Royal Academy of Engineering

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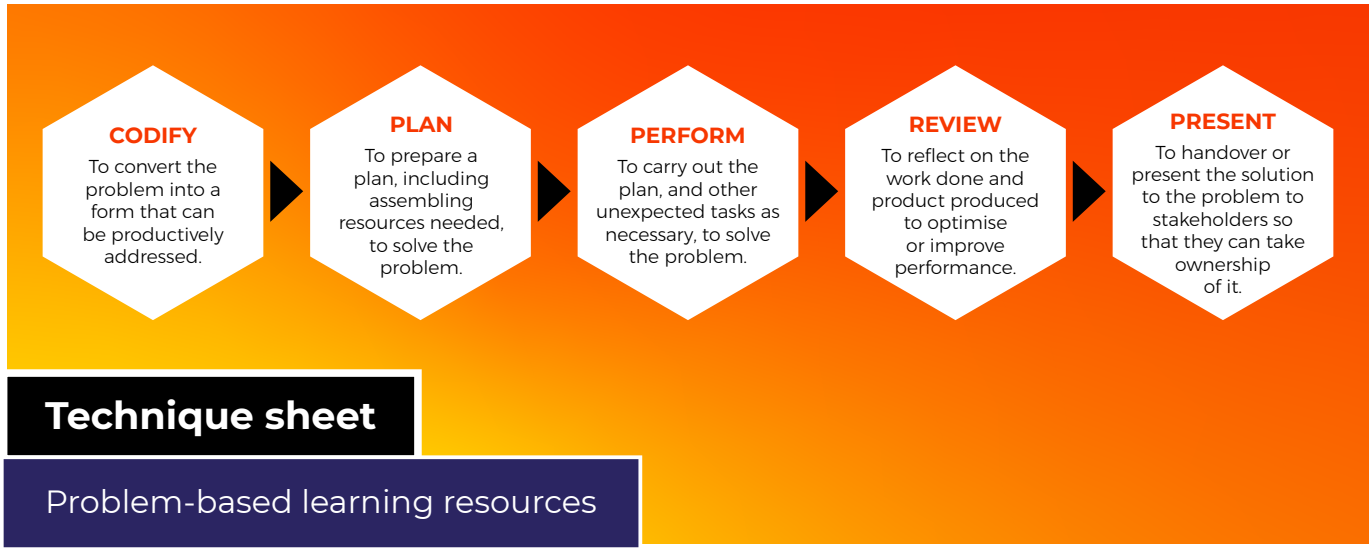
THIS IS ENGINEERING

25 The Engineering Design Process



Technique sheet

Problem-based learning resources

Introduction

Engineers identify problems and try to solve them. They build things or create services to a given standard. Every engineer also likes to fiddle and tinker to make things work better or faster! One way to describe the process that engineers go through when they think about a job is called the Engineering Design Process. There are many slightly different versions of the process, but they all share some common features. These resources use a **Codify-Plan-Perform-Review-Present** process.

How do you CODIFY a problem?

Most engineering tasks begin with a problem (e.g. 'the vehicle becomes dangerously unstable above 60mph', 'the switchboard is broken and needs replacing'). Sometimes these problems are neat and easily understood (e.g. 'how can we produce 100,000 5ml glass bottles to store vaccine solutions in the next 4 weeks?'). Sometimes they are much more open and potentially confusing (e.g. 'how can we ensure everyone has sufficient power to live, and heat their homes and cook their food in the next 20, 50 and 100 years and avoid the problems of climate change?'). It is important to spend some time researching the problem and its context. Who does it affect? How badly? What has been tried in the past? What would a successful solution look like? Success criteria are simple statements of what you regard as a successful outcome (e.g. 'the machine does not cut out randomly when it is run at full speed for 8 hours.'). This time spent understanding the problem is called codifying the problem.

- Make sure you spend time thinking about the problem and its context before jumping in with the first solution that you think of.

What does a PLAN involve?

Planning is the next stage. You are clear about your problem, have identified possible solutions and you are planning how to gather information to decide between them. Planning can involve research into what is already known (e.g. 'factors affecting the growth of crop plants under glass', 'which motor has the correct specifications for this job?') so you will be looking up results from other peoples' work – perhaps in a textbook or on the internet. Sometimes you will need to do original research yourself – particularly if the problem is unusual or in a very specific context. Planning also gives you chance to think about what you will need to do the job (e.g. 'do I need to order components?' 'Which tools and equipment do I need?', 'do I need help from a specialist?'). By the end of the planning stage, you should know what you plan to do, why you need to do it and how you are going to do it.

- Make sure you plan carefully so that when you come to do the job there are no surprises! Do not be the engineer who forgets to order the

component or doesn't have the equipment they need when they get to the site!

How do I PERFORM well as an engineer?

Every job is different. There will be complexities or difficulties every time but by planning carefully you should be able to cope with these. Performing the task (e.g. designing a conveyor belt system, replacing a broken valve, inspecting a fire alarm system) could be straightforward but remember to keep thinking throughout the process. You might need to change your plan if something unexpected happens (e.g. the project schedule or budget changes, the damage to the unit is much more extensive than originally assumed or a colleague is off ill for a week).

- Make sure you keep thinking while you do the job you have to do – watch out for unexpected difficulties or changes and adapt your performance to solve these problems as you go.

What does the REVIEW involve?

At the end of every job, you should be able to look back with pride. For some jobs with an agreed solution (e.g. replace this component with a new one) this can be simply a matter of testing the equipment to check that it now works properly. The equipment working is a good example of a success criteria and some jobs only have one or two. For jobs where there might be multiple solutions (e.g. which of these designs is the best for the new iPhone?). The success criteria may only cover part of the issue. The case has to be tough and cost-effective to produce (simple 'success criteria') but there may also be other factors to consider such as how easily it can be coloured and how the market regards the material (e.g. 'plastic may be very good but might make the phone look cheap'). Evaluation involves looking back at the objectives of the job but also thinking more broadly about what you have learned during the process and if better ways are available to do it in the future.

- Make sure you evaluate your personal performance and the performance of your solution in terms of the success criteria agreed at the codifying and planning stages. Look for ways to improve the job or tweak the performance for next time.

Why do I need to PRESENT my work – and who to?

The job is finished, the new kit is humming nicely, and you've cleaned up the mess. So, your task is finished? Not quite yet. Most engineering tasks must be handed over to the person who commissioned them. This might involve explaining to the operator how a new machine works (especially the safety features) or presenting a variety of possible power distribution solutions for the board of a major electricity supply company so that they can choose which one to develop further. Presenting the job is often the last part of an identified task but can also lead to more questions or new ideas. These can start the whole process all over again.

- Make sure you present your work to the relevant person and, if necessary, get their sign-off.

Check yourself

You should be able to answer these questions easily after reading this sheet.

1. Why is it important to spend time codifying a problem rather than jumping straight to the obvious solution?
2. What are success criteria and why are they useful?
3. What can the engineer and the client get from a review of the work done?

Taking it further

These activities will deepen your understanding of this topic.

1. Think of a project that went really well – can you recognise the stage of the Engineering Design Process in the project? What did you do to make sure you understood the problem? How did you organise your planning? And did you present your work to someone afterwards? How did they respond? Look for things that worked well and work out how you can make them part of your normal work habits.
2. Think of a project that did not go so well. What caused the problems? Did you miss out any of the key stages in the Engineering Design Process? Or was it just, bad luck? Be honest – things going wrong don't have to be your fault! Try to identify the points where a deeper understanding of the problem, or better planning and a clearer review could have helped. What can you learn from this? What things could you do differently in your next project?