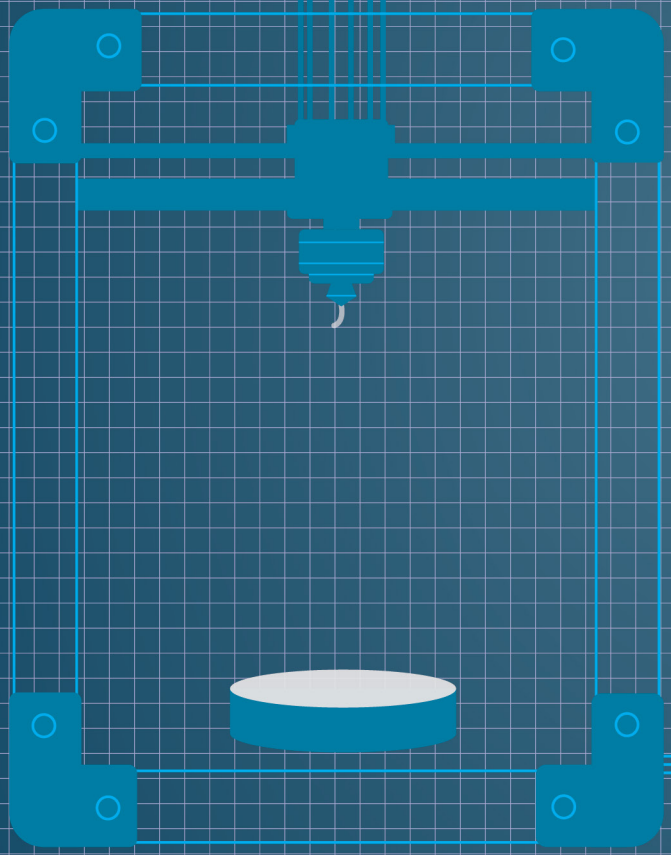
Ri Aus STEM careers



follow your interest in ...

3D PRINTING

STEM Careers Pack 5
Suitable for
Upper primary teachers
Careers counsellors
Year 7–9 science teachers

Government of South Australia
Department for Education and Child Development

Contents

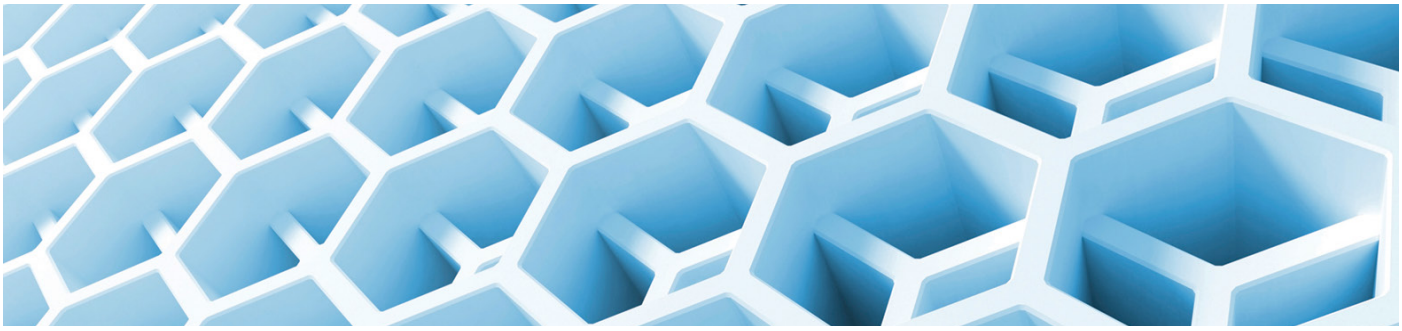
Pages

Tasks

How to Use this Pack:

- Designed to be used as a whole, or select individual tasks.
- In conjunction with units of work on Science Understanding and Science Inquiry Skills.

Introduction



Follow your interests in…
Each STEM Career Pack provides teachers with a sequential set of tasks and information, including interviews, to take into the classroom. The Packs are aimed at: helping students to understand the nature of scientific knowledge, how science influences society and how society influences science (i.e. Australian Curriculum: Science, Science as a Human Endeavour); and making students aware of the wide variety of exciting STEM careers they could aspire to.

STEM Career Packs 5 – 8 focus on four interest areas: 3D printing, Art Conservation, Robotics and Forensics. It is anticipated that students who don't typically 'like' 'science' but are interested in 3D printers, art restoration, robots or CSI television shows, will come to see how their interests relate to the science they study at school and STEM career possibilities.

Bringing STEM careers to life:
There is a current shortage of people, particularly women studying and working in STEM (also referred to in these Packs as 'science'). There are many factors at play supported by a substantial body of research; two of these factors are addressed in these Packs. The first of these factors is that students find it difficult to identify themselves with scientists, technologists, engineers and mathematicians; they can't picture themselves working in a STEM career[1]. The second factor addressed here is that many students are simply unaware of the STEM careers available, what day to day work is entailed and what pathways lead into these careers[2].

Why is it important to address these factors in the middle years? Research has shown that experiences prior to 14 years of age are pivotal in developing students' interests in science, and influencing career choices[3].

> *'When asked about when they became interested in science, 48 per cent of the students traced the origin of their interest to junior secondary school; 12 per cent mentioned primary school…'*[1].

[1] Office of the Chief Scientist 2012, Health of Australian Science. Australian Government, Canberra.
[2] Panizzon, D & Westwell, M. 2009, Engaging students in STEM-related subjects. What does the research evidence say? Flinders Centre for Science Education in the 21st Century, Adelaide.
[3] Tytler, R, Osborne, J, Williams, G, Tytler, K, Cripps Clark, J, 2008, Opening up pathways: Engagement in STEM across the Primary–Secondary school transition. Australian Department of Education, Employment and Workplace elations, Australia.

