



SciFest



A Guide to Doing an Engineering Project

Adapted from: Design and Discovery - A Transition Year Module for TY Students. Intel Ireland



An Roinn Oideachais
agus Óige
Department of Education
and Youth

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Where Can You Find Information About SciFest?

The best way to find out all about SciFest is to visit the official SciFest website: <https://scifest.ie>.

On the website you will find lots of resources and advice on how to do your project.

You can also



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Design and Discovery

Design and Discovery is an introductory course to engineering designed by Intel and aimed at transition year students. The complete course is downloadable from the SciFest [website](#) or from the NCCA [website](#) as a TY module. The module focuses on some basic design and engineering concepts in which students follow a design process, used by professionals, that culminates in building prototypes of their ideas. The module encourages a hands-on, inquiry-based experience by encouraging students to identify and design creative solutions to everyday problems in the world of design and engineering.

Design Notebooks

The design notebook is a diary of progress of an idea. It is a place to record ideas, inspirations, discoveries, sketches, and notes. It is very important for students planning to participate in a science fair such as SciFest or who are interested in applying for a patent.

Design Notebook Guidelines

- Date and sign each page
- Number each page
- Never remove pages
- Do not erase
- Include explanation notes with any sketches or diagrams
- Keep accurate and detailed notes
- Be consistent and thorough

The Design Process

Getting from “Think” To “Thing”

The design process guides the development of a project from an idea to the design of a prototype. Throughout the stages of designing a product, many of these steps are revisited and the ideas refined.

1. Identify a design opportunity.

Notice that design opportunities are everywhere and often come from a need, problem, or improvement to an existing solution. The goal is to identify many design opportunities and then narrow them down later.

2. Research the design opportunity.

Gather lots of information about the nature of the problem in order to narrow your choices down. Find out about user needs and similar products.

3. Brainstorm possible solutions to the problem.

Try to come up with five to ten ideas for solving the problem or addressing the design opportunity. Brainstorming may involve the use of SCAMPER (see page 3) and other techniques.

4. Write a design brief.

Define the problem clearly in a problem statement. Describe the user needs and a proposed solution.
Draw a sketch of the solution.

5. Research your solution.

Do a literature review and talk to experts to find similar solutions and other approaches.

6. Refine your solution.

Analyse the solution for feasibility, safety, and implications of the idea. Consider materials and methods for constructing the project.

7. Prepare design requirements and conceptual drawings.

Write up the criteria (the solution must meet requirements) and sketch drawings.

8. Build models and component parts.

Analyse the project design for its systems, components, and parts. Now build a model of the entire design and/or its systems.

