NSW GOVERNMENT | Office of the Chief Scientist & Engineer

Student Name:

Fire-Ed Up

ISTEM - STAGE 5
STUDENT DESIGN FOLIO

Class:

Teacher:

Design Situation

Australia has recently faced the severe impacts of bushfires, with events like the Black Summer fires causing significant personal, environmental, and economic harm. This situation urgently calls for innovative approaches to manage and reduce the impact of bushfires.

As climate change leads to more frequent and intense fires, adopting new and emerging STEM-based solutions becomes more and more crucial. These approaches utilise advanced technological tools that enhance our ability to predict, understand, and respond to bushfires, offering more effective strategies in a time of escalating bushfire risk in Australia.

Design Brief

This design brief seeks innovative STEM-based solutions to a range of bushfire-related scenarios. Over a course of 10 weeks, students engaged in the Fire-Ed Up iSTEM unit will have the opportunity to fully explore, develop, and refine their bushfire-related solutions using the established iSTEM Engineering design process. To showcase their innovative solutions, students are required to prepare a detailed portfolio, produce a prototype and a 5-minute video pitch. The breadth of this task will challenge students to think critically, work collaboratively, and communicate effectively, preparing them for future STEM opportunities.

Learning Intentions

- Gain a comprehensive understanding of current bushfire challenges in Australia.
- Develop proficiency in applying engineering design processes.
- Cultivate teamwork, problem-solving, and effective communication skills.
- Create design solutions that demonstrate conceptual and practical knowledge.

Design Scenarios

Students working in teams are encouraged to design a STEM-based solution for one of the following bushfire-related challenges:

1. Fire Detection Technology: Develop a cost-effective, deployable technology to detect bushfires early. This may include microcomputer technologies, sensors, satellites, robotics, AI systems, or data analysis techniques for rapid detection of potential fire conditions.

2. Australian Fire Danger Rating System: Utilising STEM technologies and local environmental insights to enhance your community's bush fire danger rating system.

3. Fire Prediction Models: Utilise data science to formulate a model that predicts bushfire occurrences based on factors like weather, vegetation, and topography.

4. Bushfire Resistant Buildings: Create a new or redesign an existing structure to enhance bushfire resistance, using fire-resistant materials and landscaping techniques to create defensible spaces.

5. Cultural Burning Practices: Conceive solutions that combine traditional cultural burning practices with modern fire management strategies, using technology as an enabler.

6. Fauna and Flora Protection: Propose a STEM-based design solution to protect fauna and flora from bushfire impacts. This may involve designing animal shelters, techniques to shield fire-sensitive environments, or methods to safely move wildlife during a fire.

7. Post-Fire Rehabilitation: Design solutions for rehabilitating lands after a fire, including strategies to prevent erosion, promote new growth, or restore wildlife habitats.

8. Firefighting Equipment Innovation: Devise innovations or improvements to existing firefighting equipment, which might include development of new fire suppression substances, efficiency enhancement of water-dropping aircraft, or design of portable firefighting devices for residents.

9.Bushfire Emergency Communication: Design a reliable, accessible communication system for use during bushfires, including alert systems, communication channels with emergency services, or real-time public information dissemination methods.

10. Student Identified Problem: Students are welcome to design a solution to a bushfire-related problem they have identified themselves.

Project Tasks

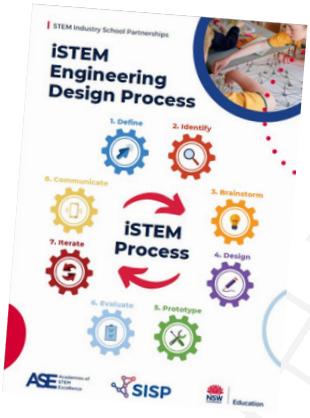
1. Engineering Design Portfolio: This portfolio tracks your journey through the iSTEM Engineering Design process, highlighting how your understanding of the bushfire issue evolved, the steps you took to develop your solution, and your final prototype. It showcases your skills in critical thinking, creativity, problem-solving, and applying design principles**.**

2. Pitch Video: Students will create a 5-minute video to pitch your Bushfire STEM solutions. Include your team, the bushfire scenario you are addressing, and your innovative solution. Highlight how you have used STEM in your solution, its benefits, challenges faced, and future plans for the project. Your video should be clear, captivating, and show your enthusiasm for the project.

3. Prototype Solution: Build a prototype for your chosen bushfire scenario. It should demonstrate your innovative solution and its real-world application. Focus on using your STEM skills to create a practical prototype. This prototype is a key part of the Fire-Ed Up project, showing how your idea works and ties in with your portfolio and pitch video. Your goal is to bring your concept to life, even if it's not perfect – it is about learning and demonstrating your solution.

iSTEM Engineering Design Process

In the Fire-Ed Up iSTEM unit, students are required to apply the iSTEM Engineering Design Process developed by the NSW Department of Education. This structured approach promotes critical thinking, problem-solving and innovation, which are essential skills for developing effective solutions to real-world challenges.



The process includes the following steps:

1. **Define** – the problem
2. **Identify** – the constraints
3. **Brainstorm** – possible solutions
4. **Design** – the most promising solutions
5. **Prototype** – your solution
6. **Evaluate** – and test your solution
7. **Iterate** – to improve your solution
8. **Communicate** – and share your solution

The steps guide students to grasp the problem, devise a solution, and effectively present their work. This fosters critical thinking, collaboration, effective communication, and learning from failures, essential skills in STEM and beyond. There is an Engineering Design Process guide available from the NSW Department of Education web site to assist teachers and students.
The iSTEM Engineering Design Process was developed by the NSW Department of Education for the iSTEM course.

Select Your Fire-Ed Up Team

Skills audit

Activity: Look to form teams, start with writing down your skills. Try to find team members with different skills to yourself.

What Makes a Good Team?

Need some tips on how to create a great team dynamic? Look no further. Find out which characteristics make up a high-performing team.

1. **Diversity** - Thriving teams value diversity.
2. **Communication** - A thriving team has open and honest discussions, sharing their thoughts, ideas and opinions.
3. **Clear goals** - As a team, members should agree on and set goals.
4. **Leadership** - A good leader is an essential component of a successful team.
5. **Trust and respect** - Every thriving team relies on a high degree of trust
6. **Managing conflict** - If the environment empowers team members to challenge one another in a constructive and open manner, then the working relationship within the team is likely to be more creative and productive.

Teamwork

People with strong teamwork skills are sought out by organisations for many reasons—they demonstrate leadership, collaboration, and good communication.

Teamwork is very important in firefighting. Performing your duty of battling fires and rescuing people definitely requires several firefighters working harmoniously and effectively to get the job done. So, if you're planning to **become a firefighter**, you must definitely know how to work in a team. Find out more about the importance of teamwork in firefighting.

Activity:

It is now time for you to select your Fire-Ed Up team and to select different roles based on your individual skills. Roles could include; Captain, Research Lead, Technology Specialist, Solutions Architect, Community Liaison, Environmental Analyst, STEM Integration Lead, Communications Lead.

Mission Team

Design a Brigade Patch

Let's get creative!

Brigade Patches:
The NSW rural fire service has 45 districts grouped into seven area commands. You can find your local area map using this link or find a local brigade using this link. Each district has its unique characteristics. There are a number of Australian Fire Service patches from all states including patches worn by Volunteer Fire Fighters and patches worn by paid Fire Fighters available online .

Learn More about the NSW Rural Fire Service!

The NSW Rural Fire Service (NSW RFS) is the world's largest volunteer fire service, made up of more than 70,000 dedicated volunteers right across NSW.

NSW RFS volunteers are ready to respond to emergencies 24 hours a day, 7 days a week, all year round, attending a range of incidents from bush and grass fires to house and structure fires, road accidents and assisting at other events like floods, storms and searches.

Watch this video to find out more about what it means to join the NSW Rural Fire Service. Interested in applying? Visit www.rfs.nsw.gov.au/join for more details. Click on image to watch video about joining the NSW RFS!

Task: Locate your local brigade and create a unique 'Brigade patch for your local area and team. Research typical patch designs used by fire fighters around the world. Use the box below to sketch your final design concept.

Choose a Fire-Ed Up Scenario!

Evaluate all the Scenario's
Now you have formed teams you need to decide which of the ten Fire-Ed Up scenarios will be best to select. Discuss each of the scenarios with you team, are there any scenarios that stand out? Do you have team members with interests or skills in any of the areas? Briefly describe each scenario in the boxes provided and use the pros and cons boxes to evaluate each scenario.

Scenario 1: Fire Detection Technology

Scenario 2: Australian Fire Danager Rating System

Pros	Cons

Pros	Cons

Scenario 3: Fire Prediction Models

Scenario 4: Bushfire Resistant Buildings

Pros	Cons

Pros	Cons

Scenario 5: Cultural Burning Practices

Pros	Cons

Scenario 6: Fauna and Flora Protection

Pros	Cons

Scenario 7: Post-Fire Rehabilitation

Pros	Cons

Scenario 8: Firefighting Equipment Innovation

Pros	Cons

Scenario 9: Bushfire Emergency Communication

Pros	Cons

Scenario 3: Student identified Problem

Pros	Cons

Choose a Fire-Ed Up Scenario!