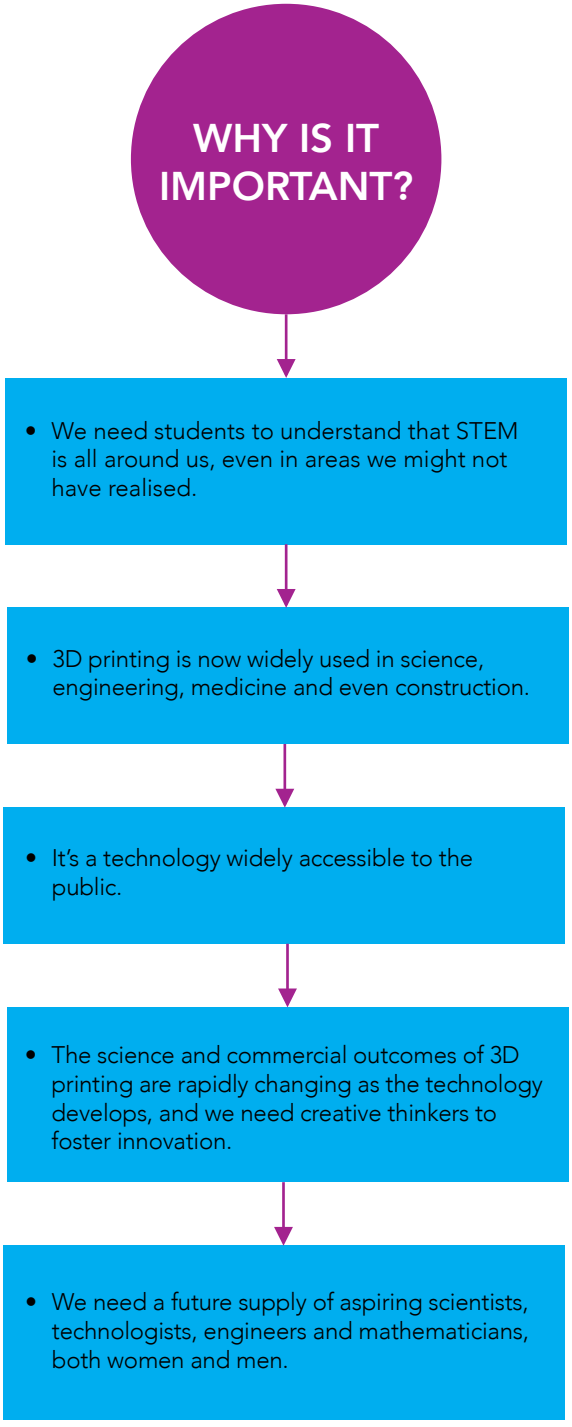
What do we want them to learn?

What is the intended learning?

It is intended that students learn about the ways in which 3D printing is transforming research, design and manufacturing. The potential products of 3D printing include everything from cars to houses to food and even body parts. Some industry experts say 3D printing might be the biggest thing to come along since the factory in the 19th century. 3D printing has been around for a while but is now widely available and affordable for the general public. It could spell the end for 'mass manufacture' – production lines spouting thousands of identical objects – and the beginning of 'mass customisation', where everything we buy is tailor-made for our individual needs. In this sense, 3D printing is not a specific invention but a revolution in how things are made.

What do students bring?

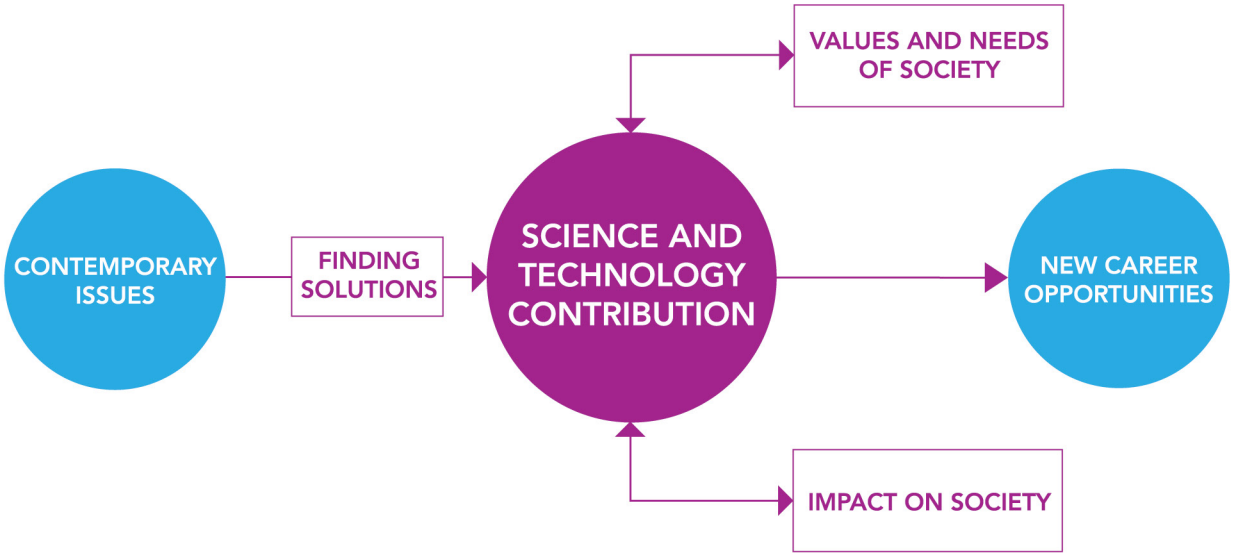
Students might have seen the products of 3D printing, read articles and viewed programs about 3D printing. They might have their own ideas of what can and can't be made using 3D printers and why it should or shouldn't be used for different applications, from weapons, to cars and body parts. Students' own perceptions and their awareness of the ideas of others will be enhanced through this guide.



Planning approach
Planning approach based on the SA Department for Education and Child Development's Learning Design: aligning what and how of teaching and learning in the Australian Curriculum. www.decd.sa.gov.au/teachingandlearning/pages/Leadersresource/44209/?reFlag=1

How will we know if they got it?

What could the intended learning look like at this level?



The **Australian Curriculum: Science** focus for this unit is **Science as a Human Endeavour**. Students will be able to look at the ways in which 3D printing is used in different jobs and industries. They will learn about the potential and current applications of the technology, its limits and the ethical concerns it raises. They will look at what careers are available to people using 3D printing now and in the future.

As well as identifying and questioning their own beliefs and those of others, students will understand why such beliefs should be openly questioned and how they can do this in a constructive, respectful manner. Students will be able to demonstrate an increase in their knowedge of science careers as well as the role of science in society.

Teachers use the intended learning, as indicated in the Quick Reference table for this unit overleaf, in conjunction with the Achievement Standards in the integration of the Tasks or the development of whole units of learning and assessment. Students will demonstrate development towards the following Australian Curriculum skills and dispositions.