9. Build the prototype.

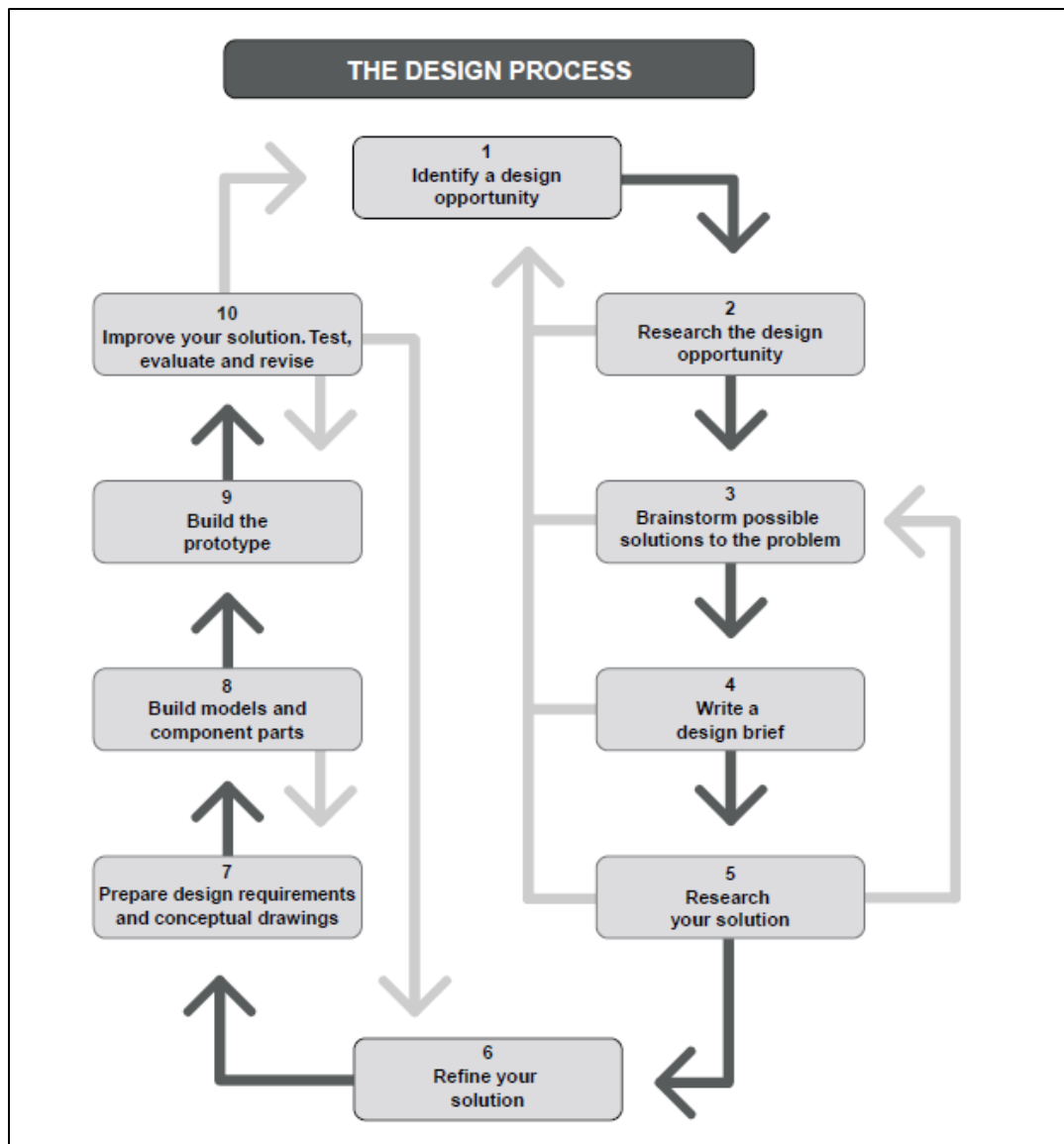
Develop project specifications and create a working prototype.

10. Improve your solution. Test, evaluate, and revise.

Evaluate the prototype for function, feasibility, safety, aesthetics, and other criteria. Revise or build another prototype.



"Beat The Drought" - A Smart, Staged, Domestic Greywater, Eco-treatment System Providing a Viable, Sustainable Irrigation Water Supply to Combat Drought and Water Restrictions"
Ronan Walsh, Coláiste Choilm, Tullamore, Co. Offaly



1. Design Process Step 1: Identify a Design Opportunity

The First Step to a Good Design Is a Good Description of the Real Problem

- The ability to really see a need, and then be able to describe that need, is at the heart of successful product development.
- It requires a heightened awareness of the way people use things, and an ability to observe one's surroundings.
- Watching for difficulties people experience in doing a task, or how a particular product is used in an unintended way, takes practice and skill.

SCAMPER

What is SCAMPER?

SCAMPER is a technique that gets you to think about improving an existing design. It is an acronym that helps you remember seven different ways to think up new improvements. It is useful for being creative in a systematic way. It generates ideas you might not have on your own. Try it on an everyday object such as a potato peeler!

S	Substitute one thing for another
C	Combine with other materials, things, or functions
A	Adapt: Can it be used for something else?
M	Minimize/Magnify: Make it larger or smaller
P	Put to other uses: Can you put it to another use?
E	Eliminate/Elaborate: Remove some part or material, or make one section more detailed or refined
R	Reverse/Rearrange: Flip-flop some section of the item, move parts around

Are You Ready for a Design Challenge?

Design Challenge 1

Can you use the SCAMPER technique to design an even better potato peeler?