Choose the scenario
Describe the scenario that you have chosen and explain why you have chosen this particular scenario. In your justification be sure to include things such as skills of your teams makes, interests, how the scenario relates to your local area or school, etc. Complete a PMI

Chosen Scenario:

Description of Scenario:

Justification of selection of Scenario

Plus Write down all the good points of the scenario you have chosen

Minus Consider where your choice of Scenario might cause challenges

Interesting Observations that are neither plus or minus, although worth noting.

Fire-Ed Up Defining the Problem!

Design brief statement

An integral part of the iSTEM engineering design process is the definition of a meaningful and actionable, statement. This is one of the most challenging parts of the process, as the definition of a problem also known as the **design brief statement** requires careful consideration.

The **design brief statement** builds upon the design brief given, but is your opportunity to guide you and your team's work and will kickstart the ideation process. The statement should be specific to the problem that you wish to solve based on the given design brief.

A design brief statement should have the following traits. It should be:

- **Human-centred.** This requires you to frame your design brief statement according to specific users, their needs and the insights. The statement should be about the people the team is trying to assist, rather than focusing on aspects such as; technology, money or product details.

- **Broad enough to be creative.** This means that the design brief statement should not focus too narrowly on a specifics regarding the implementation of the solution.

- **Narrow enough so it can be achieved.** On the other hand, a design brief statement such as, “Stop all wildfires worldwide,” is too broad and will likely cause team members to easily feel daunted. Design brief statements should have sufficient constraints to make the project achievable.

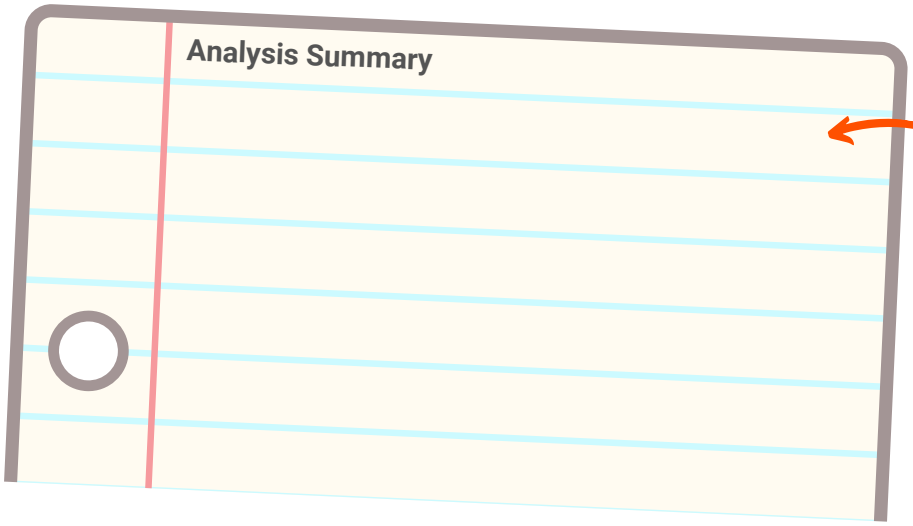
How to produce a design brief statement?

In order to produce a good design brief statement you need to clearly define, 'What is the problem you are going to solve'? In the Fire-Ed Up iSTEM unit you have been given the design brief of ‘designing a STEM-based prototype solution related to fire prevention, detection, management or clean up .’ You brief must relate to the scenario that you have previously selected.

To effectively define the problem, begin by thoroughly analysing the situation, then identify and evaluate potential issues within that context, and finally, gain a clear understanding of the target audience for your solution.

Fire-EdUp Analysing the problem

Analysing the problem worksheet



Analysis task: Review the design brief and scenario to better understand the task. Investigate the scenario, and consider the users' needs as you prepare to create your design solution. Outline your findings in the space provided.

Constraints

Deliverables task: In the space to the right list any possible constraints your team might have, e.g functional, economic, environmental, social, technical and usability.

Problem solving task: In the boxes below indicate;

- Who is the problem being solved for?
- What are you going to solve? and,
- Why does the problem need to be solved.

Problem Solving

Who	What	Why

Fire-EdUp Brainstorming

Hello team, following our analysis, we now proceed to the ideation phase. It is time to apply our critical thinking and innovate. Based on our prior work, let us engage in a brainstorming session to identify which problems you shall address based on your chosen scenario. I encourage you to think expansively and propose thoughtful solutions. Let us begin.

Space, saturate and group method

Let's brainstorm!

We shall now commence a structured brainstorming session. Please follow these steps carefully:

Step 1: Generation of Ideas

- Please take a post-it note. You are free to express your ideas through writing or illustrations.
- Contemplate the various challenges within your chosen scenario. Allow your creativity to flourish without constraints.
- You will have a period of 5 to 10 minutes to formulate and note down as many ideas as possible.

Step 2: Assembly of the Problem Collection

- Proceed to affix your post-it notes to a designated wall, desk, or whiteboard.
- Consider this a curated exhibition of challenges within bushfire management awaiting solutions.

Step 3: Categorisation

We shall now categorise. Collate the post-it notes with similar concepts.
This process will enable us to discern predominant themes and bring order to our diverse ideas.

Step 4: Prioritisation Exercise

- Together, we shall evaluate and prioritise our ideas, identifying those that are most compelling.
- Elevate these selected ideas to a prominent position on our board. It is imperative to approach each idea with respect, as all contributions are valuable.

Fire-Ed Up Design Thinking

Nick De Leon Design Thinking - Exercise Part 1

Task: In 2 minutes team members individually brainstorm different ideas for the scenario you have chosen. Produce annotated sketches to describe your ideas.

Share
Students to hold up their drawings and share their ideas with the group.

Discussion: Did anyone come up with any wacky ideas?

Design Thinking

Nick De Leon Design Thinking - Exercise Part 2

Task: Now in 9 minutes combine your ideas that you developed individually into 9 new ideas.

Evaluation: Now evaluate each of the different ideas, ranking them from 1 to 9.

Fire-EdUp Synthesize

Let's pick our top ideas!
Following our brainstorming, let's now select the four best ideas. Our focus is on identifying the problems, not yet the solutions.

Choosing the Top Four

- Review all the ideas and, as a team, select the four most compelling one's. For each, note down its advantages (Pros) and potential challenges (Cons).

Idea 1:

Idea 2:

Pros	Cons

Pros	Cons

Fire-EdUp Synthesize

Idea 3:

Idea 4:

Pros	Cons

Pros	Cons

Fire-EdUp Synthesize

Choosing Our #1 Fire-Ed Up Idea!

It is now time to determine the best problem that we will address in our Fire-Ed Up project from the top four problems we identified.

Procedure for Selection:

1. Think about Our Options
- Reflect on the four problems we found most compelling.

2. Decisive Selection
- Choose the problem that most intrigues the group. Consider either one of the original options or a combination for a more nuanced challenge.

3. Document Our Choice
- Below, let us articulate the specific problem we aim to resolve. This is our defined mission.

Significance of the Selection:

- Selecting our challenge personalises this project, placing us at the helm of this intellectual endeavour.

Fire-Ed Up Mission Problem - Description

Fire-EdUp Empathy mapping

Developing an Empathy Map
Having identified a significant problem to address, our next step is to create an empathy map to better understand the stakeholders involved.

Understanding an Empathy Map
An empathy map serves as a comprehensive guide to understanding the perspectives of those affected by the problem. It helps us visualise what an individual or group might think, feel, say, and do in a given situation, essentially allowing us to 'walk in their shoes.'

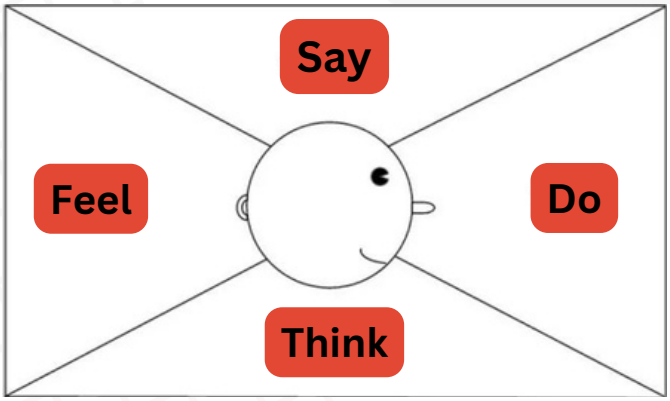
Initiating the Empathy Mapping Process

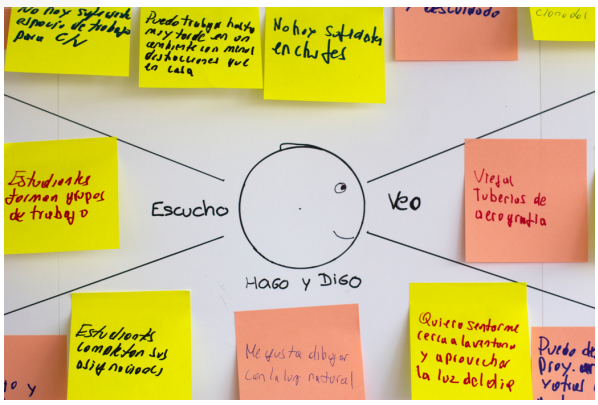
1. Identifying Our Beneficiaries:
- Consider the individuals or communities for whom we are solving this problem, such as families living in bushfire-prone areas. They form the focal point of our empathy map.

