem, but it could also be a solution as methane can be burnt to produce energy. Imagine a future where the methane from farms stayed on farms and didn't contribute to environmental problems – now that's cool.

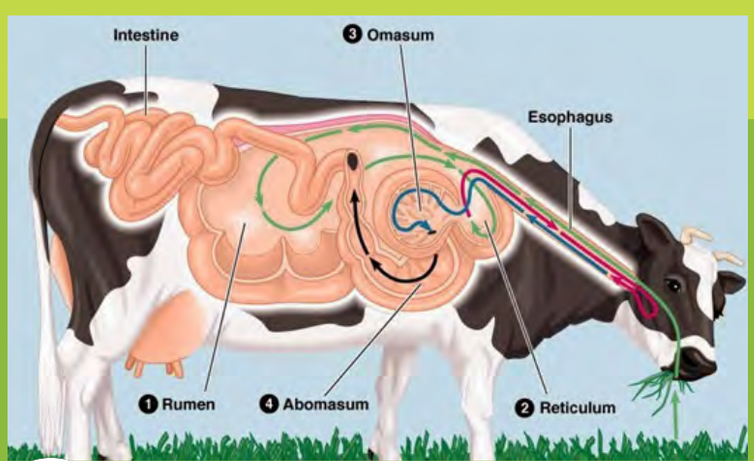
## How do cows produce methane?

Cows are herbivores and mainly eat grass. As you can imagine grass does not have a lot of nutrition therefore, cows have adapted a specialised digestive system to get the most nutrients from grass as possible.

Cows have one stomach with 4 chambers called ruminants. A ruminating animal stores and chews it's food more than once. The balls of food, or the cud, are regurgitated and chewed more than once to extract all the nutrients. When the grass breaks down methane is released by burping (90%) or when the grass moves all the way through the digestive track and is released as farting (10%).




Cows are not the only animals that produce methane. Methane is produced by anything breaking down including rotting plants, animals, or food we through away. However cows are the most significant contributors to excess methane in our atmosphere.




## Is Methane All Bad?

Earth's atmosphere needs methane to stay warm, without methane all of the Earth's warmth would escape into space and Earth would be frozen, but too much methane and the Earth gets to warm – this is the problem with Climate Change.

## Poo-lotion Solution?

Many countries reduce their methane emissions by turning waste into energy!

Take Vietnam for example – lots of regional households have family pigs that are raised for meat but can also be used to reduce waste by eating household vegetable scraps.

Pigs are not ruminating animals, but they still fart out methane and methane is emitted from their poo.

A very effective way of reducing that waste is to collect the poo in a biodigester. The biodigester traps the gas and that can be piped into homes for cooking on gas stoves.

## Stock feed to reduce methane

Farmers in Ancient Greece did not have to worry about Climate Change but they did need to worry about what to feed their precious dairy cows and often used seaweed to supplement their feed.

Research from Canada has discovered that cows feed supplements made from seaweed can reduce the amount of methane production by 20%. So why not just feed cows seaweed?

Cows have not evolved to eat a diet made up completely of seaweed. The researchers looked at the amount of seaweed needed to reduce methane production and found that the quantities would need to be too high to be good for the cows.

However, new Australian research into different types of seaweeds is looking promising. Maybe in the future our cows will have a very different diet.

For more info on climate change and methane reduction, check out the website!

How can we innovate the diary industry so that the impact on the environment is not so great?

Is there a way to balance the good and bad aspects of methane and milk?

How can we educate people about what happens during milk production?

If we didn't have milk what would change?

# PROBLEM CARD 10: HYDROGEN FUTURES INDUSTRY

We have all heard about the impact global warming is having on our environment. There are many gases in the atmosphere that are contributing to climate change – but the worst culprit is carbon. Carbon is emitted as a by-product of burning fossil fuels like petrol, diesel and natural gas. These non-renewable fuels not only harm the environment, but take millions of years to create and are running out. There are lots of alternative energy sources like solar and wind but have you ever thought about a gas as a way of fuelling the future?

## What is Hydrogen?

Hydrogen is the most common chemical in the universe and is the third most abundant element on the Earth's surface after oxygen and silicon. We often think of hydrogen as a gas but actually there is very little hydrogen gas in Earth's atmosphere as it is a light gas and can easily escape Earth's gravitational pull.

Hydrogen has been used as a fuel for a very long time – in fact the first rocket to the moon was powered by hydrogen and it still used as a rocket fuel today.