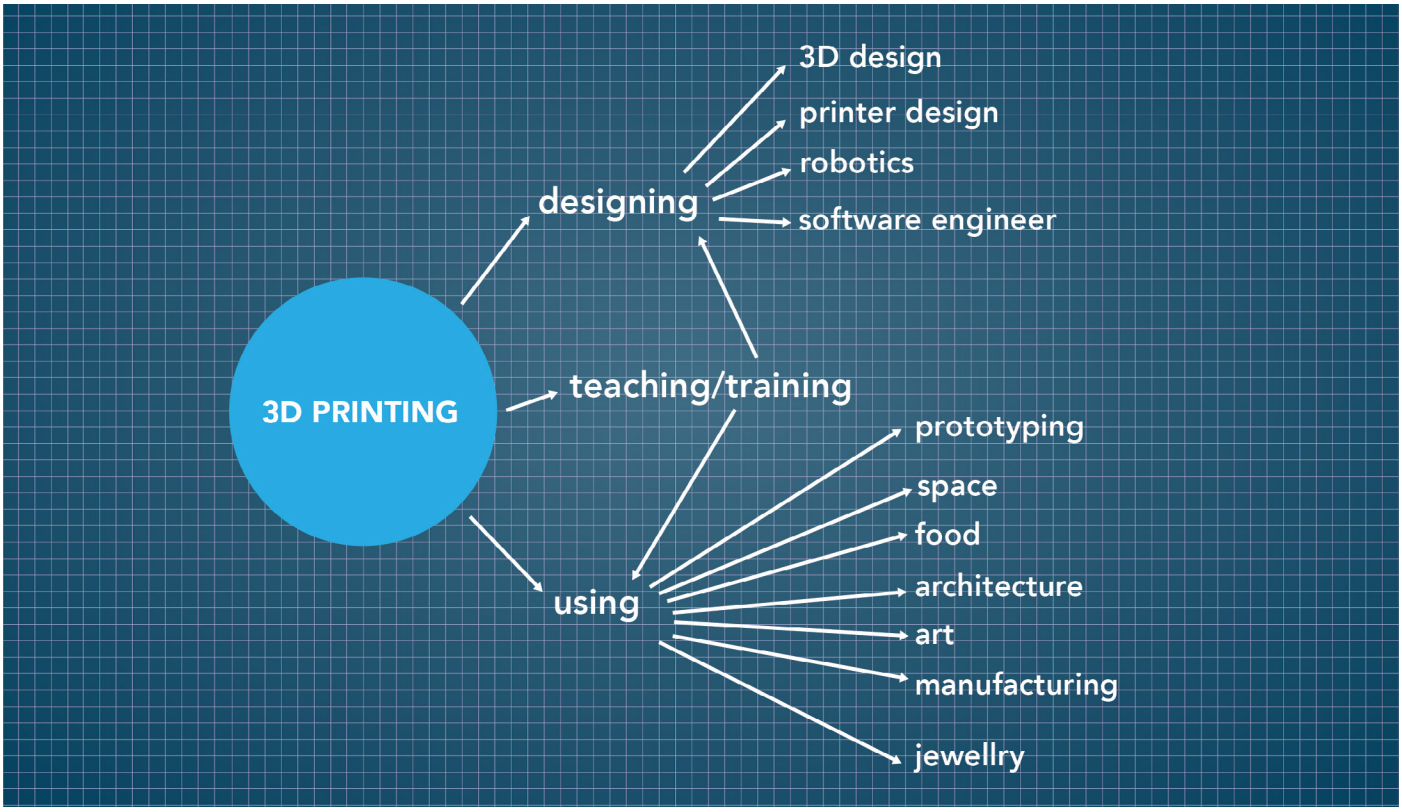
Quick reference table

Australian Curriculum: Science as a Human Endeavour

Australian Curriculum: Science as a Human Endeavour	Tasks				
Year 7	1	2	3	4	5
ACSHE120 - Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations.					
ACSHE121 - Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management.					
ACSHE224 - People use understanding and skills from across the disciplines of science in their occupations.					
Year 8					
ACSHE135 - Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations.					
ACSHE136 - Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management.					
ACSHE227 - People use understanding and skills from across the disciplines of science in their occupations.					
Year 9					
ACSHE158 - Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries.					
ACSHE160 - People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions.					
ACSHE161 - Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities.					
ACSHE228 - The values and needs of contemporary society can influence the focus of scientific research.					
Year 10					
ACSHE192 - Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries.					
ACSHE194 - People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions.					
ACSHE195 - Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities.					
ACSHE230 - The values and needs of contemporary society can influence the focus of scientific research.					
General Capabilities					
Personal and Social Capability: social awareness; and self-awareness					
Ethical Understanding: understanding ethical concepts and issues; reasoning in decision making and action; exploring values, rights and responsibilities.					
Critical and Creative Thinking: inquiring – identifying, exploring and clarifying information ideas; generating ideas, possibilities and actions; reflecting on thinking and processes; analysing, synthesising and evaluating reasoning and procedures.					
Literacy					

How will we know if they got it?

What evidence will enable us to assess the intended learning?



Science as a Human Endeavour

1. Students' knowledge and understanding of how professionals use 3D printing and issues around 3D printing.
2. Students' understanding of the role of science, technology, engineering and maths (STEM) in 3D printing and of STEM careers that utilise these technologies.

Personal and Social Capability and Critical and Creative Thinking

3. Students' ability and disposition to reflect on their own and others' beliefs.
4. Students' ability to participate in a whole class discussion.

Ethical Understanding and Critical and Creative Thinking

5. Students' ability to identify current and future ethical issues relating to 3D printing and to articulate their position with reasons on these issues.
6. Students' ability to participate in reasoned discussion with peers (in pairs, small groups, or whole class) including the ability and disposition to draw on evidence and an underlying ethical principle when making informed decisions, as well as to evaluate their own and others' reasons.

What will we do to get there?

How will we engage, challenge and support their learning?

Tasks will draw on students' prior knowledge, relate learning to students' everyday lives and provide opportunities for students to direct their own learning. Throughout the unit, students will be expected to:

- reflect on their own ideas about 3D printing and how the ideas of others may differ from their own;
- understand how people use 3D printing to manufacture goods, in research and in medicine;
- engage in reflection and analysis during whole class discussions, group activities and peer assessment tasks; and
- understand the ethical considerations involved.

The three big ideas of the South Australia Teaching for Effective Learning framework (TfEL), were used in designing this unit:

Create safe conditions for rigorous learning
Focus – building a community of learners

Develop expert learners
Focus – expanding strategies for thinking, learning and working collaboratively

Personalise and connect learning
Focus – building on learners' understanding.