2. Investigate
- Watch what your potential customers do and ask them questions.
- Use post-it notes to jot down notes or draw pictures.

3. Set up your map:
- Find a wall or whiteboard, or just draw a big picture with the four parts: Say, Do, Think, and Feel.

4. Fill in the quadrants:
- **What did they SAY?** Write down their exact words or key phrases.
- **What did they DO?** Note their actions, or draw them.
- **What might they THINK?** Guess their thoughts, like their goals or wishes.
- **How did they FEEL?** Think about their emotions from how they act or speak.





Fire-EdUp Empathy map

Say

Feel

Do

Think

Fire-EdUp Design brief statement

By now you have done the following tasks;

- Identified who is the problem being solved for, what is being solved and why.
- Brainstormed and determined the problem that you wish to solve
- Completed an empathy map to better understand the needs of the end user.

You are now going to produce a **design brief statement** that will guide you and your team's work based on the research and analysis that you have undertaken.

Design Brief Statement

Task: In the space provided write your design brief statement which is human centred, not to broad, but is also narrow enough to be achieved.

Sample design brief statements

- **Team X:** The issue we aim to address is the need for more accurate determination of the Fire Behaviour Index in our area, by developing an automated satellite-based system capable of precisely identifying various types of local vegetation.

- **Team Y:** The challenge is to enhance the precision of the local Fire Danger Rating System through a new field experiment that incorporates real-time environmental data and community insights, aiming for more accurate and reliable fire risk assessments.

- **Team Z:** We are addressing the need for a real-time, comprehensive fire danger indication by designing a digital sign that simultaneously presents the Fire Behaviour Index (FBI) and the current fire danger rating, improving community safety and awareness of bushfires.

Identify the constraints

The Importance of Constraints in Design
Constraints serve as essential guidelines in the design process, akin to the outlines in a colouring book that direct our creative choices. They include fixed parameters, such as the dimensions of a space, as well as self-imposed challenges, like utilising recycled materials.
Watch video.

Introducing Expert: Nick De Leon:
We have the privilege of learning from Nick De Leon, a distinguished professional in the field of design and technology from the Royal College of Art, UK. With a background that includes a tenure at IBM and experience in business development, Nick brings a wealth of knowledge to our project.

Insights from Nick De Leon: Nick advocates for viewing constraints as opportunities, describing them as puzzles that enhance creativity and innovation. He will guide us in understanding design from a user-centric perspective, while also adhering to necessary guidelines.

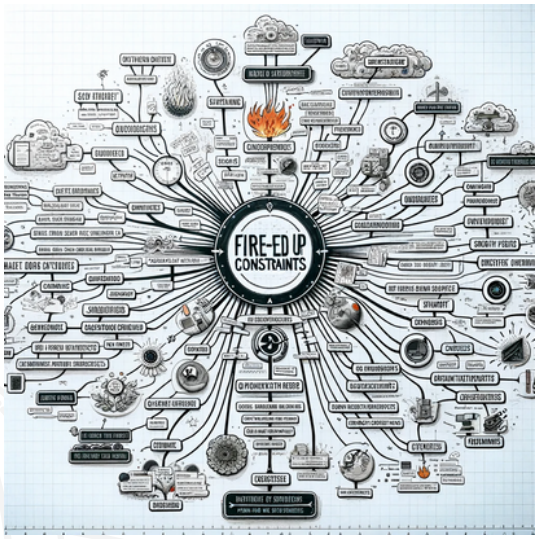
Exploring Constraints in the Fire-Ed Up Project

- **Technological Constraints:** This involves the technology available to us, ranging from basic tools to advanced equipment, which will influence our design process.
- **Spatial Constraints:** We must consider the physical environment of our project, both in terms of our working space and the area affected by our project, ensuring efficient utilisation of available space.
- **People Constraints:** This factor revolves around our target audience, whether they be peers, the community, or specific professionals like firefighters.
- **Social Constraints:** These relate to societal values, such as environmental sustainability or enhancing bushfire safety, which are integral to our community.
- **Commercial Constraints:** Budget considerations play a critical role, ensuring that our ideas are not only innovative but also economically viable for widespread use.

By understanding and embracing these constraints, we can create designs that are not only innovative but also pragmatic and beneficial within the Fire-Ed Up program. Let us embrace these boundaries as we seek to innovate.

Fire-Ed Up Identify constraints - Mind maps

Let's Find Out Our Project Limits with a Mind Map!



Following the development of our design brief statement, our next task is to delineate and understand the constraints or limitations within which our project must operate.

Constructing a Mind Map
A mind map is an effective tool for visually organizing our thoughts and identifying interconnections. It begins with a central concept and expands through various branches, each offering more specific details.

Guidelines for Creating Your Mind Map

1. Central Idea Initiation:
- Place "Fire-Ed Up Constraints" at the centre of a large sheet of paper, a digital document, or the provided sheet on the next page. Encircle this to denote the core subject of our map.

2. Establishing Major Themes:
- Draw lines radiating from the centre to represent major categories such as "Time," "Technology," and "Resources."

3. Detailing Subcategories:
- Branch out from each main category with more specific elements, like project duration, available technology, etc.

4. Conciseness and Clarity:
- Employ brief words or phrases on each branch for clarity.

5. Visual Enhancements:
- Optionally, incorporate simple illustrations or symbols alongside your text.

6. Adaptive Modifications:
- Be prepared to update the mind map as the project evolves and new insights or solutions emerge.

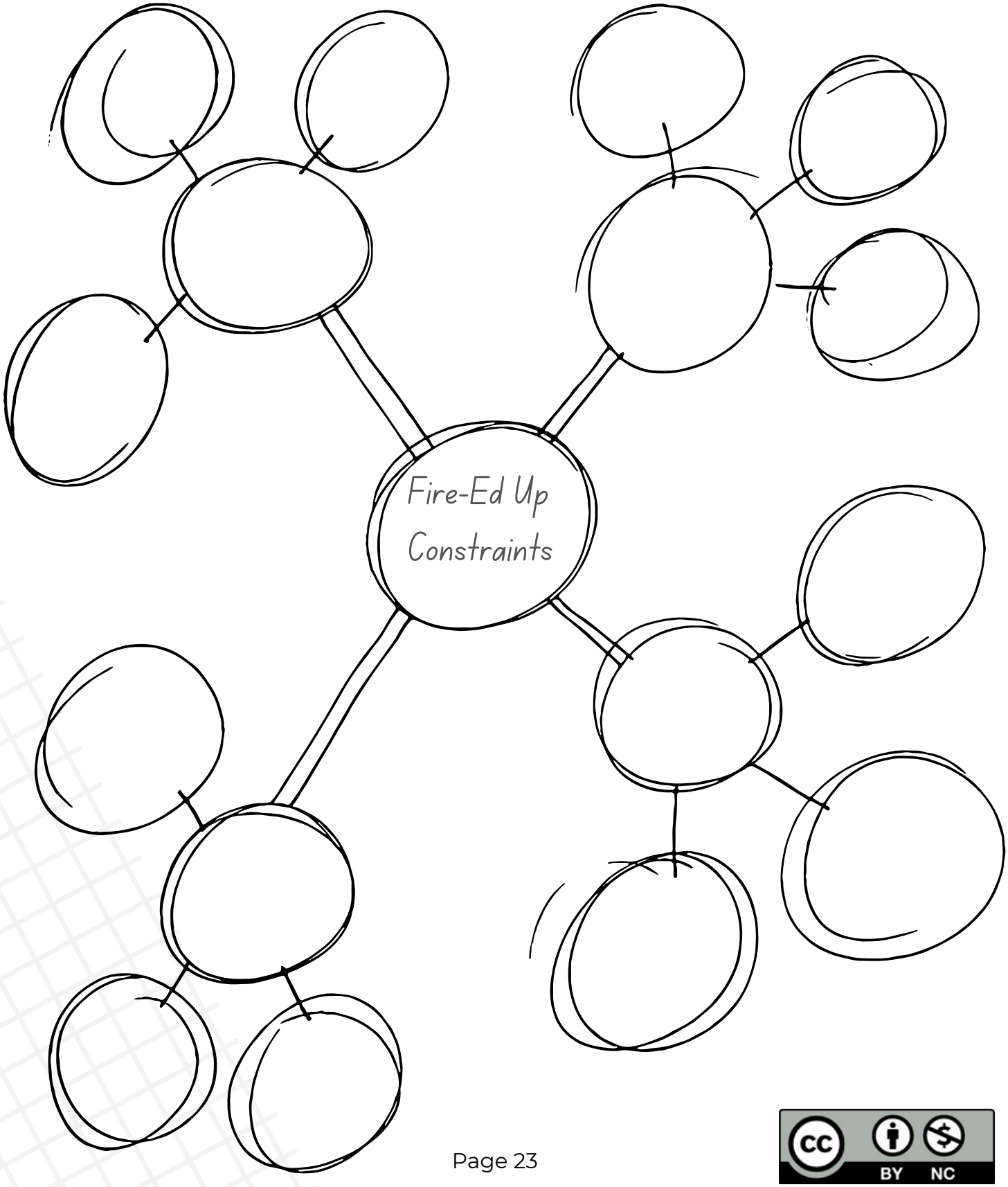
Purpose of This Exercise:
This mind mapping exercise aims to clarify our project's requirements and constraints, equipping us for potential challenges ahead.