Design Challenge 2

Can you use the SCAMPER technique to redesign a backpack that is more ergonomic, functional and stylish, and more sustainable and eco-friendly?

2. Design Process Step 2: Research Your Design Opportunity

The next step is to survey people from the general public and do some market research on your idea.

Writing a Survey

Writing a survey is harder than it appears. Remember to include a brief introduction explaining what you are doing.

Survey Questions

Questions should be as simple as possible. Remember not to include too many questions and that you are looking for short answers.

Sample questions you might like to ask

1. Do you use this product? yes ☐ no ☐

2. What do you not like about this product? _____

3. Would you use this product if (describe change)? _____

yes ☐ no ☐

When you have written your survey you should test it on other members of the class. This will help you identify any questions that might need changing.

Refine the Problem

Review the results of your survey

Using the survey results write the pros and cons of your design challenge.

	Pros	Cons
1		
2		
3		

Develop a Problem Statement

Write a clear problem statement. This is intended for someone who knows nothing about this problem. The problem statement should:

- Begin with a clear, concise, well-supported statement of the problem to be overcome
- Include data collected during the survey/observation in order to better illustrate the problem
- Establish the importance and significance of the problem
- Describe the target population

3. Design Process Step 3: Brainstorm possible solutions to the problem

Scamper to Solutions

You now need to consider possible solutions to your design project. In doing so, it is important to consider the outcome of the design - what do you want the product to do?

Use **SCAMPER** to come up with some solutions. You do not have to use all the steps of SCAMPER

Possible Solutions to the Problem

Substitute (What else can be used instead? Other ingredients? Other materials?)

Combine (Combine other materials, things, or functions.)

Adapt (Can it be used for something else?)

Minimise/Magnify (Make it bigger or smaller.)

Put to other uses (New ways to use as is? Other uses if modified? Other people or places to reach?)

Eliminate/Elaborate (Remove some part or materials or make one section more detailed or refined.)

Reverse/Rearrange (Flip-flop some section of the item or move parts around. Interchange components?)

List your design solution ideas below:

1. _____
2. _____
3. _____
4. _____

Review your solutions, ask yourself questions such as:

- Does it address the problem?
- Is it practical?
- Can it be made easily?
- Is it safe?
- Will it cost too much to make or use?
- Is it too similar to something else?

4. Design Process Step 4: Write a Design Brief

A Design Brief –What it is

A design brief contains:

- a short description of a design problem
- a proposed solution
- the profile of a typical user
- a proposed solution in terms of how it will solve the problem
- a sketch or sketches of the solution
- the basic requirements needed to produce a prototype

A Design Brief – What it does

- It helps clarify the problem that the designer/engineer is trying to solve.
- It doesn't provide a lot of detail about the solution but puts on paper the thinking and research about the problem. Often the act of writing and communicating the problem and proposed solution helps the designer move along in the design process.
- It also serves to introduce the idea to others for feedback.

Remember the design brief may be changed at any time throughout the design process.



"The Microplastic Filter - A Small Solution to a Global Problem"
Ruth Madden, Larcy College, Clones, Co. Monaghan

Your Design Brief

Writing your own design brief should help you clarify your ideas and think about them systematically. This is a working document: It will be your road map as you develop your ideas.

Describe the problem. Write a statement that focuses on what's wrong and not working. Recall the features of a problem statement:

- Begins with a clear, concise, well-supported statement of the problem to be overcome
- Includes data collected during the survey/observation in order to better illustrate the problem.
- Establishes the importance and significance of the problem

Describe how the current product is used. Provide a context for the problem and explain any related solutions that resemble or relate to the problem but have failed to address the problem.

Describe a typical user (user profile). This addresses who uses the product and how their needs are or are not met. How will they benefit from a different product?

Propose a solution: Describe how it will work, and how it solves the problem. Explain the features.

Draw a quick sketch of your ideas. This is a rough sketch and can include drawings of different angles of the solution.

Describe the basic requirements that will best suit the proposed product. This describes the quality (for example: flexible or sturdy), and the type of materials (for example: metal or plastic).