South Australian Teaching for Effective Learning Framework (SA TfEL)
www.decd.sa.gov.au/teachingandlearning/pages/Teaching/Teachlearnandassess/?reFlag=1

The terms 'understanding' and 'knowledge' are synonymous and thus used interchangeably throughout this unit.

Tasks

Page

Task 1:
What is 3D printing

Australian Curriculum Links			
Year 7 –	Year 8 –	Year 9 –	Year 10 –
Personal and Social Capability Critical and Creative Thinking Literacy			

Part 1: Introduction to 3D printing

Students read the information below introducing them to the basics of 3D printing and stimulating their prior knowledge and ideas about 3D printing.

Activity: Student reading

For thousands of years, people made things by taking a solid block (such as a rock or a piece of wood) and chipping away until the desired shape was achieved. 3D printing turns that process on its head. A 3D printer is a computer-controlled robot that can create something using only raw materials.

In engineering terms, 3D printing is a form of 'additive manufacturing'. It builds objects from the bottom up by adding material layer-by-layer. Intricate internal architectures can be created in this way, without any joins or glue. Objects with multiple parts can even be made in a pre-assembled state, something that is not possible by any other means.

The American inventor, Chuck Hull, built the first 3D printer in 1984. Hull was working with a special type of polymer (or plastic) that could be coated onto a surface in liquid form, but then made solid by shining UV light on it. He realised that, by drawing a pattern with the light beam, he could solidify some parts of the polymer, while the rest remained liquid. What's more, if he coated more layers of liquid polymer on top, he could use the light beam patterns to build onto the first layer. Draining off the excess liquid left behind a freestanding 3D structure.

Hull also developed the software to automate the process. Hull's software takes the drawing and divides it up into thousands of slices stacked on top of one another like a paper sculpture. When you hit 'print', the printer robot kicks in, depositing polymer material and zapping it with UV. Every slice of the digital picture is printed as a single layer of plastic the thickness of a human hair. After many hundreds (or thousands) of layers, the full 3D object is created.

These days, all you need to use a 3D printer is a digital drawing of the object you want to build. The drawing can be made using computer aided design (CAD) software, or by performing a 3D-scan of a real object.

In the past two decades, the principle has been extended to many different types of materials, not just plastics. Modern metal printers use metal powder as the base material – when hit with a high-temperature laser, the powder melts to form solid metal. Complex titanium or stainless steel parts can be made in this way.

A 3D printer will be installed aboard the International Space Station (ISS) in 2014 after the custom-built device passed final NASA certification. Having a 3D printer will enable astronauts to manufacture solutions to unforeseen problems, without having to wait for a resupply mission.

Task 1:
What is 3D printing

Australian Curriculum Links			
Year 7 –	Year 8 –	Year 9 –	Year 10 –
Personal and Social Capability Critical and Creative Thinking Literacy			

Part 1: Introduction to 3D printing
Students are to use the information above, and their own research (if time permits), to think of questions to investigate as a class. Write the questions on large sheets of paper to display in the classroom. Group the questions into the following types:

- questions about 3D printing itself (such as, what it is and what it does);
- questions about how 3D printing relates (now and in the future) to you, your family and/or your friends;
- questions about how 3D printing relates to global issues affecting society.

Add questions into these categories as they arise throughout the unit, and check off what questions have been answered and which still need to be answered after completing the unit.

Example questions:

- What raw materials can you print with?
- How long do 3D printers take to build, say, a mobile phone cover?
- Should I study 3D programming if I want to be guaranteed a job in the future?
- How will society best detect fake 3D-printed copies of valuable items?
- Will there be more or less environmental waste when 3D printing is common?

Task 2:
Applications of 3D printing

Australian Curriculum Links			
Year 7 ACSHE 120 ACSHE 121 ACSHE 224	Year 8 ACSHE 135 ACSHE 136 ACSHE 227	Year 9 ACSHE 158 ACSHE 160 ACSHE 161 ACSHE 228	Year 10 ACSHE 192 ACSHE 194 ACSHE 195 ACSHE 230
Personal and Social Capability Critical and Creative Thinking Literacy			

Part 1: How are 3D printers changing the way people work?

Activity: Student reading

Who uses 3D printing and how?

The most immediate career impacts of 3D printing relate to engineers and scientists. Engineers have used 3D printing for nearly three decades to quickly create and test new product designs, a strategy known as 'rapid prototying'. The engineering firm Dyson (inventors of the bagless vacuum cleaner, and the Airblad hand -dryer) have been keen adopters of rapid prototyping. Car manufacturers also speed up the design of new vehicles this way. Many universities are now purchasing 3D printers as a means to accelerate their own research programs. Industrial designers can use 3D printing to develop prototypes and try out their ideas.

Outside of research, 3D printers are used as the ultimate problem solver. If deployed in a remote rural area, for example, a printer could be used to quickly make the tools and parts needed to fix a faulty irrigation system – or any other machine, for that matter. NASA plans to send a 3D printer up to the International Space Station in late 2014. Astronauts being sent to the International Space Station are testing 3D printing to create replacement parts and tools on demand, thereby reducing the multitudes of spares they need to pack with them on every resupply trip. They are even looking at using 3D printers to 'print' space food in the future!

Although 3D printing has existed for nearly three decades, a dramatic reduction in equipment cost has seen it hit the mainstream in recent years.

3D printers are now springing up in all sorts of unexpected places. Many artists, fashion designers and jewellery makers are adopting 3D printing to create custom-made pieces. Some high-end restaurants and patisseries are printing delicate three-dimensional structures of multi-coloured sugar, and even chocolate.

It's likely that 3D printing will continue to impact many diverse industries and art forms. People with a proficiency in creating digital models using CAD and with a good understanding of materials science will always be highly sought-after in this field.

Part 2: What would you print?

Ask students: If you had access to a 3D printer, what would you print and why? Draw or describe your idea. Present your ideas to the class. What were your reasons for choosing this object? What would its role be in society and how would people use the item.

As a class discuss the different objects students chose to print. For example: how many people chose to print artistic items, how many chose to print parts to fix things, how many chose something that could save lives, and who designed something new?