Let us embark on creating our mind map to explore and understand the various factors that will influence our project's trajectory. Let's begin mapping!

Fire-Ed Up Identify constraints - Mind maps

Clearly identify the constraints of the Fire-Ed Up challenge

Team Fire-Ed Up you can use this model or create your own mind map, or on a large piece of paper or a whiteboard.



Fire-Ed Up Identify the constraints

Constraints

Determine Project Constraints
Our next step is to select the most crucial constraints and establish clear boundaries to ensure the success of our project.

Your Assignment:
Please document the chosen constraints in the provided space. Consider the following as starting points:

1. **Project Deadline:** Specify the completion date, e.g., "Our project must be finalised by next Friday."
2. **Prototype Specifications:** Define requirements for the prototype, such as, "Our prototype should have semi-autonomous capabilities."

These constraints will guide our project development, ensuring we remain focused and on track.

Criteria for success

Determine the Success Criteria of the Project!
Let's define the success criteria for our project. What makes a design successful? Here's what to consider:

Your Task:
In the space provided, write down your 'Criteria for Success':

1. **Effectiveness:** Does our design achieve its intended purpose?
2. **Visual Impact:** Is our project visually appealing and engaging?
3. **User Response:** Does it improve or enhance user experience?

Measuring Success:
To verify our success, we could:

- Get feedback from a teacher or expert.
- Collect opinions from peers or friends.

These steps will help us determine if our project meets our defined standards of success.

Identify the Constraints

Materials

Selecting Materials for Our Project
Now we turn our attention to the materials required for constructing our project. Let's compile a list of available resources.
Your Responsibility: Document potential materials that could be utilised in our design. Consider the following categories:

1. **Prototype Components:**
   - Identify materials necessary for constructing a scaled model of our design. This might include items like cardboard, adhesives, or small motors.
2. **Final Design Materials:**
   - Contemplate the requirements for the completed project. This could encompass more advanced elements such as Raspberry-Pi, metal components, or specialised sensors.

Tools and equipment

What Tools Do We Need for Our Project?
Let's figure out what tools, workspaces, and equipment we'll need to make our project awesome!

Your Task:
We're going to make a list of all the things we might need to get our project completed.

Think about:
Tools:
- Do we need scissors, glue guns, or maybe some tech?

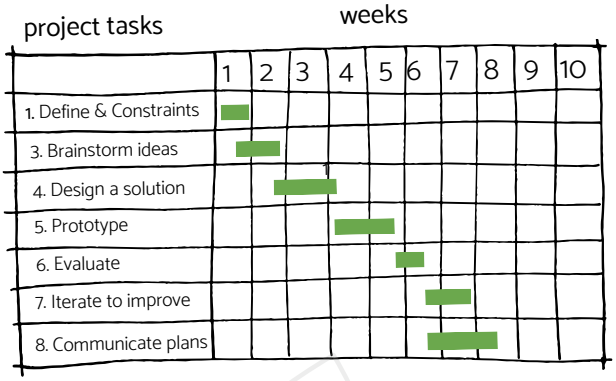
Where to Work:
- Will we work in the classroom, a lab, or somewhere else?

Special Equipment:
- Maybe we need a computer, a camera, or something else to help us out.

Project management

Project Management

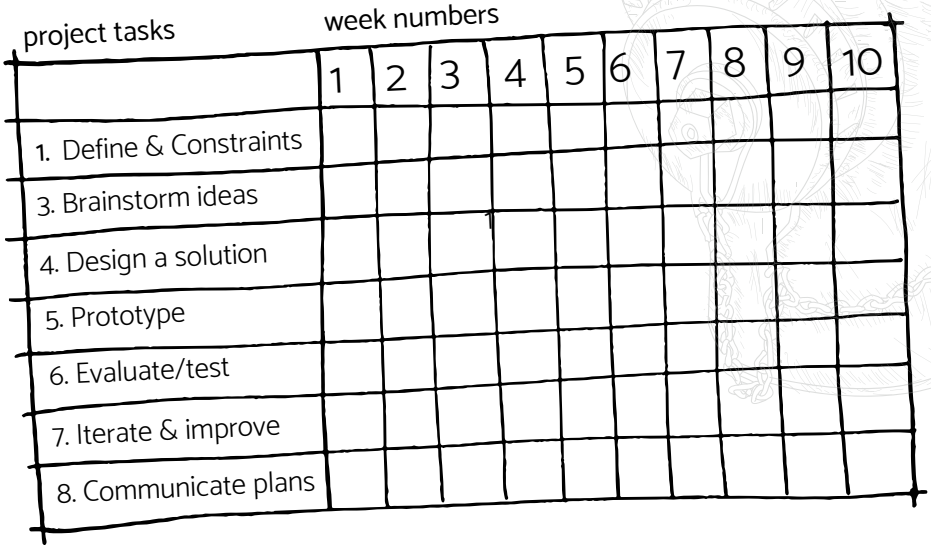
Time Plan



Gannt Chart

A Gannt chart is a visual project management tool that displays the progression of tasks and activities over time. It represents the start and finish dates of individual tasks, their dependencies, and the overall timeline of a project. By showcasing tasks in a chronological sequence against a calendar, Gannt charts help teams understand the relationship between different tasks and track project milestones, making them essential for planning and scheduling projects.

Activity:
Try scheduling your own project in this blank Gantt chart (right) or by using a MS Excel Spreadsheet. Your teacher will specify a project completion date. You may also be given a date for 'deliverables'. It could be that you report on your progress at agreed 'milestones'.



Action Plan

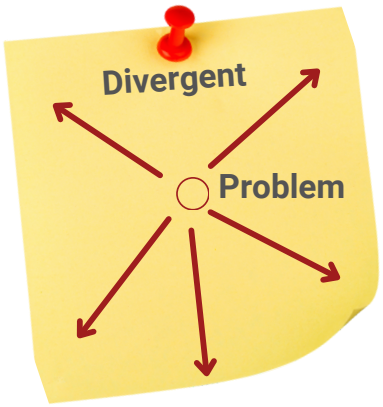
An action plan is a list of steps you plan to follow to complete a project. This is usually completed in sequential order and details what actions need to be taken to complete the project.

Activity:
Teams complete an action plan for the Fire-Ed Up mission.

Design Thinking

Design thinking include both divergent and convergent thinking techniques. Up until know most of the techniques we have used have been divergent.

Divergent Thinking



Divergent thinking is the process of generating multiple ideas to maximize the range of possible solutions, applications, examples, etc. It is the initial stage of creative problem solving where learners have the space and freedom to explore out-of-the-box ideas, take risks, push beyond obvious answers, probe deeper, and defy some of the conventional boundaries and constraints of a particular discipline. Typically, divergent thinking involves brainstorming, collecting spontaneous and random associations with a given topic, and increasingly expansive ideation.
In the design phase of the engineering design process, we ask students to use convergent thinking techniques.

Convergent Thinking

Convergent thinking usually follows divergent thinking. It is a process in which learners critically sift through the collection of possible solutions by considering realistic limitations and feasibility, comparing positive and negative attributes. Divergent thinking unfolds and broadens; convergent thinking narrows down and focuses, filtering the set of creative options to identify and clarify the next step. The challenge during divergent thinking is pushing through the initial blockers, blinders, and biases, and resisting the natural inclinations to turn toward convergent thinking prematurely.

In the design phase of the engineering design process, we ask students to use convergent thinking techniques.

Activity: Based on the work of Anne Manning from Harvard Professional Development get students to complete the following exercise which demonstrates the concepts of divergent and convergent thinking to inspire new ways to approach problem-solving.

Step 1: Stand up, and stretch your arms into the air for about 30 seconds. (Divergent Thinking)
Step 2: Bend over and touch your toes for about 30 seconds. (Convergent Thinking)

Discussion: Think about how you felt when doing each of the exercises.

Fire-Ed Up Divergent Thinking - Brainstorming

Engaging in Creative Brainstorming for Our Fire-Ed Up Project:

We will now embark on the stimulating process of brainstorming for our Fire-Ed Up project. Brainstorming encourages us to explore imaginative and unconventional solutions, fully utilising our creative potential.

Understanding the Essence of Brainstorming:

- **Encourage Unconventional Thinking:** Brainstorming invites a plethora of diverse, even unconventional ideas. Sometimes, the most unconventional concepts evolve into excellent solutions.
- **All Ideas Are Valuable:** Every suggestion, no matter how outlandish it may seem, is worthy of consideration and could lead to further innovative ideas.
- **Broaden Perspectives:** It enables us to think differently and approach our challenge from various angles.

Guidelines for Effective Brainstorming:

1. Withhold Judgment:
- Embrace each idea without critique; every contribution is valuable at this stage.

2. Foster Openness:
- Allow your thoughts to flow freely, without concern for correctness or feasibility.

The Significance of Brainstorming:

- Brainstorming liberates us from conventional thought patterns, paving the way for a myriad of creative solutions.

