iSTEM Engineering Design Process
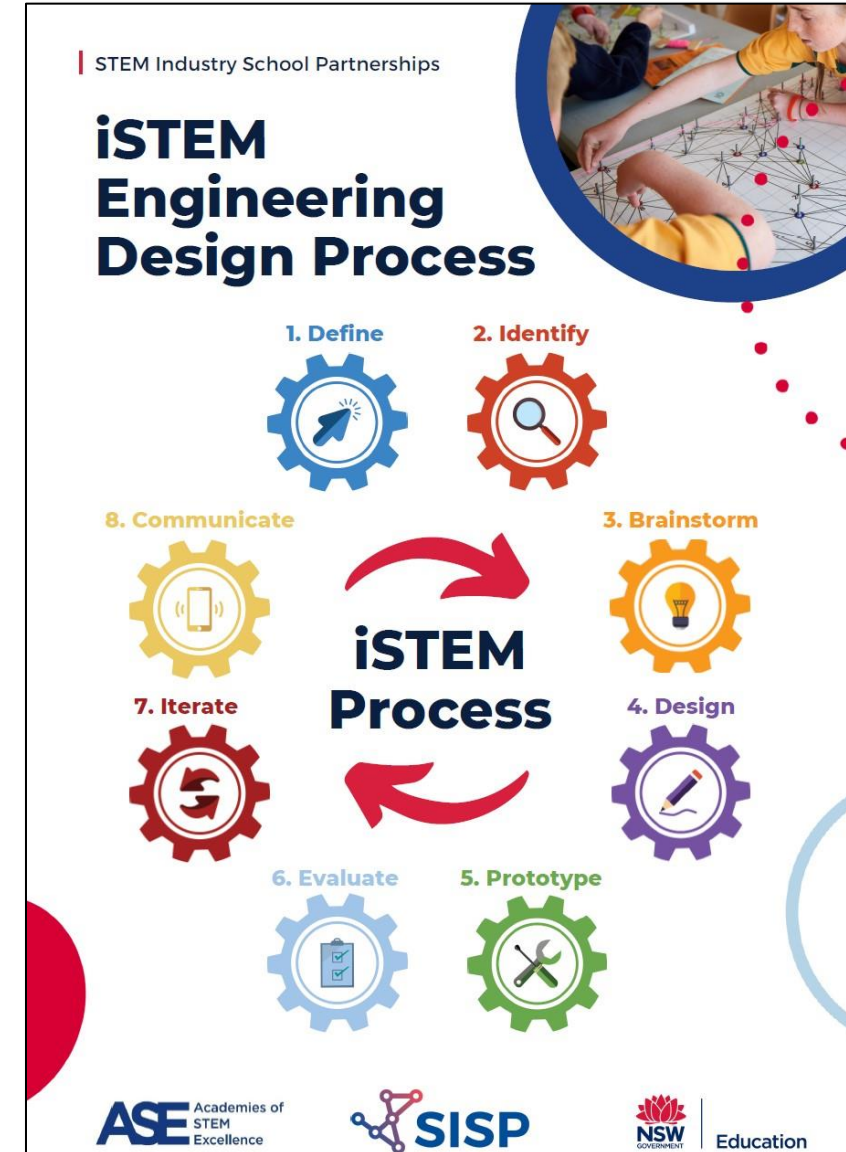
Curriculum Secondary Learners

iSTEM engineering design process

Curriculum Secondary Learners

- iSTEM process sometimes referred to as the 'cogs' is an engineering-design process developed specifically for the Stage 5 iSTEM course. It was initially developed by the [STEM Industry School Partnerships (SISP) program](). It has been since refined by the Curriculum Secondary Learners team in consultation with a range of educators and industry partners. It is designed to provide a consistent language and process across K-12 schools based on an industry-recognised engineering-design process and scaffolds the understanding and application of design thinking. Teaching and learning units developed for iSTEM will embed this process into curriculum materials. The iSTEM process is available as a poster design recommended for display in classrooms. Activity cards and resources are available to embed design thinking in the classroom.