### *Where Does Hydrogen Come From?*

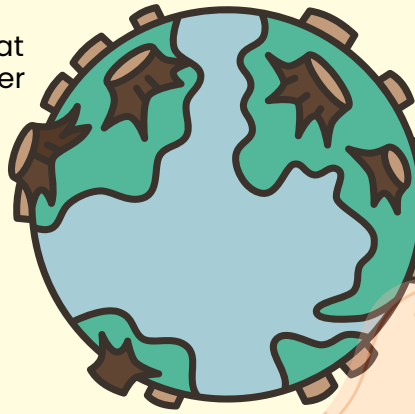
At the moment there are 4 main ways to get hydrogen:

Biomass: trees and other organisms can draw carbon from the air and combine it with hydrogen to grow bigger (hydrocarbons).

Natural gas and other fossil fuels: this means breaking the hydrocarbons up releasing carbon and hydrogen.

Solar: sunlight can directly and indirectly provide energy to produce carbon but it is complicated.

Wind: wind energy can generate electricity and that electricity can be used to split hydrogen from other compounds.



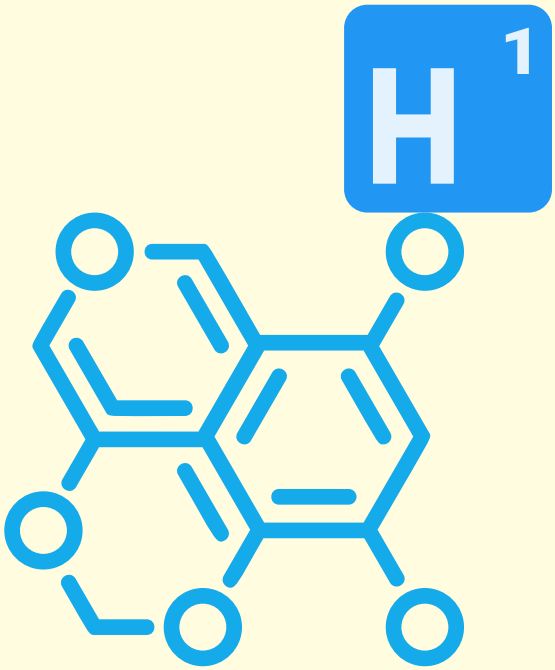
## How does hydrogen power electric cars?

Hydrogen contains a lot of chemical energy and when ignited will react with oxygen to cause a powerful explosion. There is, however,a way to use that power and contain it in a hydrogen fuel cell.

The hydrogen fuel cell can take energy in the form of hydrogen and use it to power an electric engine in an electric car. It works by having a safe and secure hydrogen fuel tank, much like a petrol tank, where the hydrogen is stored before it is mixed with oxygen.

Inside the fuel tank a chemical reaction occurs that frees electrons from the hydrogen to produce water and the electrons are used by the electrical energy as energy powering the car.

This type of car is called a Fuel Cell Electric vehicle and is different from a battery electric vehicle. Telsa is an example of a battery car and gets its energy from solar panels.




For more info on hydrogen and how it may be used to power homes, check out the website!

How can we innovate the future of the hydrogen industry?

What sort of impacts are carbon emitting cars having on our society and how can these impacts be minimised?

Is there a way to balance the good and bad aspects of hydrogen as a fuel source?

How can we educate people about hydrogen as a fuel source?

Are we ready for hydrogen energy, and if not, what needs to change?

# PROBLEM CARD: 11
# FLOODPLAIN MANAGEMENT

You have no doubt seen footage of what can result when flash floods hit our towns and cities. Strong rains and blocked drains can happen anywhere, but towns built in low areas, near seas or near waterways may be more prone to flooding-and the damage from floods in these places can become catastrophic.

Waterways engineers are in charge of understanding flooding in the area and what that means to the protection of buildings, roads and bridges. They have a big job ahead of them as a changing climate is causing flooding patterns to become unpredictable.

## WARRNAMBOOL WATERWAY WOES

Warrnambool Victoria is a flood prone area because of its location between the coast and a river. The image above we can see where flooding is likely to occur in the township of Warrnambool. The biggest flood ever recorded was in 1946 – known as the Big Flood when waters rose to over 8 metres.
The Glenelg Hopkins Catchment Management Authority is the government body assigned to looking after waterways in the district and play an important role in preparing for flooding.

Maybe there is a design structure that could protect homes from flooding? Or possibly a material that can make a house stronger? Some developments push water away from infrastructure and into other areas – has this happened here?

## Why build near water?

Many towns were settled along waterway in order to provide easily accessible freshwater for residents and livestock as well as fertile land. What early settlers did not realise is that that fertile land was due to repeated flooding events.

Floods happen when water falls as rain somewhere in the catchment, usually in hilly areas. In hilly areas the water flows down creeks and rivers quickly. This quick flowing water does not have the opportunity to fill up the waterway as it is moving fast. It is not until the water reaches areas in the catchment that are flat does flooding become a problem. When neighbouring rivers join during floods aquatic animals get to migrate to different areas and provide valuable new genetic material to other populations.