Let us engage in this brainstorming session with enthusiasm and see what exceptional ideas we can generate for our Fire-Ed Up challenge. Let the brainstorming begin!

For a deeper understanding of brainstorming techniques, visit (https://www.mindtools.com/brainstm.html).

Divergent Thinking - Sketching

Sketch *lots* of ideas to encourage creative thinking

'Thumbnails' are small, quick sketches. They are thoughts on paper, with no time for neatness.

Activity: Practice being creative. In the space below, draw thumbnail sketches of your ideas for a prototype. Be sure to annotate your sketches for further clarity of your ideas.

"annotate your sketches", means to use arrows and labels to help explain your ideas.

"A student with good ideas is simply a person with ***lots*** of ideas!"

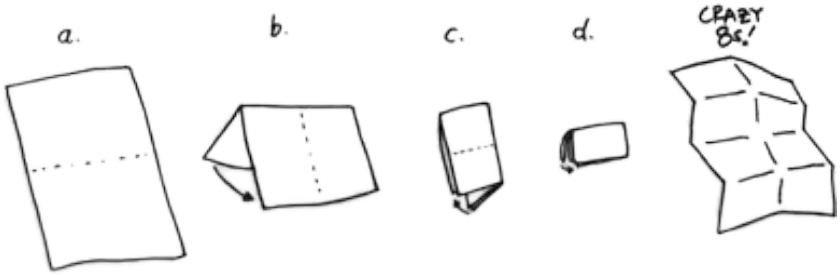
Fire-Ed Up Divergent Thinking -Brainstorming

Crazy 8's

Let's Try Crazy 8's: A quick sketch challenge!
Crazy 8's is fun– it's all about quick drawing and coming up with lots of ideas. Here's how we do it:

Step 1: Paper folding fun:

- Take a piece of A4 paper and fold it in half three times.
- Unfold it, and you'll have 8 equal boxes to work with.



Step 2: Solo brainstorming blitz:

- On your own, sketch a different problem in each box. Add a few words to explain each one.
- You've got 8 minutes to fill all 8 boxes with your ideas.

Step 3: Idea gathering:

- Let's see what everyone's come up with. Group similar problem sketches together.

Step 4: Group brainstorming:

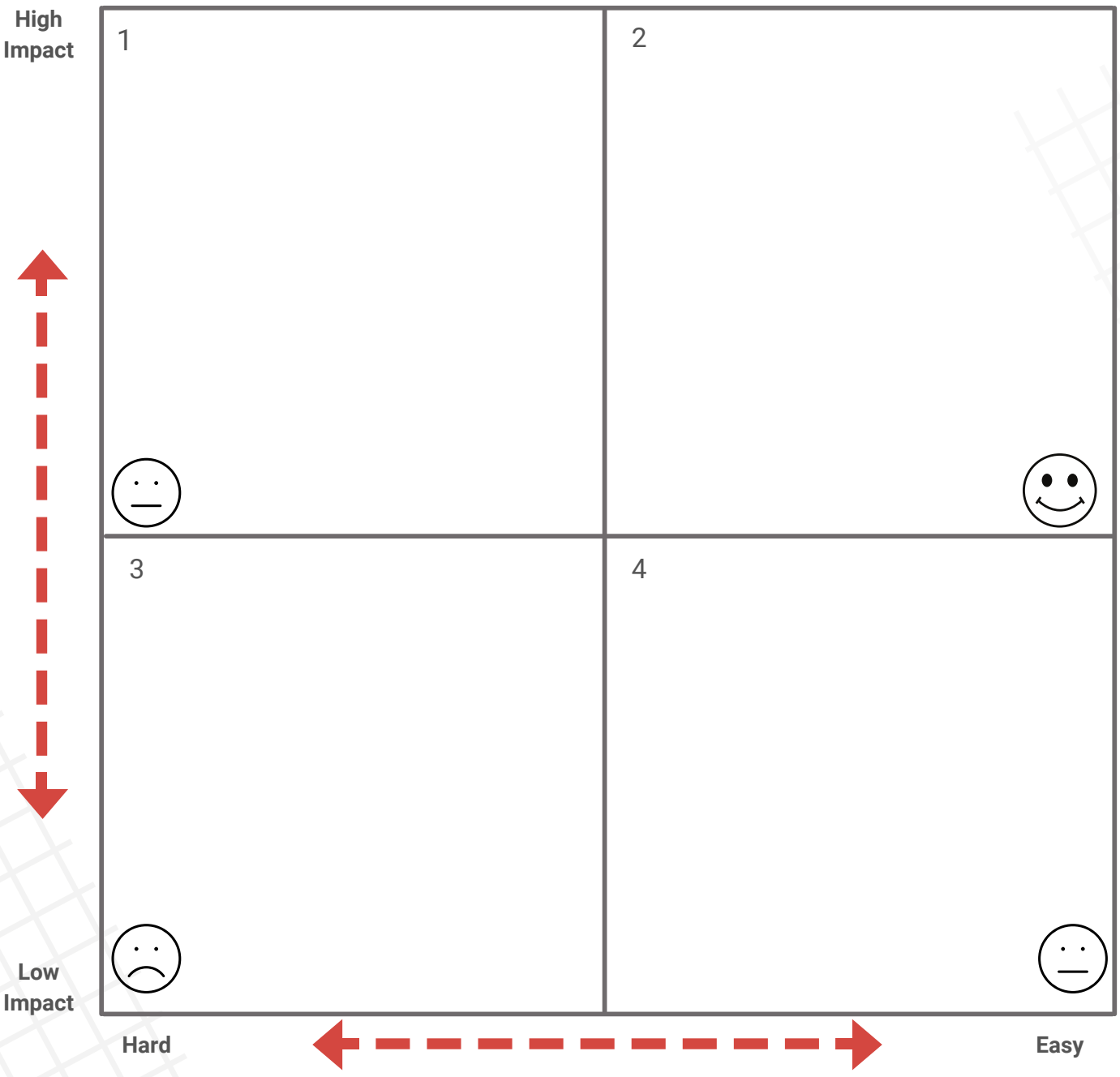
- Now that we've seen all the ideas, let's do the sketching again, but this time as a team.
- For a fun twist, in the last two boxes, think like Elon Musk or a NASA scientist. What would they come up with?

Convergent Thinking

Convergent Thinking Activity 1: Choose six designs from the Crazy 8 brainstorming. Sketch these in the circles provided and annotate around them to describe each design in more detail.

Evaluate

Evaluate - Now evaluate your six best ideas further using the impact/effort matrix below. Add all six ideas and connections into one of the four segments.



What is an Impact Effort Matrix?
An impact effort matrix is a decision-making tool that assists people to manage their time more efficiently. Each potential idea, strategy or project is assessed based on the level of effort required and the potential impact or benefits they will have.

Convergent Design

Convergent Thinking Activity 2: In the circles below, combine the best aspects of your top six designs to produce two new combined design solutions. These should have aspects of two or more ideas. Use the space around the circles to annotate you ideas or make detail sketches.

Final Design Idea

Convergent Thinking Activity 3: Finally, select one the final design solution that you wish to prototype. Ideally, it will combine some of the successful features of the two previous combined design ideas. Sketch your idea in the space provided and use the space around the out side to annotate and provide detail sketches.

In the space provided, tell us why you think this one is the best design.

Design Drawings

Activity: Draw a top view and a either a side or front view of your final design idea.

Sketching a front and top view.

What is Design?
A design is a plan or specification for the construction of an object or system. The result of that plan or specification can be in the form of a prototype, product or process.

The design usually has to satisfy certain goals and constraints, may take into account aesthetic, functional, or economic considerations, and is expected to interact with a certain environment. Major examples of designs include architectural blueprints, engineering drawings, detail drawings, concept drawings as well as sketches, renderings or artist impressions.

Design Drawings
Design drawings are typically aesthetic drawings or renderings that represent possible solutions. Drawings are typically the first step in the design phase.

Design Activities
In some cases, constructing an object first, without plans may also be considered to be a design activity.

TOP VIEW

FRONT/SIDE VIEW

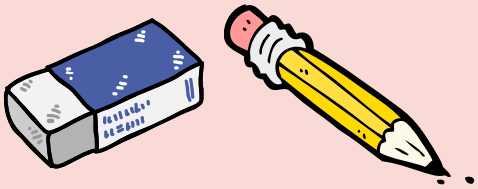
Design Drawings

Activity: Pictorial views
Practise sketching one small part of your design as a pictorial view.

Sketching pictorial drawings at www.iteachstem.com.au

ISOMETRIC VIEW

Design Drawings



Rendering
Rendering is the process of creating the effects of light, shade and light source to achieve contrast in drawings. rendering improves the quality of line drawings. while line drawing indicate more of the shape than the form of an object drawn, rendering improves the quality of the drawing so as to give it a photo- realistic quality.

Colouring vs Rendering
Colouring = Coloured "in the lines", or put colour in the areas they belong.
Rendering = Making the image really pop, by adding shading and details so it looks more polished and professional.

Annotations
Annotations are brief, written explanations provided with design deliverables in order to define & describe aspects of the design.

Watch the video by Splat 3D on how to produce annotated and rendered drawings such as those to the right/top.