5. Design Process Step 5: Research Your Solution

Now that you have a particular design idea in mind it is time to concentrate on the improvement and refinement of your design solution by gathering information about a typical user. It is also a good idea at this stage to look at other inventions and to find out about patenting your idea. This will help you see that there are many different approaches to solving problems and the result is often a variety of design solutions.

The User

Think about your product area. Consider the following questions.

- Who will use this product?
- What is the person's gender? Age? Experience with this type of product?
- Where will they use this product?
- Why will they use this product?
- What will they be doing to operate or use this product?

Using the above information, describe one person who will be the user. What are their characteristics and the scenario in which they will use the product? You may include a drawing of the person using the product if that helps.

What considerations will you need to keep in mind when you design the product to meet the needs of the user?

Remember you should be keeping detailed records in your design notebook. Be sure to record any changes and additions throughout the process and date everything!

6. Design Process Step 6: Refine Your Solution

Project Analysis

Now that you have narrowed down your design solution, you are ready for Step 6 of the design process. You need to do testing throughout your project development to ensure that your project is safe, durable, and works the way you want it to. It is also necessary to analyse the solution for cost, safety and other implications of the idea.

Refine Your Solution.

Before you continue give your design project more thought and answer the following questions about your design solution.

- Is my idea practical? If so, how?
- Can it be made easily? How?
- Is it as simple as possible? Explain.
- Is it safe? How?
- Is my project durable? Will it withstand use, or will it break easily? Explain.
- Will it cost too much to make or use? Explain.
- Is my idea really new? Explain.
- Is my idea similar to something else? Explain.
- Will people really use my product? How?

Design Process Step 7: Prepare Design Requirements and Conceptual Drawing

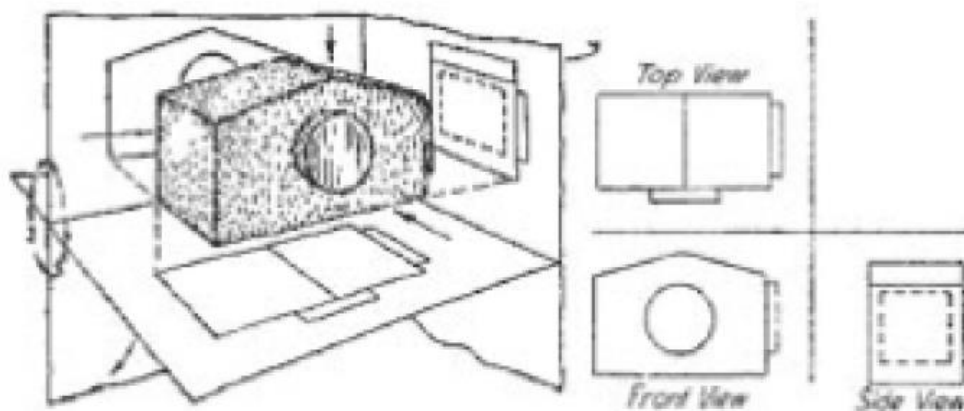
Drawing from All Sides

Drawing your ideas can help you visualise your plan and will be very useful when you make your model. You may find it very useful to draw the different components and parts of your project from different perspectives. You will probably have several drawings of your project as your ideas evolve.

Example of Conceptual Drawing

Compare the 3-D drawing of the object below to the three views of the object on the right.

What do the three views show you about the object that you didn't know about the 3-D version?



Now You Try

In your design notebook try your hand at conceptual drawings. Be sure to draw different views as well as individual drawings of the components and parts. Make lots of drawings. Make them large enough to label components and show the direction of any movement that may be appropriate to your design.



" An R&D Study on Using a Nutrient Treatment Biofilter to Combat Oceanic and Freshwater Dead Zones which Harnesses the Intrinsic Potential of Halophyte Species", Timothy McGrath, Community College Killorglin, Killorglin, Co. Kerry

8. Design Process Step 8: Build models and component parts

Materials and Modelling Plans

A Model is a small but exact copy of something

- What will this model help you understand about your idea?
- Will it be a small or full-scale version?

As you plan, you may select and manipulate different materials. Be sure to make notes about the materials that you study: their flexibility, strength, and their suitability as a modelling material. Fill out the checklist.