Task 2:
Applications of 3D printing

Australian Curriculum Links			
Year 7 ACSHE 120 ACSHE 121 ACSHE 224	Year 8 ACSHE 135 ACSHE 136 ACSHE 227	Year 9 ACSHE 158 ACSHE 160 ACSHE 161 ACSHE 228	Year 10 ACSHE 192 ACSHE 194 ACSHE 195 ACSHE 230
Personal and Social Capability Critical and Creative Thinking Literacy			

Part 3: Who is using 3D printing to print what?
Students are to watch the interview clips of Josh and Zoz, as well as a selection of clips from the list below, and list the science, technology, engineering and maths (STEM) careers evident in the videos as well as the items being printed.

You want students to recognise the wide range of careers using 3D printing and variety of purposes. Ask students to review the footage in video 7. Discuss and research what type of printing is used to create the titanium horseshoe. How it is different from the method used by Josh and Zoz for example?

ZOZ, 3D Printing

ZOZ, Follow your interests ...


JOSH, Follow your interests ...


JOSH, 3D Printing

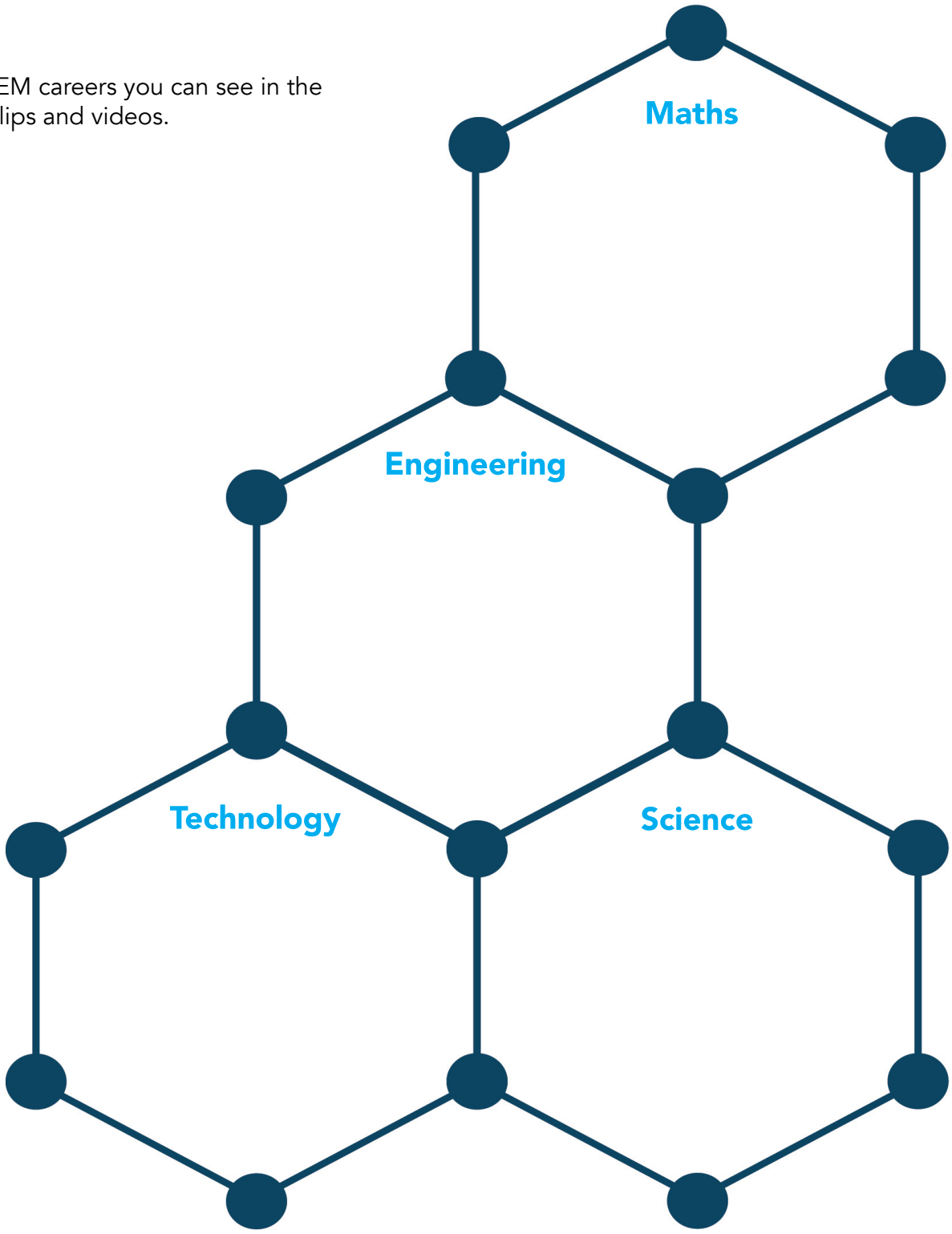
3D Printing videos

1. Andreas Forgacs on 3D printing meat (scroll down to embedded video) *http://3dprintingindustry.com/2013/03/07/update-andreas-forgacs-on-3d-printed-meat/*
2. Buttercup the Duck Walks Again Thanks to 3D Printed Prosthetic Foot *http://3dprintingindustry.com/2013/07/04/buttercup-the-duck-walks-again-thanks-to-3d-printed-prosthetic-foot/*
3. The 3D Printshow London 2013 *http://www.youtube.com/watch?v=UADoHv6dBrk*
4. Using 3D Printing to Reconstruct Dinosaurs, Students Learn to Think Like Paleontologists *http://www.amnh.org/explore/news-blogs/education-posts/students-use-3d-printing-to-reconstruct-dinosaurs*
5. How NASA will use 3D printers in space *http://www.space.com/23532-3d-printer-space-station-video.html*
6. Giant 3D printed bugs shed light on insect anatomy *http://www.csiro.au/Portals/Media/Giant-3D-printed-bugs-shed-light-on-insect-anatomy.aspx*
7. CSIRO's 3D Printer Titanium Horseshoe with Luke Wells Smith and Holly the Pony *http://www.youtube.com/watch?v=g0rmuQCI5vs*

Task 2:
Applications of 3D printing

Australian Curriculum Links			
Year 7 ACSHE 120 ACSHE 121 ACSHE 224	Year 8 ACSHE 135 ACSHE 136 ACSHE 227	Year 9 ACSHE 158 ACSHE 160 ACSHE 161 ACSHE 228	Year 10 ACSHE 192 ACSHE 194 ACSHE 195 ACSHE 230
Personal and Social Capability Critical and Creative Thinking Literacy			

List the STEM careers you can see in the interview clips and videos.