Above: Design sketches and renderings

Below: Click on any of the five core 3D objects for a demonstration of how to render them.

Design Drawings

Activity: Using the isometric grid below try drawing/sketching a more detailed example of your design. Include some measurements.

Annotate your design using notes with arrows. Explain the highlights of your design.

Identify the materials in your design.

Final Design Drawing

Activity: Bring all your design ideas into one final design drawing or blueprint for your Fire-Ed Up design. This does not need to be a fantastic drawing, it just helps to get to the next stage in the iSTEM process - prototyping. It is a good idea to base your drawing on the materials, parts or lab equipment that you know will be available to use while constructing your prototype.

Fire-EdUp Prototype

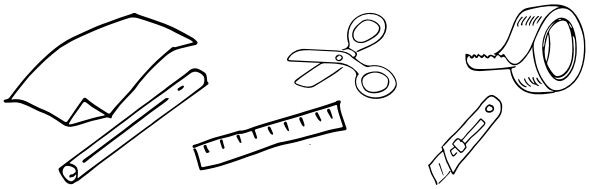
A prototype is where you construct a physical example of your design.

Constructing a prototype

Prototypes are for validating a design or a hypothesis. A prototype is used for testing whether the design will work as expected or not. Usually new insights are gained once the engineers and scientists get to experiment with the physical product. Prototypes are for learning, so it is a good idea to keep them as simple as possible.

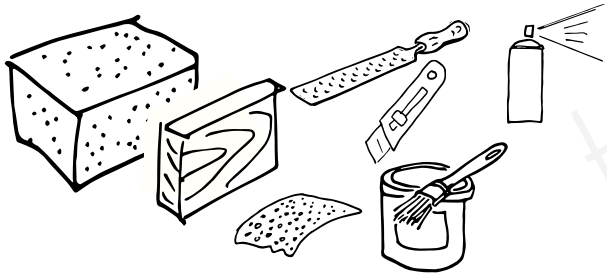
Different kinds of prototypes

1. **Paper prototypes** - 'thinking in paper' are super quick to make and help us to visualise our ideas, especially those that are hard to sketch . They are most often used in the early stages of design. Typical materials include;



2. **Rough prototype** - a proof of concept is a working prototype that proves a device or system works. It does not need to look like your final design, and will be constructed as quickly as possible. Sometimes just one part of your design is prototyped to demonstrate it works. This rough build is sometimes called a 'mock-up'.

Materials may include MDF sheet, Coreflute panel, corrugated cardboard, hot glue, acrylic, aluminium rod, screws, nuts and bolts, plastic bricks, elastic bands, springs, microcontroller, motors, sensors etc.



3. **Appearance prototype** - a static model is used to show the final look and feel of a design, especially for products that must have visual (aesthetic) appeal. 3D printed parts are often smoothed and painted for this purpose. Materials may include balsa wood, plaster, blue foam, styrofoam, wood, undercoat/sealer and brush, spray paint, abrasive paper etc

4. **Engineering prototype** - is a working example of a design but also has the appearance, size and the same materials found in the design/blueprint. This type of prototype can be very expensive to make because it requires specialist knowledge and equipment.

Fire-EdUp

Testing your Solution

Testing can be undertaken throughout the progression of a project, although it is most commonly undertaken concurrently with the **Prototype** phase.

Testing, using the iSTEM process involves:
1. using the prototype to see if it actually works or performs to the specifications set at the beginning.
2. generating user feedback as related to the prototypes you have developed, as well as gaining a deeper understanding of your users

When undertaken correctly, testing can often feed into most phases of the iSTEM process:

- it allows you to **empathise** and gain a better understanding of your users
- it may lead to insights that change the way you **define** your problem
- it may generate new ideas in the **brainstorming** phase and finally
- it might lead to an **iteration** of your Prototype

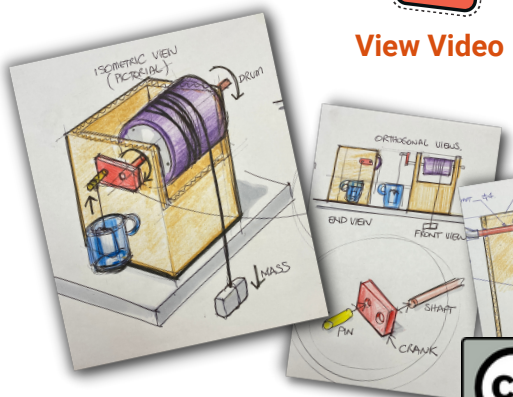
Prototype Testing

Activity: Previously you were asked to list some of the criteria for success of your project. Relist them below as they will become the criteria you will use to test and evaluate your project.

Criteria

Design with Glenny D:
The best conditions for testing a new design is under real conditions, watch Glenny D, our resident designer, as he tests and Iterates his Jiggler machine.

View Video



Prototype Documentation

A prototype is where you construct a physical example of your design.

Activity: Attach photographs of your prototype to this page and, if possible, a link to a video of your prototype in action.

Activity: Outline the steps in the construction of your prototype and describe at least two obstacles encountered in the process.

Evaluate - Testing

Test and evaluate prototypes against the set constraints and criteria

Activity: Devise an appropriate test for your design solution. In this test make sure that you can assess at least one **criteria for success** that you set earlier in the design process.

PMI is a quick method for evaluating ideas. Write down all the positive points of your design, then all the negative. Note anything interesting, e.g. questions that need to be answered to move forward.

Test results: Does your design solution meet your criteria for success?

Plus	**Minus**
Write down all the good points of your design e.g. 'aesthetics'	Consider where your design did not perform as well as expected.

Interesting Observations that are neither plus or minus, although worth noting.

Evaluate

Test and evaluate prototypes against the criteria to evaluate the success of the project

Activity: Using the table below list the criteria to evaluate the success of your project that you set at the start of the design challenge. Indicate in the table if the criteria has been met and if so to what extent has it been met.

Criteria	Yes/No	Basic	Satisifactory	Good	Excellent

Activity: Based off the results of the evaluation above, please indicate if you believe that the prototype has been successful and describe why?

Evaluate

SWOT Analysis
Students to identify the Strengths, Weaknesses, Opportunities or Threats related to their prototype design.

S

W

O

T

Extension
Based on the responses recorded, identify two actions that could be taken to improve the prototype.

Iterate - Improvements

An iteration is the next or improved version of a design

Often with projects, we do not get time to make an improved version/iteration. Let's at least consider a second iteration of your design idea.

Activity: In the boxes below, sketch and/or explain four possible improvements to your design. Apply what you learnt from testing & evaluating.

Tip: 'Annotate' your work, i.e. use arrows and notes on your sketches. Work like an engineer!

1	2
3	4

Iterate - Ideas Blitz

Ideas Blitz - Dr Ken Hudson developed the ideation tools of speed thinking and Ideas Blitz. Students will complete an Ideas Blitz to rapidly come up with solutions for their experiment, device or environment.

Refine Your Concepts with Ideas Blitz!

Having identified four potential improvements, let's employ the 'Ideas Blitz' design thinking tool to advance to the second iteration of your design.

Refer to this sheet for guidance on executing an Ideas Blitz, aimed at generating a variety of design concepts. This process exemplifies divergent thinking, and we'll subsequently apply convergent thinking to hone these ideas into the most effective solution.

STEP 1: START
Every individual working by themselves aims to create 9 initial thoughts, ideas or solutions in 2 minutes (capture in the inner circles). Creating quickly will stop you filtering your ideas and to get started.

STEP 2: ENHANCE
The next step is to build on the initial ideas. The aim is to build, expand or improve on all of these ideas. Think 'Yes And' not 'Yes But' (capture in the outer bubbles).

STEP 3: CONNECT
Try and combine different thoughts to create a bigger idea or solution (either through logic or random pairing).

STEP 4: EVALUATE
Select a criteria and quickly evaluate each idea (and connected ones). The criteria should flow from the challenge (score from 1 to 10).

If you are working in a bigger group have each pairing or smaller group present their best ideas to each other. Aim to build an even better idea or solution.

STEP 5: ACTION
Take the best idea(s) and develop a 9 point action plan.

What is an Ideas Blitz?
A Blitz is a short, fast, semi-structured creativity and productivity tool you and/or a group can use everyday.

Ideas Blitz can help you and others become more energised, confident and stop procrastinating.

How to run an Ideas Blitz (5 steps)
These are suggestions only. Based on our experience the Start stage is the only fixed one. You may do 1 or all 5 steps depending on the challenge.