9. Design Process Step 9: Build the Prototype

Now that you have a model made, it's time to move on to the next step: building a prototype. Remember the differences between a prototype and a model.

Model: A small but exact copy of something.

Prototype: A working model of a machine or other object used to test it before producing the final version.

Building a prototype can be fun and challenging. Here are a few tips to keep in mind.

1. Make it large enough. Remember that others will want to see the detail and you will want to make sure all the parts work.
2. Pay attention to detail. Be sure that you show all the parts and components.
3. Make it strong. Use durable materials.
4. Make it "green." Use recyclable materials when possible.
5. Make it realistic. The prototype should be as close to the real product as possible.

Ask yourself the following questions.

1. What ideas do you have for developing your prototype?
2. What suggestions do your peers have for you?
3. What materials are you considering using for your prototype?

BUDGET

Prepare a budget for your project, include the materials, how much you will need of each material, the cost for each material and the total cost.

Materials	Quantity	Cost
Total Cost =		

Develop the Prototype

It is helpful to keep good records of your prototyping efforts. Good records allow you to adjust your design based on what you learn from each step of the process.

The questions below can help with this record keeping.

Plans

How do you plan to build your prototype?

Purpose

What will this prototype be able to do?

Testing

Will the prototype meet your specifications? How will you test this and what data will you gather?

Next Steps

What do you want to do next? Adjust this prototype? Build another version of this prototype?

10. Design Process Step 10: Improve your solution. Test, evaluate, and revise.

The time has now come for you to test and evaluate your prototype for function, feasibility, safety, and aesthetics and then make modifications. This process of testing and modification continues until you have a final working prototype.

Test, Evaluate and Revise.

User testing will help you to know if your product does what you want it to do. For example:

- Does it work the way it is supposed to?
- Do people like the way it looks?

It's best to conduct user testing with people who you think will be using this product and have more than one prototype (if possible) for them to compare.

In order to make the user testing most useful, select appropriate people to do the user testing and appropriate conditions to conduct the testing.

Sample Questions

1. What do you like and dislike about this product?
2. What do you think this product should do?
3. What could be done to make you want to use this product more?
4. What do you think of the way this product looks (the aesthetics)?
5. Is this product efficient, safe, and comfortable to use? If not, how could it be improved to make it more ergonomic?
6. What do you see as some problems with this product?
7. What can be done to solve these problems?

Observations

1. What does the user do with the product?
2. What are the user's perceptions of the product?
3. How successful or unsuccessful does the user think the product is?
4. How does it meet or fail to meet the user's needs?
5. How safe is the product?

Priority—Decide how this problem ranks.

H = High Priority
M = Medium Priority
L = Low Priority

Problem—Describe the problem.

Criteria—Decide what type of change it is:

- Functional
- Safety
- Aesthetics
- Feasibility
- Other

Revision—Describe what changes would be needed.

Priority	Problem	Criteria	Revision

Evaluate and Revise it

Now that you have feedback from your user testing, you need to organize the information in order to figure out which suggestions you will incorporate into your revisions. After completing the chart, decide which revisions are most feasible and what your process will be.

The Design Process

The Design Process: Getting from “Think” To “Thing”

The checklist below is adapted from the design process steps. This is a tool to keep you organised and thinking about where you have been and where you want to go. It would also be a good idea, at this stage, to look at the planner at the beginning of the module to check how much time you have left to work on your project before SciFest.

1. Identify a design opportunity.

- ✓ Identified about 10 design opportunities (needs, problems, or cool things to design).
- ✓ Narrowed the list of opportunities to three for further research.

2. Research the design opportunity.

- ✓ Refined my design opportunities with interviews and other data-gathering research.
- ✓ Selected one design opportunity to address.
- ✓ Wrote a problem statement to clarify and explain to anyone what I will solve with a design solution.

3. Brainstorm possible solutions to the problem.

- ✓ Expanded my possible solutions using SCAMPER and other research.
- ✓ Evaluated my solutions using criteria that we determined.
- ✓ Narrowed my solutions to three possibilities.
- ✓ Began thinking about the types of materials I could use for my solutions.