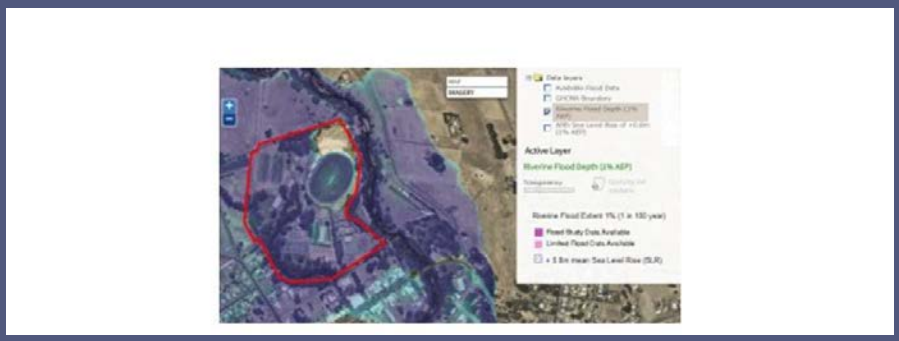
In addition, the fast-flowing water brings fresh nutrients and soils from other areas in the catchment. This then makes it a great place to grows crops and food.

# Floods

## How can models be made that tell us about floodplain management?

Understanding flooding can mean assets such as houses, farms, sheds, schools, roads and bridges can be protected in a flooding event.
How do we know where the water will go? In some circumstances it is not possible to predict where the water will go, but gathering data when there is a flood event gives a good indication of where the water might end up. The most effective flood water data is photographs and marking high water.

When there is data a model can be made that is used to predict future risks in the floodplain such as the one below.



AN EXAMPLE OF A FLOOD PLAIN MODELS WHERE THE RED LINE IS THE PROPERTY AND THE PURPLE IS THE PREDICTED FLOOD EXTENT.

## How can we innovate the floodplain management?

What sort of impacts will climate change and flooding have on our society and how can these impacts be minimised?

Is there a way to balance the good and bad aspects of flooding?

How can we educate people about what happens when we develop floodplains?

How can engineers and councils design with natural disasters such as flooding in mind?

If we didn't do anything what would change?

## Flooding happens all over the world, what can we learn?

Japan for example has prepared for Typhoons and their associated flooding by building massive storm water tunnels under large cities like Tokyo.In Demark cities prepare for flooding by building parks that are designed to flood, therefore concentrating flood water into areas away from houses, roads and other infrastructure. If we know that flooding could get worse there is a chance to prepare.

TOKYO STORM WATER DRAINS – WOW!!

# PROBLEM CARD 12 Bee Pollination

## How can we protect Australian agricultural industries from potential threats? In what ways can science and technology assist us with this process? Scientists ask questions and undertake investigations to determine the success of innovative solutions to problems caused by these threats.

## THE LATEST BUZZ IN BEE POLLINATION…

We have all seen bees buzzing in our gardens. Visiting flowers, gathering and spreading pollen grains as they go. Bees are powerful pollinators and important in our food supply and industries producing fruits, vegetables and nuts.

### Buzz on- Almond crops

Almonds are a huge crop in Australia with 61% of almonds are grown in Mildura's sunraysia district in Victoria. Almond pollination in Victoria requires **200,000** bee hives. Victoria has **120,000** bee hives and relies on the additional bee hives to come in from NSW. When the Varroa mite outbreak was detected in NSW in June 2022. The hives were 'locked out' of Victoria to protect the bees. The almond growers were seriously worried about the timing of the pollination of the almond crops. Concerned about how they would pollenate crops without the extra help of the NSW bees.

### Whats the problem?

You might have heard of Varroa mite (Varroa destructor) a small round brownish-red blood sucking mite with a big impact. The mite has only recently been detected in Australia in New South Wales (NSW) and affects bees. This has the **horticultural** (food producing plant growing) industry worried. The Varroa mite causes problems for developing bees. The mites survive on the bee larvae and cause body and wing deformity, reduces their overall health and chance of catching viruses. The presence of the mite makes it hard for the bees to perform their role of pollinators for important food crops like almonds, avocados, fruit and grains.

## Bee lock down

A key threat to Australia's bees is the Verroa mite.

Australia is one of the only countries in the world that does not have a permanent population of Verroa mites.

To help the most recent outbreak the government has called a 'lock down' of bee's keeping NSW bee keepers out of Victoria! This helps to protect bees by limiting the spread of the Verroa mite.