STEM Industry School Partnerships

iSTEM Engineering Design Process

iSTEM Process

1. Define
2. Identify
3. Brainstorm
4. Design
5. Prototype
6. Evaluate
7. Iterate
8. Communicate

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Eight cogs

1. **Define** – the problem

2. **Identify** – the constraints

3. **Brainstorm** – multiple solutions

4. **Design** – most promising solution

5. **Prototype** – your solution

6. **Evaluate** – and **test** your solution

7. **Iterate** – to improve your solution

8. **Communicate** – and **share** your solution

iSTEM engineering-design process

Guide to the eight cogs

- The following slides provide a guide for teachers to the 'key questions' and 'possible activities' that students might typically complete for each of the 'cogs' that make up the iSTEM engineering design process

- This is not an exhaustive list, but is designed to stimulate ideas and give direction to teachers

- In order to solve complex problems, students must complete a series of steps. The cogs provide a recognised scaffold for solving typical problems in the Stage 5 iSTEM course

- Each engineering design journey is different and will require students to consider a range of key questions and activities depending on the type of problem they are attempting to solve. Provided is a set of examples to assist teachers to develop students complex problem solving skills

1. Define – the problem

Define the problem or need in detail to gain understanding

Key questions

- Why does the problem need to be solved?

- What experiences can you relate to the problem?

- What are your initial thoughts of how you could possibly solve the problem?

- How can you help contribute to the solution?

- Do you have more questions about the problem?

- Who would benefit from finding the solution?

- What processes will need to occur to achieve the result?

- Where do you start to resolve the problem?

1. Define – the problem

Possible activities

- Produce a clear statement describing the problem to be solved

- Mind map initial thoughts and additional questions

- Generate discussion about prior knowledge and experience

- Collaborative discussion on what assets are available

- Discuss resources available/needed to solve

- Define the problem clearly and concisely in a brief

- Identify sources of information

- Articulate the scope and nature of the problem

- Produce a statement of the problem

2. Identify – the constraints

Outline the specific boundaries for which the project will be confined

Key questions

- How much will it cost and what is the overall budget?

- What skills and knowledge will be required to solve the problem?

- How much time do I have for completion?

- What tools and equipment are required and available?

- What data or information will be needed?

- What are the aesthetic, functional and ergonomic considerations?

- What are the features that must be included within the solution?

- How will I know the solution was successful?

2. Identify – the constraints

Possible activities

- Research and list all relevant constraints

- Meet with client to determine customer needs

- Produce a budget/finance plan

- Develop a resource list, including tools, materials and people

- Identify start and finish dates and milestones for the project

- Identify data and information that will need to be collected

- Research the problem and potential solutions

- Produce matrix identifying the aesthetic, functional, ergonomic considerations

3. Brainstorm – multiple solutions

Create, develop and communicate ideas

Key questions

- What goals are you trying to achieve?

- What is the best outcome you can think of for this project?

- What makes this project different from other similar projects?

- What might contribute to the success of the project?

- Who will do what by when?

- What is the best way to communicate your ideas?

- What do I need to research or learn to do in order to solve the problem?

- Are their opportunities to reflect on quality and application throughout the process?

3. Brainstorm – possible solutions

Possible activities

- Use a range of brainstorming techniques to produce ideas on developing solutions

- Produce a range of thumbnail sketches and annotated drawings

- Combine ideas to create new ideas

- Research existing solutions and design ideas

- Complete a skills audit

- Research possible technologies and techniques

- Use a mind map to organise ideas

- Expand on knowledge and solutions, reseacrh most relevant ideas

4. Design – most promising solutions

Investigate options, refine ideas, create, communicate solutions and processes to solve problems

Key questions

- What will the final product be - concept/prototype/product/presentation/research task?

- Refine and investigate ideas generated from brainstorm

- What is the estimated, budget, timeline and actions?

- What skills are needed?

- What equipment and materials are required and are available?

- What tools and skills do you need?

- Has size, ergonomics, and aesthetics been considered?

- How are you going to communicate your solutions?