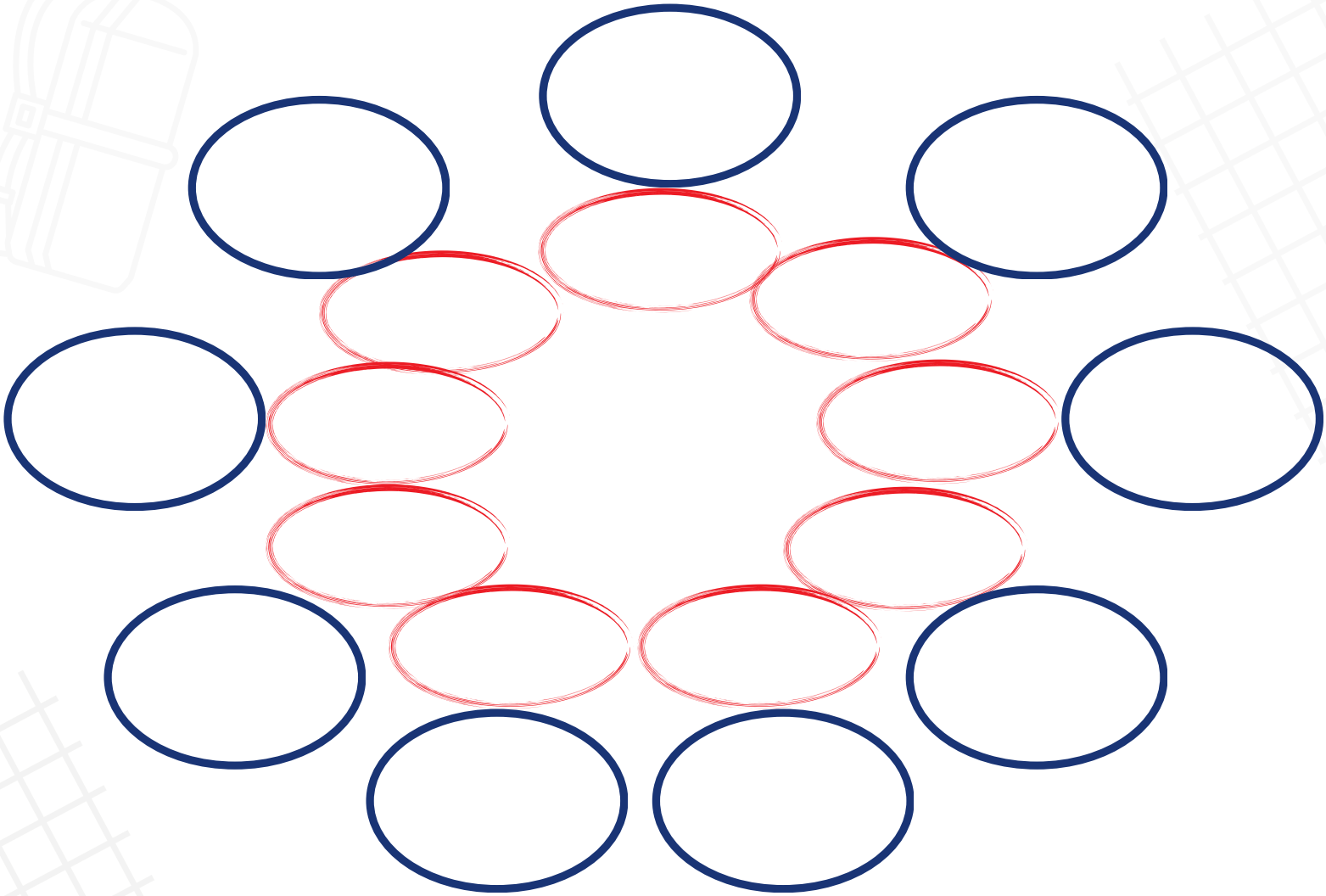
The Challenge
The specific problem, opportunity, issue or decision to be Blitzed.

When can you Blitz?
An Ideas Blitz can be used for any problem, opportunity, issue, or decision. In fact, any time you feel stuck and/or want a new set of ideas, solutions or options – fast! It can be used by yourself, with a partner or as part of any group or brainstorming process.

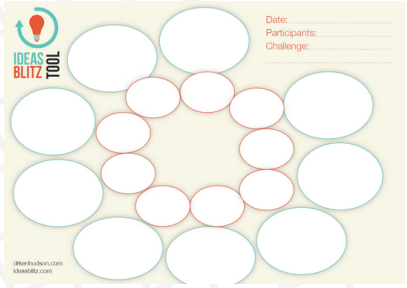
Ideas Blitz - Steps 1 & 2

Activity

Step 1: Start - Each team member independently generates nine initial thoughts, ideas, or solutions within 2 minutes, recorded in the inner red circles. This rapid creation process prevents overthinking and kickstarts ideation.



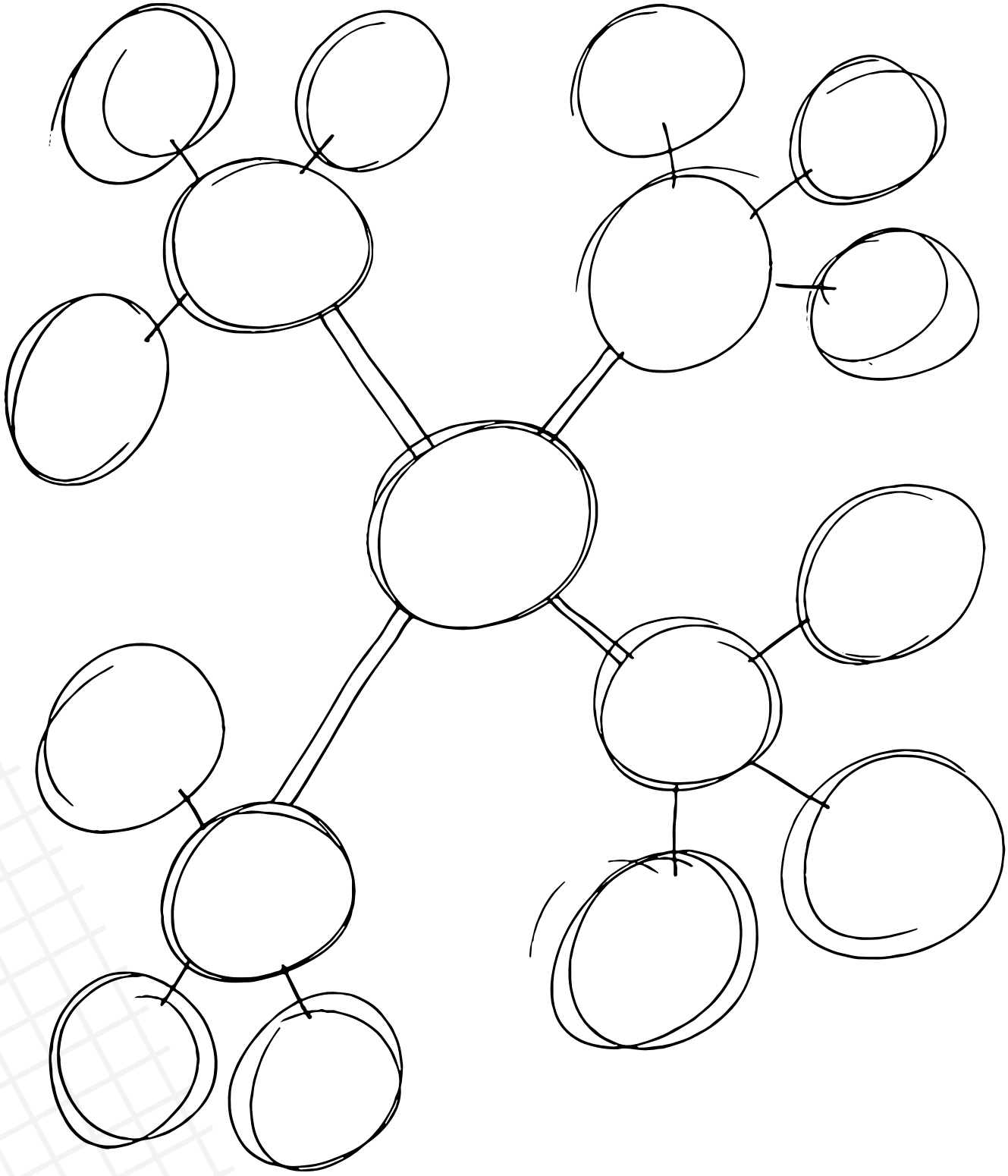
Step 2: Enhance - The next step is to build on the initial ideas. The aim is to build, expand or improve on all of these ideas. Think 'Yes And' not 'Yes But' (capture in the outer bubbles).



If you wish download the original 'Blitz Tool' courtesy of Dr Ken Hudson. http://ideasblitz.com/

Ideas Blitz - Step 3 Connect

Step 3: Connect -Try and combine different thoughts to create a bigger idea or solution (either through logic or random pairing). Use the mind map below to capture your ideas and connections.



Ideas Blitz - Step 4 Evaluate

Step 4: Evaluate - Transfer your big ideas into the boxes below. Select a criterion and quickly evaluate each idea. (Score from 1 to 9). If you are working in a bigger group, have each pairing or smaller group present their best ideas to each other. Aim to build an even better idea or solution.

1.	2.	3.
4.	5.	6.
7.	8.	9.

Ideas Blitz - Step 5 Action

Step 4: Action - After evaluating your blitzed design improvements for the Fire-Ed Up project, choose the most promising idea. Below, create a 9-point action plan detailing how you will modify your initial prototype to develop an enhanced version of your original design solution.

1.

2.

3.

4.

5.

6.

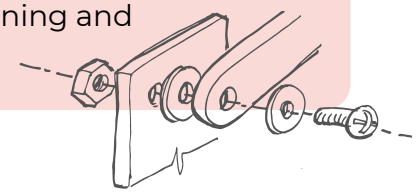
7.