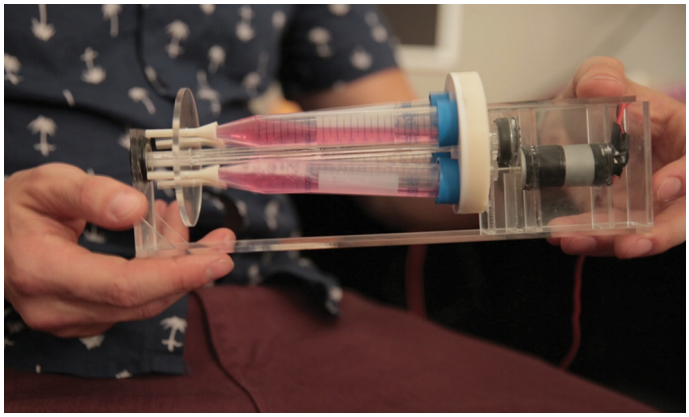


Task 3:
What kinds of materials can we 3D print with?

Australian Curriculum Links			
Year 7 ACSHE 120 ACSHE 121	Year 8 ACSHE 135 ACSHE 136	Year 9 ACSHE 158 ACSHE 228	Year 10 ACSHE 192 ACSHE 230
Critical and Creative Thinking			

Part 1: 3D printing materials
Students read the following passage about how 3D printing works and then research what products are made using different 3D printing techniques.

Activity: Student reading
Hundreds of materials can now be 3D printed. More are being developed every day as researchers explore the diverse applications of this technology.



Thermoplastics – become soft when heated and return to a solid when cooled down again. The two most common examples are ABS and PLA. ABS (Acrylonitrile Butadiene Styrene) is a plastic derived from petroleum – it's the same material that LEGO is made from. PLA (Poly-Lactic acid) is a similar material, but derived from plants, making it kinder to the environment and more biocompatible. Every household printer on the market will use one or other (or both) of these plastics.
Resolution: 3 layers/mm
Applications: toys, models, basic household items (non-kitchen), prototypes, art, etc.

UV curable plastics – are usually deposited in liquid form and then solidified using a UV light. The resolution is much better than for thermo-plastics, but they also require more sophisticated equipment and so are more expensive. Many commercial systems use this process as the parts created are very high quality and functional.
Resolution: 10 layers/mm
Applications: highly structured models, plastic gearing, casings, etc.

Metals – are deposited in powder form and then solidified in a pattern using a high temperature laser. They include stainless steel, titanium, cobalt chromium, brass and bronze.
Resolution: (stainless steel 6 layers/mm; titanium: 30 layers/mm)
Applications: jewellery, medical/dental implants and prosthetic limbs, tools, turbines, machine prototypes.

Niche – Cement (for houses), biomaterials (biomedical implants which can degrade in the body), living cells (for organs and tissues), sugar and chocolate (for exotic deserts), paper (for cheap 3D models and sculptures), ceramic (crockery, figurines, high-end industrial design), flexible plastics (self-assembling '4D printed' objects).

Australian Curriculum Links			
Year 7 ACSHE 120 ACSHE 121	Year 8 ACSHE 135 ACSHE 136	Year 9 ACSHE 158 ACSHE 228	Year 10 ACSHE 192 ACSHE 230
Critical and Creative Thinking			

Task 3: What kinds of materials can we 3D print with?

Students are to consider the following items that could be printed by a 3D printer and choose which materials could be used to print them and explain why.

3D printed item	Which material would you use?	Why would you use that material?
A snack for an astronaut		
Artificial heart		
Artificial bone		
A bicycle frame		
A 3D printing machine		
An animal sculpture		

Task 4:
How will 3D printing change our world?

Australian Curriculum Links			
Year 7 ACSHE 120 ACSHE 121	Year 8 ACSHE 135 ACSHE 136	Year 9 ACSHE 158 ACSHE 228	Year 10 ACSHE 192 ACSHE 230
Critical and Creative Thinking			

Part 1: The future of 3D printing

In this task students are being asked to speculate about the future of 3D printing. Students are to read the following passage then follow up students' questions from Task 1 that were collated and displayed. If necessary, replace some of the questions in the following table with valuable questions that the students really want answered that haven't yet been.

Activity: Student reading

We can expect more 3D printers to enter daily life in the near future. Printers that cost $20,000 in 2010 now cost less than $1000. New devices, such as the Thing-O-Matic, are being sold as high-end toys. Others are being sold as domestic appliances that will pay for themselves through savings on other purchases. After all, with thousands of designs freely available on websites such as www.thingiverse.com, you could use it to make a huge range of household items. It must be kept in mind, however, that these little machines are vastly less sophisticated than their industrial bigger brothers. The household printers work well for creating basic plastic objects such as figurines or cutlery but not much more.

The technology is developing so rapidly that these limitations may quickly be overcome. The RepRap project (http://reprap.org/wiki/RepRap) aims to produce an open-source hardware 3D printer that's free to all. The project is similar, to a 'wiki' – a community of enthusiasts from around the world work together to improve the design. The community is always growing, partly because RepRap is capable of printing many of its own parts, meaning it can be used to replicate itself.

3D printing in manufacturing

3D printers give individual inventors their very own manufacturing platform. This may be one of the lasting impacts of the technology as it allows anyone with a good idea to compete with multi-million dollar industries. Take the example of Richard Van As, a South African carpenter who cut off the four fingers on his right hand in May 2011. Dismayed by the lack of cheap prosthetic hands available, he got hold of a 3D printer and taught himself CAD. Two years later, in collaboration with Ivan Owen, the designer of a mechanical hand for a theatre production, he had created and built Robohand – a prosthetic device that is cheaper than many other prosthetics available. Robohand is made from cables, screws, 3D printing and thermoplastic. Rather than patenting and licensing the technology for profit, however, Van As made the design freely available. Now, dozens of people around the world have been fitted with a prosthetic they could never otherwise have afforded.

Printing a house

The environmental benefits of the technology are also huge. In many modern printers, such as those using metal powder, the excess material can be collected and reloaded back into the machine. This means parts are created with little or no material waste. Even better, soon we might purchase products from overseas companies but have them printed right here in Australia, instead of being shipped. This idea of 'decentralised production' will not only be cheaper, it will dramatically reduce the carbon footprint inherent in international trade.

Task 4:
How will 3D printing change our world?