But it comes with a cost for industries like the almond industry. They require bees to pollenate their trees as they blossom over at the beginning of spring. Without the bees this can reduce the size of the crop produced by almond growers in Australia.

## Industry challenges

In Victoria science researchers and field officers work with industries, communities and farmers to help reduce threats to the industry. Agriculture Victoria research scientists help horticultural industries thrive! Their role is to help solve problems that arise when pests (plants animals or insects) move into agricultural areas.

- What would happen if bees didn't pollenate crops?
    - What this would mean? Would we have enough to eat?
    - What would happen to the foods we eat?
    - Would the crops survive?
- How can technology help the process of pollination?
    - Can we pollenate crops in different ways?
- Can we create more bee habitat to help overwintering of bees?

## Brilliant Bee links:

Bee maps and bee gardens

Paintbrush techniques

Bee hygiene and checking

The purple hive project- Bee Cause- High tech early warning device

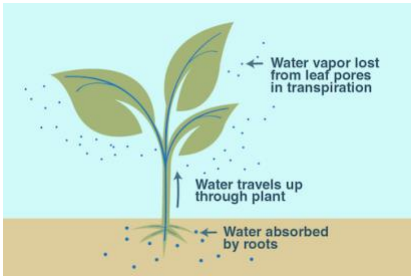
Engineers design artificial intelligence varroa mite sensing bee hive | Bee Cause #1 | ABC Australia

# Problem card 13

# Grain research - climate changing crops

It is no secret that the earths climate is changing. Our climate is changing quicker than ever before. We are experiencing the hottest summers, longest drought periods and the biggest storm events on record (since people began to record the earth temperatures in 1800's)! These hot dry conditions affect all living things on the planet, especially the plants we grow!

## Can't stand the heat!




Have you ever forgotten to water a plant, and seen the drying effects of life without water. Leaves quickly become limp and begin to droop (especially if it is in a warm sunny spot). Plants need water to keep its leaves in tip-top shape so it can **photosynthesize** and make the energy needed to grow and produce fruits, seeds or leaves. Plants can't simply get up and move to a more suitable location, they have to stand the heat if they are to survive.

## Developing climate ready seeds

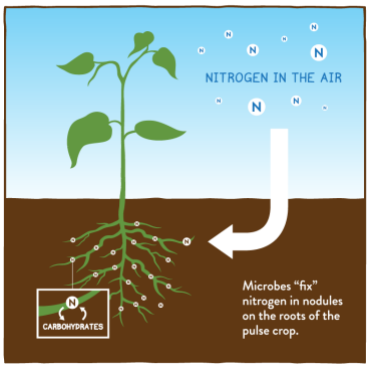
Plant research helps the cropping industries farmers grow the best crops, to put food in our supermarkets and onto our tables, plus have grains to trade around the world. Agronomists and research scientists work to develop varieties of plants to best suit the environmental conditions. They want to create seeds that will germinate and grow well in the changing climate (less water and increase in heat) and are adapted to the changing environmental conditions. To do this the scientists work on trials to cross pollenate strains of plants and select the strongest that survive. They help the process of **natural selection** to grow climate adapted seeds.

## Do rain fed crops grow great yields?

The growing of large scale crops for food production is big business with over 3 billion dollars made from the industry each year. These crops include legumes (chickpeas, lentils) and cereal crops (wheat, barley). In the Wimmera Mallee region of Victoria the food crops are rain fed. These crops rely on natural rainfall to nourish the soil to survive. The timing of the rain is very important but so are a number of other factors as well, like the temperature and the intensity of the sun. its all about increasing the plant yield (harvestable seeds).

**What are super power plants?**

Legumes are a special group of plants that have a superpower. They are able to take the nitrogen from the air store it in the ground with the help of soil microbes. These nitrogen fixers have protei in their seeds and are highly sought after in the world grain market! They are the a superfood source. Super helpful for soils and so good for us.





**If its not meat what is it? Climate saving burgers**

There is a growing trend in food at the moment that includes a substituting meat for plants. So if its not meat what is it? Legumes or protein based seeds are at the source. The crushed up grains are shaped into burger sized patties and sold as a eco-plant based alternative. This new food trend is climate friendly, good for the planet and good for our health too! Less cows, less methane, reducing the release of poo-lution and climate harmful gases.

**How does science help grow great crops?**

**What new technologies help our food industries?**

**Is plant based meat a solution to climate change?**

**Can tests and trials can inspire new innovation in plant selection technologies?**

**Will there be an increase in the need for grains in the future?**

# Girls as Leaders in STEM
# Problem Card Lesson Plan 1-4

## Introduction:

The following nine pages will introduce you to specific lesson plan regimes and assessment ideas connected to the GALS Problem Cards. The lesson plans form a framework which can be applied to any problem card. Included in this resource are links to Victorian Curriculum discipline strands, content descriptors and achievement levels. Learning intentions are explicit to lessons and tasks.