4. Write a design brief.

- ✓ Wrote a design brief with a problem statement, description of user needs, a proposed solution, and a sketch of the solution.

5. Research your solution.

- ✓ Researched and refined my proposed solution.
- ✓ Took notes and wrote down information from my research.

6. Refine your solution.

- ✓ Interviewed experts and possible users to analyse my project for feasibility, safety, and other implications of my solution.
- ✓ Researched materials and methods that would be appropriate for constructing my project.
- ✓ Conducted a project analysis to consider any changes to my solution.

7. Prepare design requirements and conceptual drawings.

- ✓ Developed design requirements that focused on the needs of the user.
- ✓ Completed conceptual drawings.

8. Build models and component parts.

- ✓ Analysed my project design for its systems, components, and parts.
- ✓ Planned models to build and what each model would test or be able to demonstrate.
- ✓ Built a model or models of components of my design.
- ✓ Developed a project plan for completing my design.

9. Build the prototype.

- ✓ Conducted further research, model building, and testing, as needed to complete a working prototype.
- ✓ Developed specifications.
- ✓ Completed first working prototype.
- ✓ Analysed prototype for functional improvements.

10. Improve your solution. Test, evaluate and revise.

- ✓ Prioritized improvements needed and built new or revised prototype to meet priorities.
- ✓ Evaluated prototype for function, feasibility, safety, aesthetics, and other criteria.



" Scrum Developer - a device that would help establish good scrummaging habits in underage players."
Ronan Mullane, Desmond College, Newcastle West, Co. Limerick

Patents

If you have a design that can be used commercially, and you would like to seek a patent you should register your idea before you present it at a STEM fair. For more information on this please visit the Intellectual Property Office of Ireland [website](#).

The Presentation

Now that you have completed your project you need to spend some time improving your presentation skills.

Conduct a brainstorm with your team members. Ask yourself the following questions:

- What will you need to explain in the presentation?
- What will you need to show in the presentation?
- What presentation skills will make your presentation successful?
- How long is the presentation expected to be?

Presentation Content

- Problem clearly described
- Solution clearly explained
- Design process articulated
- Drawings, models, and prototypes explained
- Documentation on hand for questions

Drawing, Models, and Prototypes

- Design drawn in detail
- Models show how project works. Model may include parts and components
- Prototype is a working prototype
- Drawings, models, and prototypes explained in detail



" CPR Pedal Chest Compression Device."

Paula-Eve and Jim Culhane, Comprehensive School Tarbert, Listowel, Co. Kerry



REMEMBER

Log on to

<https://scifest.ie>

SciFest

The SciFest science fairs programme is a national initiative founded by Sheila Porter in 2006 to encourage a love of science, technology, engineering and maths (STEM) through active, collaborative, inquiry-based learning. Following two successful pilot SciFest science fairs hosted by the Institute of Technology Tallaght the programme was launched nationwide in 2008. SciFest expanded rapidly and today encompasses four distinct levels of participation: SciFest@School, SciFest@College, SciFest National Final and SciFest International.

SciFest is accessible, inclusive and free to enter. Participation in the programme offers an innovative way to expose second-level students to, and enhance their understanding of, STEM subjects. Own choice of topic, collaboration, hands-on activities, presentation skills and recognition of work done are all attractive aspects of the programme. The emphasis on real-world problems helps make STEM relevant to all students. They grow in confidence, develop their critical thinking, problem solving and communication skills and become aware of the variety of exciting careers associated with a STEM qualification.

Winners from the SciFest National Final which takes place in Dublin each year in November represent Ireland and SciFest at the [Regeneron International Science and Engineering Fair \(ISEF\)](#) which is held each year in the USA. Winners also attend the [Long Night of Science in Berlin](#) and represent Ireland and SciFest in the Eskom EXPO for Young Scientists.

See <https://scifest.ie> for more details.

Contact Us

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w: <https://scifest.ie>

Where Can You Find Information About SciFest?

The best way to find out all about SciFest is to visit the official SciFest website: <https://scifest.ie>.

On the website you will find lots of resources and advice on how to do your project.

You can also

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