Australian Curriculum Links			
Year 7 ACSHE 120 ACSHE 121 ACSHE 224	Year 8 ACSHE 135 ACSHE 136 ACSHE 227	Year 9 ACSHE 158 ACSHE 160 ACSHE 161 ACSHE 228	Year 10 ACSHE 192 ACSHE 194 ACSHE 195 ACSHE 230
Personal and Social Capability Ethical Understanding Critical and Creative Thinking			

Ever more ambitious projects come to light every month. In early 2014, a professor at the University of Southern California presented a giant 3D printer robot that might provide the solution to the world's housing crisis. The robot travels along parallel tracks and lays down concrete, layer-by-layer, to build up a house in less than 24 hours. More info: http://viterbi.usc.edu/news/news/2014/3d-printing-a.htm

Organs on demand

One of the most exciting applications of 3D printing is in the medical field. Some hospitals are already bringing in equipment to print custom-made implants, such as artificial hips. The really special thing is that computerised tomography (CT) scans can be used to develop patient-specific parts perfectly tailored to the patient's unique physiology.

On top of all this, researchers are already exploring the next frontier: 3D bioprinting, or the printing of living cells. One day, transplantable organs such as livers and kidneys might be created this way. These organs would be printed using the patient's own cells, and so could be implanted without fear of rejection or the need for immunosuppressant drugs. Though many years away from being implantable as working organs, 3D printed prototype livers are already being used in the US to assist drug development in the rapid screening for toxicity.

There seems no end to the possible uses of 3D printing. Like few other inventions before it, this magic box allows our imagination, quite literally, to become reality.

Break the class into five groups and assign each an impact area (see Table page 18). Ask each group to consider the questions for their area, research where necessary and make predictions based on the information they have learnt thus far. Each group is to present their responses to the class and participate in an ensuing whole class discussion. **Note:** there are varying numbers of questions across the areas so you may want to suggest groups only answer a specific number.

3D printed custom-made artificial hip

Task 4:
How will 3D printing change our world?

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Year 7 ACSHE 120 ACSHE 121 ACSHE 224	Year 8 ACSHE 135 ACSHE 136 ACSHE 227	Year 9 ACSHE 158 ACSHE 160 ACSHE 161 ACSHE 228	Year 10 ACSHE 192 ACSHE 194 ACSHE 195 ACSHE 230
Personal and Social Capability Ethical Understanding Critical and Creative Thinking			

Impact area	Questions to discuss
Technology & Industry	• What will happen to primary industries such as mining? • How will health and medical technology change? • How will communication technology change? • Which jobs will be popular? • What will students learn at school? • What kind of art will be produced? • Will everyone become a designer? • How much piracy of designs will there be? • How will we monitor IP (intellectual property)? • What will happen to large-scale manufacturing when people make their own objects?
Human Behaviour	• How will people use 3D printers, or the objects they print, to influence others? • How would we behave if our 3D printer broke down? • How might the ability to make what we want affect our behaviour? • If someone has an accident with a 3D-printed item, who is responsible?
Society	• Will artists and craftspeople be valued if everyone can make what they want? • How will ancient artifacts and their copies be treated? • Will the world be safer? • What will 3D printing crime look like? • What new laws will need to be put in place? • What will happen between the people who have 3D printers in their homes and those who don't? • What will be the results of keeping people with printed organs alive for longer?
Environment	• Will natural things still be appreciated? • What will happen to natural resources? • Will there be less pollution? • Will the world be cleaner – eg: less waste? • Will things still have aesthetic beauty?
Thinking	• How will being able to make what we want affect our thinking? • Will using a 3D printer be like playing God? What are the consequences of this? • Will 3D printing change our ideas about science? • Will people become more impatient when something breaks or if they want something (eg: another doorknob or vase)?

Suggestions for Assessing Task 4

Students could develop a set of 'good presentation' criteria and use these criteria to peer assess group presentations.

Regarding content knowledge, students could give constructive feedback on the depth to which the questions were answered.

Task 5:
Ethical uses of 3D printing

Australian Curriculum Links			
Year 7 ACSHE 120	Year 8 ACSHE 135	Year 9 ACSHE 160 ACSHE 161 ACSHE 228	Year 10 ACSHE 194 ACSHE 195 ACSHE 230
Personal and Social Capability Ethical Understanding Critical and Creative Thinking			

Part 1: Ethical uses of 3D printing

As with all new technology, it inevitably raises ethical issues that ought to be thought through by those designing, manufacturing and using that technology. 3D printing technology is of course no different. Some of these issues have already been discussed in the media, such as, 3D printed guns and the copying of trademarked designs. In the following set of vignettes (page 21) these two issues and others are posed for students' consideration.

NSW Police 'terrified' 3D plastic guns will be used

There are a couple of ways you can have students tackle this task. For example:

1. Read the vignettes to students and pose the ethical question to discuss as a class. You can collate for and against reasons on the board as the discussion unfolds.
2. Ask students to individually consider each vignette, take an ethical stance and record their reasons (either one vignette at a time or all at once). Discuss as a whole class each vignette in turn (either one vignette at a time or all at once).

You can collate for and against reasons on the board as the discussion unfolds. A few possible responses from students are included in the table below for your preparation.

In order to answer these ethical questions students must of course apply (consciously or subconsciously) an ethical principle in order to work out which action should be taken and why.

As part of the whole class discussion what you want to be drawing out from students are the ethical concepts they are using (such as, fairness, rights and responsibilities) and the ethical principles they are basing their decision on, such as the weighing up of consequences and choosing the action that brings about the best (likely) consequences for those most in need.

What is important here is that students practice giving reasons and evaluating their own and others' reasons. This is an important disposition and set of skills to develop in students in relation to science and everyday life. Raising and addressing ethical questions in the classroom ought to be encouraged and is supported by the Australian Curriculum in the Ethical Understanding General Capability.

Task 5:
Ethical uses of 3D printing

Australian Curriculum Links			
Year 7 ACSHE 120	Year 8 ACSHE 135	Year 9 ACSHE 160 ACSHE 161 ACSHE 228	Year 10 ACSHE 194 ACSHE 195 ACSHE 230
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Suggestions for Assessing Task 5

Peer assessment of reasoning and discussion skills: as a class, prior to engaging in the task, develop a set of criteria for a reasoned whole class discussion. Students should be able to identify basic criteria for engaging in whole class discussion. Students could also use these criteria to assess their own reasoning and discussion skills and even identify a specific skill which they would like to focus on developing. As for the reasoning elements, you could develop your own checklist using the criteria for Community of Inquiry discussions outlined in the above resources or use the checklist on the RiAus website: http://riaus.org.au/wp-content/uploads/2013/05/SBTH_Reasoning_Skills_checklist.pdf .