## Learning Intention:

- Students pose questions to clarify the nature of a problem and make predictions
  ***(Lesson 1: Task A)***
- Discover alternative ideas and consider how science is used to enhance people's lives
  ***(Lessons 1: Task A, Lesson 2, Lesson 3: Task A)***
- Students will be able to communicate ideas using judgements and experiment with alternative ideas suspending judgement
  ***(Lesson 1: Task B, Lesson 3: Task A & B)***
- Students reduce large pieces of information into smaller pieces that can then be used to fill gaps in knowledge
  ***(Lessons 1: Tasks A & B)***
- Students critique the needs and opportunities for design and development of components
  ***(Lesson 3)***
- Generate, develop and test idea plans
  ***(Lesson 4)***

# Lesson one: Getting to know the material

## Task A: Organising information

- Arrange the students into teams of 5.
- Assign each member of the team a different Problem Card – or the students can choose different cards that interest them.
- In a Think-Pair-Share activity, students first individually read the text found in the Problem Card and summarise what they think the key information is. This can be done in dot point form.
- Have the students Pair up with team members from another teams who share their summarised Problem Card. Students need to share what they think are the key information points are and try to match their key points with other so there is a common set of key points. If there is a point that is not shared students need to determine amongst themselves if that point is key information or useful information. They can determine this by answering the following questions:
    1. Does this piece of information explain something about an action or process? If yes, then it is a key piece of information.
    2. Is this piece of information repeated throughout the problem card? If yes, then it is a key piece of information.
    3. Does this piece of information name an action or process that is needed to identify it later?
       If yes, then this is a key piece of information.
    4. Does this piece of information remind me of something I have heard somewhere else?
       If yes, then this may not be a piece of key information as the reasons behind when you heard it last may have changed – the information may be familiar but not essential to understanding the information on the Problem Card.
    5. Everybody else says it is so it must be!
       If yes, then this may not be a key piece of information. It is ok for you to ask the other why they think it is and for you to say why you think it is not. Make sure you listen to everyone and that everyone listens to you. Only then decide if it is a key piece of information.
- Once students have a set of dot points that include a shared understanding of the key pieces of information they can return to their original team of five and Share their key pieces of information.

**Diagnostic assessment**: Listening to the students as they negotiate their common understanding of the key pieces of information. How they justify their thoughts will give you an indication of how novel the information is to them. As a general rule the better a student is at justifying their key pieces of knowledge the less novel the information is. Students who are struggling with their justification probably have not had a lot of experience with the information. In the event that the information is novel to a whole team have some probing questions ready such as:

1) If this was a story where would it be set and who are the characters?
2) Choose any piece of information and try to think about why the author has told you that.

3) Choose another piece of information and think about if knowing this make you change your mind about something.
4) Choose another piece of the information and think about what would happen to your understanding if that was left out.

## Task B: Understanding the information

- Students now need to form teams and choose a problem card that they would like to work with.
- With their chosen problem card students should begin to understand some of the novel information and to document how their learning is progressing.
- Students should first draw up a KWL chart – what do I KNOW, what WOULD I like to find out and what have I LEARNT.
- Using their chosen Problem Card and some sticky notes students should read the card and write down things that are familiar to them (Know) and things that are unfamiliar (Would). The W section could include words, actions or processes. This part is important as the Problem Cards have been designed with industry professionals, students could come across technical language or names of action and processed that are novel.
- Students can then use the ideas on the W sticky notes to begin researching the meanings of the ideas or words they find novel. Some places to begin your research could be a dictionary or an internet search. There may be an opportunity to interview an expert. Experts can be found as members of your parent community, local government, or outreach project such as the CSIRO STEM Professionals in Schools or tertiary institutes like Deakin University.
- As students generate answers to their questions, they can move their sticky note from the W column to the L column.
- Before moving a W to the L column students need to complete an exit interview. This requires students to be able to explain to their teacher or a peer the meaning or understanding of their chosen W sticky note. Once the students have provided evidence of their understanding then they can move the sticky note

**Formative Assessment:** As students' knowledge increases and words, actions and processes become more familiar they will perform an exit interview as part of ongoing formative assessment.

## Lesson 2: Organising the information

- Each Problem Card has a number of stories that showcase different angles of the same industry problem. For example, the 'Innovation in the Fashion Industry' card highlights 3 aspects of the fashion industry that can be broadly categorised as waste, local career opportunities and consumer confidence. These are all real-world problems faced by the fashion industry.
- Students use Appendix 1 the Graphic Organiser or Lotus Diagram to identify the broad problem categories found as part of the information on their problem card and place the categories is the white squares.
- In their team groups the students can then use the radiating squares to organise information from the Problem Cards as well as information gained from the KWL task to document ideas generated.

