STELR

TECHNOLOGIES

5/6

Electricity Workbook

ATSE
Australian Academy of Technological Sciences & Engineering

ATSE Fellow Fact File

Distinguished Professor Yun Liu

FTSE

ARC Georgina Sweet Australian Laureate Fellow

"There are so many amazing ways we can apply materials with specific properties to solve the world's problems, including materials that haven't been discovered yet! This education resource covering the fundamentals of testing and selecting materials in circuit-making is a fantastic introduction."

Distinguished Professor Yun Liu is an internationally recognised materials chemist and engineer. Her influential work on materials that are designed with specific properties to suit a particular task has revolutionised the design of materials for a range of applications, including defence. Her discovery of new special electrical insulators enabled making a new generation of capacitors (a workhorse for all electronic and electrical systems) creating a profound impact on the electronic industry.

She is a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE), which cares deeply about a technology powered, human driven future for the prosperity of Australia

What factors do you need to consider when designing or selecting a material for a specific application?

First, we need to understand what job the material needs to do. What properties or functions does it need to have? Then we can start thinking about which materials might work. Remember, there's no perfect material that works for everything! Second, we often need to make compromises. This means balancing different features and sometimes giving up one thing to get something more important. Scientists call this optimisation.

Next, we need to check: Is the material safe or toxic during manufacturing, application and disposal? If it's dangerous or harmful, we try to find a safer alternative. After that, we consider whether we can make enough of it. Can we produce this material on a large scale? Is it affordable? We need to think about the overall cost for real-world use. Not all new innovations come to practical applications in the end. Finally, if we're going to make lots of this material and devices, we also need to think about where the materials come from, who supplies them and how we dispose of or recycle them where we are finished with them.

It's important to recognise that new materials design follows two distinct pathways: one driven by applications and practical needs, the other driven by fundamental scientific discoveries. Materials Chemistry, as a new interdisciplinary field, uniquely enables progress along both routes.

AC9TDE6K01

Explain how people in design and technologies occupations consider competing factors including sustainability in the design of products, services and environments

How do you consider sustainability when designing new materials?

To be honest, when scientists first create new materials, we don't always think about sustainability right away. But we've learned that this is actually one of the most important things we need to consider!

Whenever we invent new materials, they might create new risks for our environment and health. That's why sustainability must be part of the design process from the very beginning—not something we think about later. It's like building a house: you need to plan for a strong foundation right from the start, not try to add it afterwards!

AC9TDE6K01
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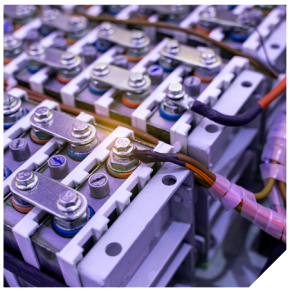
ATSE STELR

SCIENCE TECHNOLOGIES NUMERACY ENGINEERING EXPERIMENTS









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Australian Academy of Technological Sciences & Engineering

15 years of inspiring students to pursue STEM careers

STELR is a STEM in schools initiative from the Australian Academy of Technological Sciences & Engineering

Hands-on kits

Purchase our STELR Primary Electricity Kits that support this resource.

shop.stelr.org.au

STELR Technologies — Year 5/6 Electricity

Written and produced by the STELR team at the Australian Academy of Technological Sciences & Engineering.

www.atse.org.au/STELR

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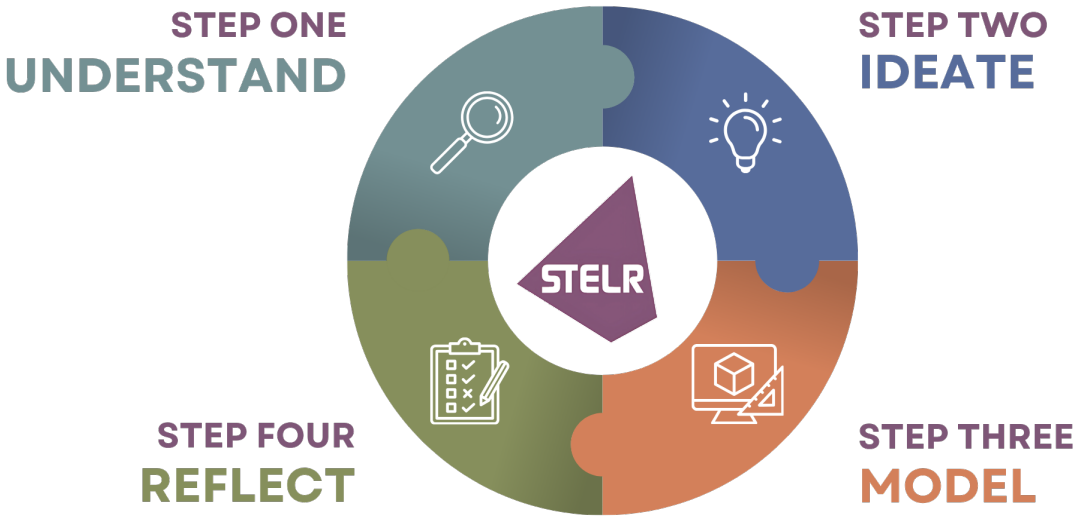
Design Process

In this project, you will be following the design process. Designing is a way of solving problems creatively. The design process helps you think clearly, test ideas and improve your work.