Ultimately you want students to be skilled at clearly articulating their position and reasons on an issue and be prepared to reassess this position and their reasons in the light of new evidence, circumstances or other relevant considerations.

Note: the terms 'morally' and 'ethically' are used interchangeably in this resource.

There are many resources to support teachers in this task, most notably, resources captured under 'Philosophy for Children' and 'Community of Inquiry'. Here are some resources that will be helpful: Institute for the Advancement of Philosophy for Children (IAPC)
www.montclair.edu/cehs/academics/centers-and-institutes/iapc/what-is/

- DeHaan, C., MacColl, S. & McCutcheon, L. (1995) Philosophy with Kids, Book 3, Hawthorn: ACER, pp. 13-17
- Cam, P. (1995) Thinking Together, Sydney: Hale & Iremonger, pp. 41-54
- White, T (1988) Right and wrong a brief guide to understanding ethics. New Jersey, Prentice Hall.
- Burgh, G., Field, T. & Freakley, M. (2006) Ethics and the Community of Inquiry: education for deliberative democracy. Australia: Thomson Social Science Press.

The Philosophy for Children movement uses Community of Inquiry as its primary methodology. In the pack 'You can be a scientist' the Community of Inquiry method was referred to in relation to whole class guided discussions. This same methodology should be used for whole class discussions of ethical questions.

Task 5:
Ethical uses of 3D printing

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3D printing vignettes	Is it ethically or morally okay?	Why/Why not? (Explain your reasons)
A father makes a prosthetic limb for his son so he can walk. The new limb has not undergone a standard safety check.		
A manufacturer uses a copyrighted design and changes one feature before printing and selling the new design.		
Someone who prints his own clothes uses about 100% more electrical energy per garment than someone who buys the garment off the shelf.		
A child's toy breaks so his mother buys a cheaper replacement from a family friend who 3D scans and prints it.		
An adult 3D prints her own hand gun using a design she downloaded free off the internet.		
As the plastic melts in the 3D printer to be reshaped into a useful device, it emits small amounts of pollution.		
A family prints the broken part for their food blender because, after searching, they discover the broken part is not manufactured for separate sale. They now have a working blender and have avoided buying a new one.		

Task 6:
Personal reflection

There are a number of ways to engage students in reflection of the tasks they have completed. You could use some or all of the following options.

Ask students:

- What did you most enjoying learning about 3D printing?
- Consider the way that 3D printing is used in different areas from engineering to medicine. Did you find that 3D printing was used more or less than you originally thought?
- Consider the item you chose to print in Task 2. What are the ethical considerations you'd need to consider before printing this item, bearing in mind the thinking you did in Task 5? Have you changed your mind now or would you still print the same object?
- Is there a particular career that uses 3D printing that you would like to look into further?

Resources

Website

3D Printers, Fab Lab Adelaide
http://fablabadelaide.org.au/about-us-2/equipment-2/3d-printers/

Relevant articles/reports

3D printing could be miners' "batman belt", Australian Mining, 17 June 2013
http://www.miningaustralia.com.au/news/3d-printing-could-be-miners-batman-belt

3D printed horseshoe breakthrough for Australia's leading science research body, Australia Network News, 18 Dec 2013
http://www.abc.net.au/news/2013-12-18/an-3d-printed-horseshoe-breakthrough-for-the-csiro/5164952

3D printed organs not far away, Science Alert, 6 May 2013
http://www.sciencealert.com.au/news/20130605-24336.html

10 industries 3D printing will disrupt or decimate, Tech Republic, 12 February 2014
http://www.techrepublic.com/article/10-industries-3d-printing-will-disrupt-or-decimate/

Don't shun 3D printers – they might save your life one day, The Conversation, 1 July 2013
https://theconversation.com/dont-shun-3d-printers-they-might-save-your-life-one-day-15127

Ethics & 3D printing, Talking Philosophy Blog, 12 July 2013
http://blog.talkingphilosophy.com/?p=7311

From fantasy to reality, The Sydney Morning Herald, 4 June 2013
http://www.smh.com.au/technology/sci-tech/3d-printing-from-fantasy-to-reality-20130604-2nn3b.html

NSW Police 'terrified' 3D plastic guns will be used in Australia, The Advertiser, 24 May 2013
http://www.adelaidenow.com.au/news/nsw-police-terrified-3d-plastic-guns-will-make-way-to-sydney-streets/story-e6frea6u-1226649899876

Printing empowers the lab, ABC Science, 16 April 2013
http://www.abc.net.au/science/articles/2013/04/16/3730811.htm

Scientists 'grow' new cartilage with help of 3D printing technology, University of Wollongong press release, 7 August 2013
https://media.uow.edu.au/UOW155364

Resources

Relevant articles/reports

The dark side of 3D printing: 10 things to watch, Tech Republic, 5 March 2014
http://www.techrepublic.com/article/the-dark-side-of-3d-printing-10-things-to-watch/

The race to build the first 3D-printed house has begun, Dezeen magazine, 21 May 2013
http://www.dezeen.com/2013/05/21/3d-printing-architecture-print-shift/

This Guy is 3D Printing a Classic Aston Martin – That Runs, Wired, 31 July 2013
http://www.wired.com/2013/07/3d-printed-aston-martin/

Video

3D printing a whistle at Fab Lab Adelaide
http://www.youtube.com/watch?v=ewtUAMNda5U

Cody Wilson Responds To Congress Shutting Down Website With 3D Printer Gun Designs, Mox News
http://www.youtube.com/watch?v=qkyDthh6AT0

Leaders Of The 3D Printing Revolution, The Creators Project
http://www.youtube.com/watch?v=IS4Xw8f9LCc

What is 3D printing? Towson University
http://www.youtube.com/watch?v=Inumb8L-kOg

What is 3D Printing and how does it work? Funk-e studios
http://www.youtube.com/watch?v=Llgko_GpXbI

Will 3D Printing Change Everything? AsapSCIENCE
http://www.youtube.com/watch?v=QD2Rdeo8vuE

RiAus STEM careers

STEM Careers Pack 5: Follow your interest in ... 3D Printing
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