## Lesson 3: Working with the Material

### Task A: Generating ideas

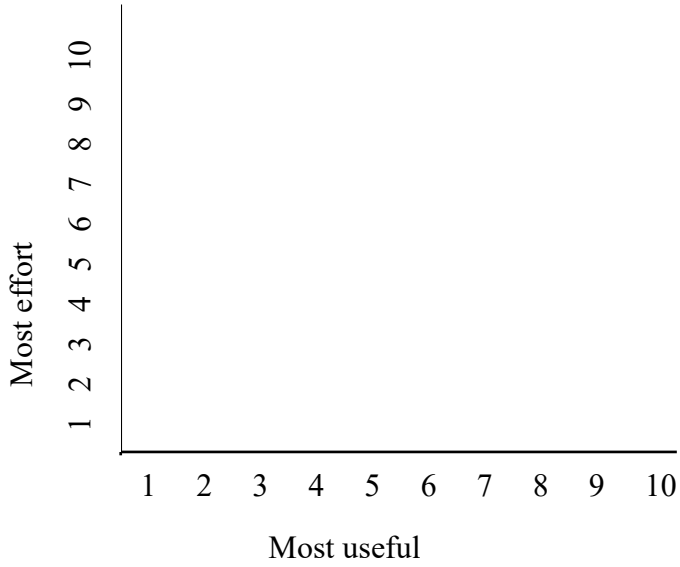
- Students now need to consider solutions to the problem presented in the Problem Cards. The best way to do that is to generate lots of ideas.
- To warm students up have a discussion about problems in industries that have been solved using examples they are familiar with such as:

  Apple iPads have a fragile glass screen that is easily broken. This problem was solved by designing a protective case. Use an iPad as an example of the product and the case it goes in. Look at the design features and consider the material it is made of.
- Use a Popcorn Assessment technique to have students identify problems and solutions drawing from their own experiences. To begin the Popcorn Assessment the teacher chooses the first student to describe a problem and the solution. After the first student has answered that student chooses the next student to answer. To encourage active listening, you can make a rule that once a problem has been said it cannot be repeated. If students have their answer 'taken' or are feeling overwhelmed they can opt to pass and put their hand up when they are feeling prepared. This activity ensures all members of the class are heard.
- To begin working with the problem on their Problem Card students need to first identify which category of problem they would like to solve. This can be done by using the ideas generated with the Graphic Organiser.
- On a large piece of butcher's paper students should spend up to 40 minutes generating ideas to solve the problem they have chosen. This long period of time is needed as there is an emphasis on squeezing out every idea – even the far-fetched ones that come out when all other ideas have been exhausted.

**Diagnostic assessment:** Listening to the students' ideas will give you an indication of those who are able to generate lots of ideas and those who are having trouble. At this point it may be necessary to change member of teams so there is a balance of those who generate lots of ideas and those who can use ideas as inspiration for their own thinking.

## Task B: Evaluating ideas

- On a large piece of butcher's paper or a table based white board students should draw a graph with an x and y axis – this is called the Ideainator.
- The Ideainator has an x axis that is labelled 'usefulness' and the y axis is labelled 'effort' with a scale of 1-10. 10 being the most useful or the most effort.




- Students then place their ideas on the Ideainator taking into consideration both the usefulness of the solution and the effort it would take to design and develop that solution.
- Once all ideas have been ranked on the Ideainator students can evaluate which ideas are worth perusing. For example, an idea that has been evaluated as 10 Effort and a 2 Usefulness does not need to be perused whereas an idea ranked 2 on Effort and a 7 for Usefulness is likely to be a candidate to peruse to development.
- It should be made clear to students that just because an idea has ranked high on the Effort scale it should not be discounted. An idea that ranks as a 10 on the Usefulness axis and a 10 on the Effort axis may be worth the effort to design and develop given its highly useful nature.
- Students should be able to pick 5 ideas from the Ideainator that are worth pursuing.

**Formative Assessment:** Observing students whilst they evaluate their ideas on the Ideainator will generate student data that can be used to determine those students who can be both creative and critical with their ideas. For those who are not as proficient with the critical aspects of their ideas ask them further probing questions about the effort or usefulness of their ideas. Questions could include:

1) What type of material would you need to develop that idea? Is that material available? Is it expensive? If it is how much do you think people would pay to have this product?
2) Is that product useful to everyone or only a few people? If it is only useful to a few people, then maybe it is not as useful as you first thought.