8.

9.

Iterate - Improvements

Activity: Utilise the provided space to create detailed sketches or design drawings of your newly iterated concept. This activity involves visually capturing the enhancements and modifications you've conceived for your design. Focus on clearly illustrating the changes and improvements from your original idea, showcasing the evolution of your project. Consider different perspectives and annotations to explain the features and functionality of your updated design. This visual representation is a crucial step in refining and communicating your concept's latest iteration.



Iteration - Design Drawings

Activity: Draw a top view and a either a side or front view of your final design idea.

TOP VIEW

FRONT/SIDE VIEW

Iteration - Design Drawings

Activity: Pictorial views
Sketch one small part of your iterated design as a pictorial view.

ISOMETRIC VIEW

Iterated Design

Activity: Using the isometric grid below try drawing/sketching a more detailed example of your iterated design. Include some measurements.

Annotate your design using notes with arrows. Explain the highlights of your design.

Iteration - Final Drawing

Activity: Bring all your ideas from your iterated design and produce one final design drawing in the space below.

Communication

Records of a design, e.g. drawings/plans/blueprints, are often kept as a computer-drawn file (CAD). This information allows other team members to update or modify the design in the future.

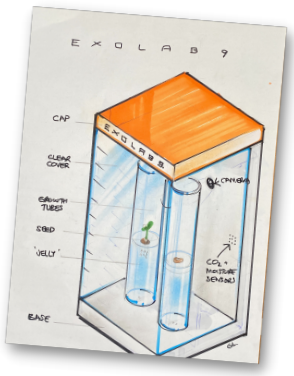
Students learn to work collaboratively in preparation for work in industry. When working in a team, complex projects rely on people's ability to create drawings that accurately communicate technical information.

Activity:
Produce an orthogonal drawing (a front and a top view). You may choose to include a detail or 'close up view' if some parts are not easy to see clearly.

Include dimensions (measurements) on your plans. Dimension lines are very thin lines so as not to distract from the actual drawing. If possible, draw your plans full size, i.e. (scale 1:1).

Click on the links below for video tutorials from Glenny D to assist with your communication

Jiggler Device



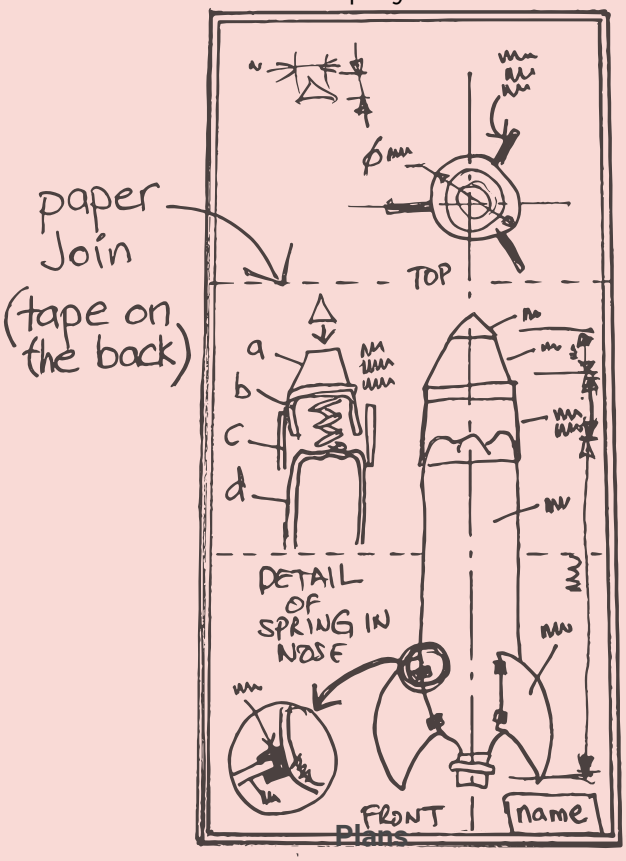
Exolab 9

In the example below our designer Glenny D joined three sheets of A4 paper together to draw a model bottle rocket at full size (see below).

To start a drawing, rule a margin. Add your name in a title block. Use a ruler and sharpened pencil and make these the drawings neat and tidy.

Placing the top view above the front view is the correct way of arranging your views on a drawing.

These sheets can be folded on the joins to fit inside an A4 display folder.



Communication

Activity: Use the space below to communicate your final design solution. This could be a CAD drawing, sketch, rendering or photo of your prototype. This will be the artefact used to pitch your solution. Make sure it clearly communicates what you are trying to achieve.

Communication

Pitching your solution

What is a Pitch?
A pitch is a concise way to tell a story about a problem, its solution and why people should invest in your product.

Pitch Deck
A pitch deck is, in essence, the presentation slides that you use for the 'Pitch'. You may use different techniques to pitch, but typically you would still design your presentation using a series of slides. You may use a storyboard to develop your pitch deck.

Common mistakes while pitching

- Taking too long
- Lack of a story
- Use graphics and images instead of words
- Not recognising a real problem
- Not identifying the opportunity

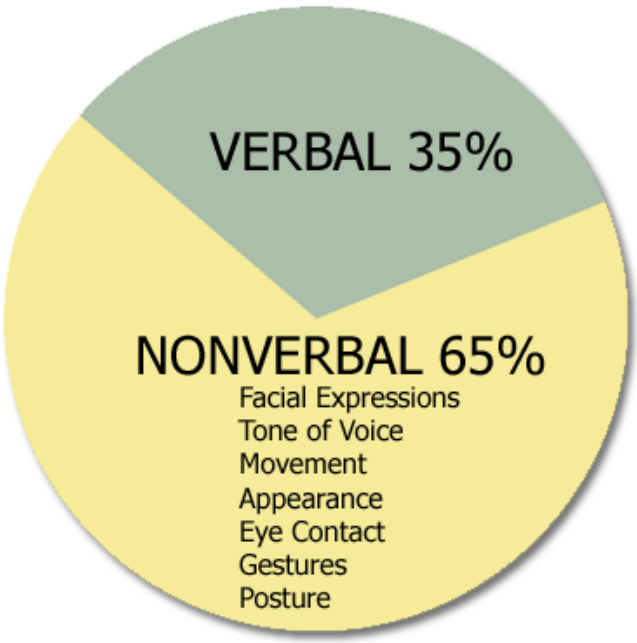
Structuring your pitch

Typically a 5-minute pitch would include eight to twelve slides. You should use at least the following headings;

- Identify the problem
- Market analysis
- Our solution
- The ask / why pick mine?
- Highlight the team
- Innovation and technology
- Impact of your idea
- Budget and resources
- Conclusions and call to action

Presentation

- Know your audience
- Keep language simple but powerful
- Be confident, be in control and do not speak too fast
- Be passionate



Make your Pitch Magical: Tell a story!

- Where did the idea come from?
- What is your background?
- How did you get here?
- What is your vision?

Some examples of a good pitch

MIT Elevator Pitch Winner 2011

TEDx Southbank Pitch Winner

University of Dayton Business Plan Competition

Communication - Storyboard

Storyboard Activity - In the boxes below produce a storyboard for your Fire-Ed Up pitch. Each box would represent a pitch deck slide or a different aspect of your talk.

1.Identify the problem	2. Market analysis	3. Our solution
4. The ask, why pick us	5.How is in the team	6. Innovation and technology
7. Impact of your idea	8. Budget and resources	9.Conclusions and call to action

Communication - Pitch

Part of your Fire-Ed Up assessment involves producing a 5-minute video that details your solution. Part of producing a great pitching video is the production of a pitch deck to be used in the video. Use the storyboard you created as a guide for both elements.

Pitch Deck Creation:

- Develop a detailed pitch deck, ensuring it covers all critical aspects of your solution. Each slide should effectively communicate the essence of your project, from the problem statement to the proposed solution, its implementation, and potential impact.
- Include visuals, data, and concise text to make your presentation engaging and informative. Remember to cover market analysis, technological innovation, sustainability, and budget considerations.

Video Production:

- Produce a 5-minute video that brings your storyboard to life. This video should serve as a dynamic and persuasive presentation of your solution.
- In the video, walk your audience through the problem you're addressing, your proposed solution, and how it works. Highlight the innovative aspects of your design and its potential impact on bushfire management.
- Use clear visuals, demonstrations, or animations to enhance understanding. Ensure your narration is engaging and clearly conveys your message.

Both the pitch deck and the video should complement each other, offering a holistic view of your project. This activity is a chance to showcase your creativity, understanding of the problem, and the practicality of your solution in addressing the challenges of the Fire-Ed Up project.

STEM Careers

Think of the types of industries that support bushfire prediction, management and suppression.

There are many!

- Ground and air transport
- Firefighting materials production
- Satellites and drones
- Climate modelling & data scientists
- App designers and ecologists & more!

Brainstorm, Investigate, Share

With your team, brainstorm and/or research;

- The types of organisations involved in bushfire prediction, management and suppression.
- The types of roles needed in each of these organisations
- The skills needed within these roles
- The courses & training opportunities that will bring people to those roles

STEM Careers

Results of brainstorming and research

Organisation

Job Roles

Skills Needed

Training & Courses

Now share what you have learned with your class!