4. Design – most promising solutions

Possible activities

- Use critical thinking, creativity, problem solving, and entrepreneurial activities to produce the 'best possible solution'

- Use divergent and convergent thinking to develop ideas and refine solutions

- Work independently and collaboratively to produce solutions to real-world problems

- Produce an action and time plan for project to completion

- Develop creative, innovative, and enterprising solutions

- Identify resources available/needed to assist

- Produce sketches, detail drawings, digital graphics to communicate solutions

- Produce computer aided design drawings of solutions

5. Prototype – your solution

Produce a model or prototype of the best possible solution

Key questions

- Do you have an adequate plan in place and are you prepared to begin construction?

- Do all stakeholders know their roles and responsibilities?

- Can the final choices be justified?

- What type of prototype: product, mathematical, computer.

- Have you considered work, health and safety (WHS)

- Are resources available to execute the task effectively? technology/materials/skills.

- How will you evaluate the model or prototype?

- What testing of the model or prototype is going to be required?

5. Prototype – your solution

Possible activities

• Use appropriate tools and materials to produce models or prototypes

• Utilise computer aided manufacturing (CAM) to produce rapid prototyped models

• Produce minimal viable products that demonstrate the aesthetic, functional and ergonomic attributes

• Apply coding techniques to create solutions using physical computing or robotics technologies

• Test prototypes or model against working criteria and goals

• Conduct, record and analyse accurate, repeated measurements in the process of testing models or prototypes

6. Evaluate – and test your solution

Evaluate the solution against the identified problem in 'Define'

Key questions

- Has the solution resolved the problem/need as defined?

- Where can revisions/improvements be made?

- What has been done in an innovative way?

- To what extent has the solution produced unintended outcomes (positive and negative)?

- Did the results of testing and experimentation suggest that the solution was successful?

- Is there more research and testing required?

- Where could improvements be made in the earlier stages?

- Do you need to redo any part of the engineering design process?

6. Evaluate – and test your solution

Possible activities

- Complete through testing and experimentation in order to evaluate the solutions

- Collect, organise and interpret data to inform and evaluate design decisions

- Critically reflect and evaluate the solution against the criteria set in the define and identify stages

- Analyse and evaluate the impact of the solution on the environment and society

- Client evaluations and feedback to establish if the solution is successful

- Self reflect on the process and identify improvements to be made

- Plan revisions if they are needed for the final product

- Re-evaluate, investigate, test and brainstorm until the solution resolves the problem effectively

7. Iterate – to improve your solution

Refine design solutions, revise and continually improve

Key questions

- Has the identified problem/need changed?

- Has the solution produced other opportunities?

- How can the solution be further improved?

- When will the solution next need to be evaluated in order to determine that it is still meeting its need?

- Do we need to revisit earlier phases of the process?

- If you decide to make revisions what will it look like? Are there plans and enough resources to make revisions?

- What skills, equipment and resources will be required for revision?

7. Iterate – to improve your solution

Potential activities

- Continual cycle from 'design, prototype and evaluate' until the 'best possible solution' is found

- Refine design ideas based on results of experimentation, testing and evaluation

- Create new models or prototypes of the final product, system or environment

- Produce a minimal viable product after numerous iterations of the design solution

- Re-evaluate the solution after some time to determine if it is still the 'best possible solution'

- Look to continually improve the design solution over its entire life cycle

8. Communicate – and share your solution

Key questions

- Have all key stakeholders been informed throughout the entire engineering design process?

- To whom do you need to share/pitch the solution?

- How can you best share/pitch the solution?

- Would the solution benefit a broader market? How could you reach this market?

- How do you most effectively commercialise the solution?

- What enterprise and entrepreneurial skills are you going to require to successfully market the solution?

- Have all the product specifications and details been documented?

- What are the results of product and market testing?

- Have you met the legal and regulatory requirements necessary to protect your intellectually property

8. Communicate – and share your solution

Potential activities

- Document all aspects of the engineering design process

- Pitch the solution to a client or potential investors (real or imaginary)

- Document the design specifications, measurements and communicate to all groups

- Communicate between key stakeholders in meetings, presentations, reports and drawings

- Develop a communications and marketing plan

- Seek all necessary regulatory and legal approvals

- Ensure all Intellectual Property is protected

- Provide all necessary materials to the manufacturer or developer for full production of the product, system or environment