# Lesson 4: Th e Design Process – Summative Assessment

- Page 2 of the GALS Teacher Guide shows the following Design Process Table and instructions:

**The Design Process**

| | |
|---|---|
| **1) Define the Problem** | What is the problem or need? Who has the problem or need? Why is it important to solve? |
| **2) Do Background Research** | Learn from the experiences of others —do background research in two major areas: Users or customers, Existing solutions |
| **3) Specific Requirement** | Indicate the important characteristics or criteria that your solution must meet to succeed. Eg consider an example of a similar product, noting each of its key features. |
| **4) Brainstorm Solution** | Try to generate as many possible solutions as they can as there are always more than one way to do something. |
| **5) Choose the Best Solution** | Check which solution best meets your design requirements. |
| **6) Develop the Solution** | Refine and improve the solution. You may come back to this step more than once. |
| **7) Build a Prototype** | A prototype is an operating version of a solution, object, product, or service, made with simpler materials. It represents your key ideas. |
| **8) Test and Redesign** | Test your solution, find new problems, make changes, and test again before settling on a final solution |

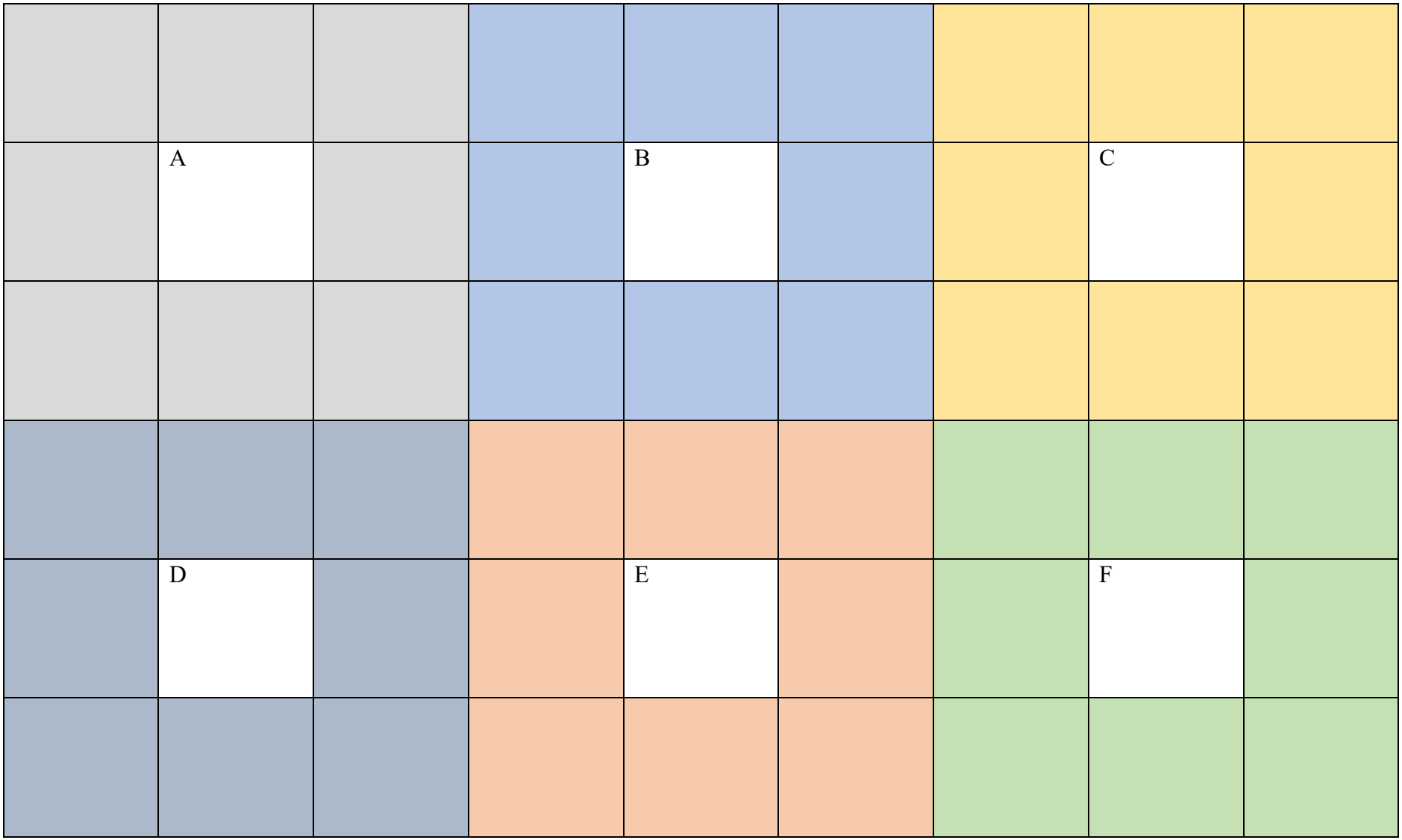
- From the Ideainator task your students will have some idea of the problem the have defined and the possible solution. They now need to settle on a solution and begin designing that solution.
- Work through the 8 elements of the Design Process using Appendix 2 as a guide to achieve an artefact that can be displayed as a solution to the identified problem.