The design process has 4 main steps:



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1 Understand

Learn about the problem before trying to solve it. Ask questions such as:

- What is the problem?
- Who is the design for?
- What are the needs, limits and rules?

You might research, observe or talk to people to understand what is really needed.

2 Ideate

Think of **lots of different ideas** without judging them at first. You can:

- Brainstorm - think creatively and "outside the box"
- Sketch ideas
- Combine ideas

The goal is to explore many possible solutions.

3 Model

In this step, you turn your best idea into something you can test. You might:

- Build a prototype or model
- Create a drawing or digital design
- Make a mock-up using simple materials

Models help you see how your idea works and what needs improving.

4 Reflect

After testing your model, you think about how well it worked. You ask:

- What worked well?
- What didn't work?
- How could it be better?

Reflection helps you improve your design and learn from the process.

The important thing to keep in mind is that **design is a cycle**, not a straight line — great designers keep improving their ideas by repeating these steps.

This is called **iterative design.**

Designing Electric Circuits

Introduction

An **electric circuit** is a pathway in which electricity flows from one terminal of a source of electrical energy, through wires and various other objects, and back to the other terminal.

For electricity to flow through the circuit, there must be an unbroken path between one terminal of the source of electrical energy and the other. A circuit with an unbroken path is called a **complete** circuit. When the circuit is **incomplete** because there is a break in the path along which electricity flows, the circuit will not function.

The objects which are part of the circuit are called the components of the circuit. A switch is a type of component that can connect and disconnect the path for the electrical energy in a circuit. This enables you to control the flow of electrical energy.

Design Brief

You are designer who has been given the challenge to plan and select components to create a switch that will control a useful system and help solve a real-world STEM problem.

You will choose a system that uses electrical energy to control movement, sound or light, and design a switch that allows the system to work more effectively.

Project Details

You will

1. Identify a real-world STEM problem that could be solved using a switch
2. Plan and select components needed to build your switch
3. Design a switch that is safe, reliable, and fit for purpose
4. Test and improve your design
5. Explain how your switch solves the problem
6. Explain why you selected the materials and components you did for making your switch

Example real-world STEM problems:

- People forget to turn lights off – design a switch that controls lights more efficiently
- Classrooms get noisy – design a switch that makes it easy for teachers to get your attention
- Emergency situations need quick alerts – design a switch that activates an alarm or warning signal
- People with limited mobility may struggle to reach switches – design a switch that is easier to reach
- Rooms become too hot or cold – design a switch that controls a fan
- People forget to turn appliances off – design a switch that cuts power after too much time
- Water is wasted when taps are left on – design a switch that alerts you if water is running

What other real-world problems can you think of?

ACTIVITY 1

Understand - Investigating and defining

What to do

Understand your problem and your audience, and what a successful outcome will look like

Question 1.1

What is the problem you are trying to solve?

Question 1.2

Who experiences this problem? This will be your **target audience**.

Question 1.3

What do you want your system to be able to do to successfully solve this problem? Write these goals as dot points you can tick off when your system can do them. These will be your **success criteria** that you will use to evaluate your project at the end.

Question 1.4

To start my project, I will need to research the following questions:

ACTIVITY 2

Ideate - Generating and designing

What to do

Generate some ideas for your switch design. It is helpful to generate lots of ideas and a range of possible designs.

Question 2.1

List at least three different switch ideas that could solve your problem. Which idea do you think best solves the problem and why?

Question 2.2

Sketch your best design idea and label all of the components you will need.

Question 2.3

Why did you choose these components or materials?

ACTIVITY 3

Model - Producing and implementing

What to do

Gather the materials and tools you will need to safely make your designs. It can be useful to make a prototype of your designs using paper or cardboard first before you start using more valuable resources. Consider re-using materials or using recycled materials wherever possible to enhance the sustainability of your design.

Question 3.1

List the steps you will follow to build your switch. What safety rules must you follow?

Question 3.2

Make your first prototype following your steps. What problems did you encounter during testing?

Question 3.1

What changes will you make to your design?

ACTIVITY 4

Reflect - Evaluating the project

What to do

Make any changes you identified to improve your design, and test again. Reflect on your design and how well it solved the problem you set out to solve.

Question 4.1

How well does your design solve the problem you identified?

Question 4.2

List the success criteria you developed in Activity 1. For each one, describe how well the final design met the criteria.

Question 4.3

Ask a classmate to test your design. What feedback did they have and what surprised you the most?

Question 4.4

What would you change or add to your design to improve it if you had more time or resources?

Question 4.5

How could your design be more environmentally friendly? Could different materials be used?

ACTIVITY 5

Reflect - Self-evaluation

What to do

Reflect on your approach to the project and the outcomes you achieved. Complete a self-assessment to demonstrate how you feel you went and what you could do to improve.

Question 5.1

Use the table below to record how you feel you achieved the goals for this project

STELR Self-Evaluation Rubric			
Success criteria	**Self-assessment** (tick the box that best represents your work in this project)		
	 Above Satisfactory	 Satisfactory	 Below satisfactory
I designed and manufactured a system that successfully addressed a real-world problem.			
I chose and used suitable tools and materials to construct my design.			
I followed the design process to understand, ideate, model and reflect.			

Question 5.2

What was one thing that you were particularly proud of accomplishing during the project?

Question 5.3

What was one thing that you would do differently next time?