# Curriculum Links

| Strand | Sub-strand | Content description | Achievement standard (extract) | Lessons | | | |
|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 |
| Science Understanding | Science as a Human Endeavour (5-6) | Scientific understandings, discoveries and inventions are used to inform personal and community decisions and to solve problems that directly affect people's lives (VCSSU073) | … discuss how scientific understandings, discoveries and inventions affect peoples' lives. | ✓ | ✓ | ✓ | ✓ |
| Science Understanding | Science as a Human Endeavour (7-8) | Scientific knowledge and understanding of the world changes as new evidence becomes available; science knowledge can develop through collaboration and connecting ideas across the disciplines and practice of science (VCSSU089) | …discuss how science knowledge can be applied to generate solutions to contemporary problems and explain how these solutions may impact on society. | ✓ | ✓ | ✓ | ✓ |
| Science Inquiry Skills | Questioning and predicting (5-6) | Pose questions to clarify practical problems or inform a scientific investigation (VCSIS082) | …students follow procedures to develop questions that they can investigate and design investigations into simple cause-and-effect relationships | | | ✓ | ✓ |
| Science Inquiry Skills | Questioning and predicting (7-8) | identify questions, problems and claims that can be investigated scientifically and make predictions based on scientific knowledge (VCSIS107) | …Students identify and construct questions and problems that they can investigate scientifically and make predictions based on scientific knowledge. | | | ✓ | ✓ |
| Science Inquiry Skills | Communicating (5-6) | Communicate ideas and processes using evidence to develop explanations of events and phenomena and to identify simple cause-and-effect relationships (VCSIS088) | …simple reports to communicate their ideas, methods, findings and explanations. | ✓ | ✓ | | |
| Science Inquiry Skills | Communicating (7-8) | Communicate ideas, findings and solutions to problems including identifying impacts and limitations of conclusions and using appropriate scientific language and representations (VCSIS113) | … simple word to communicate science ideas, methods and findings. | ✓ | ✓ | | |
| Critical and Creative thinking | Questions and possibilities (5-6) | Experiment with alternative ideas and actions by setting preconceptions to one side (VCCCTQ022) | … copy, borrow and compare aspects of existing solutions in order to identify relationships | | ✓ | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | and apply these to new situations. | | | | |
| Critical and Creative thinking | Questions and Possibilities (7-8) | Suspend judgements temporarily and consider how preconceptions may limit ideas and alternatives (VCCCTQ033) | …students demonstrate flexibility in thinking by using a range of techniques in order to repurpose existing ideas or solutions to meet needs in new contexts. | | ✓ | | |
| Critical and Creative Thinking | Meta-Cognition (5-6) | Investigate how ideas and problems can be disaggregated into smaller elements or ideas, how criteria can be used to identify gaps in existing knowledge, and assess and test ideas and proposals (VCCCTM031) | | ✓ | ✓ | | |
| Critical and Creative Thinking | Meta-Cognition (7-8) | Consider how problems can be segmented into discrete stages, new knowledge synthesised during problem-solving and criteria used to assess emerging ideas and proposals (VCCCTM042) | | ✓ | ✓ | | |
| Design Technologies | Investigating (5-6) | Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (VCDSCD038) | …they combine design ideas and communicate these to audiences using graphical representation techniques and technical terms. Students record project plans including production processes. | ✓ | ✓ | ✓ | ✓ |
| Design Technologies | Investigating (7-8) | Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas (VCDSCD049) | …create and adapt design ideas, make considered decisions and communicate to different audiences using appropriate technical terms and a range of technologies and graphical representation techniques. | ✓ | ✓ | ✓ | ✓ |
| Design Technologies | Generating (5-6) | Generate, develop, communicate and document design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (VCDSCD039) | … create designed solutions | | | ✓ | ✓ |
| Design Technologies | Generating (7-8) | Generate, develop and test design ideas, plans and processes using appropriate technical terms and technologies including graphical representation techniques (VCDSCD050) | | | | ✓ | ✓ |

Appendix 1 – Graphic Organiser (Lotus Diagram)



Name: _____ Group Members: _____

# Engineering Design Process