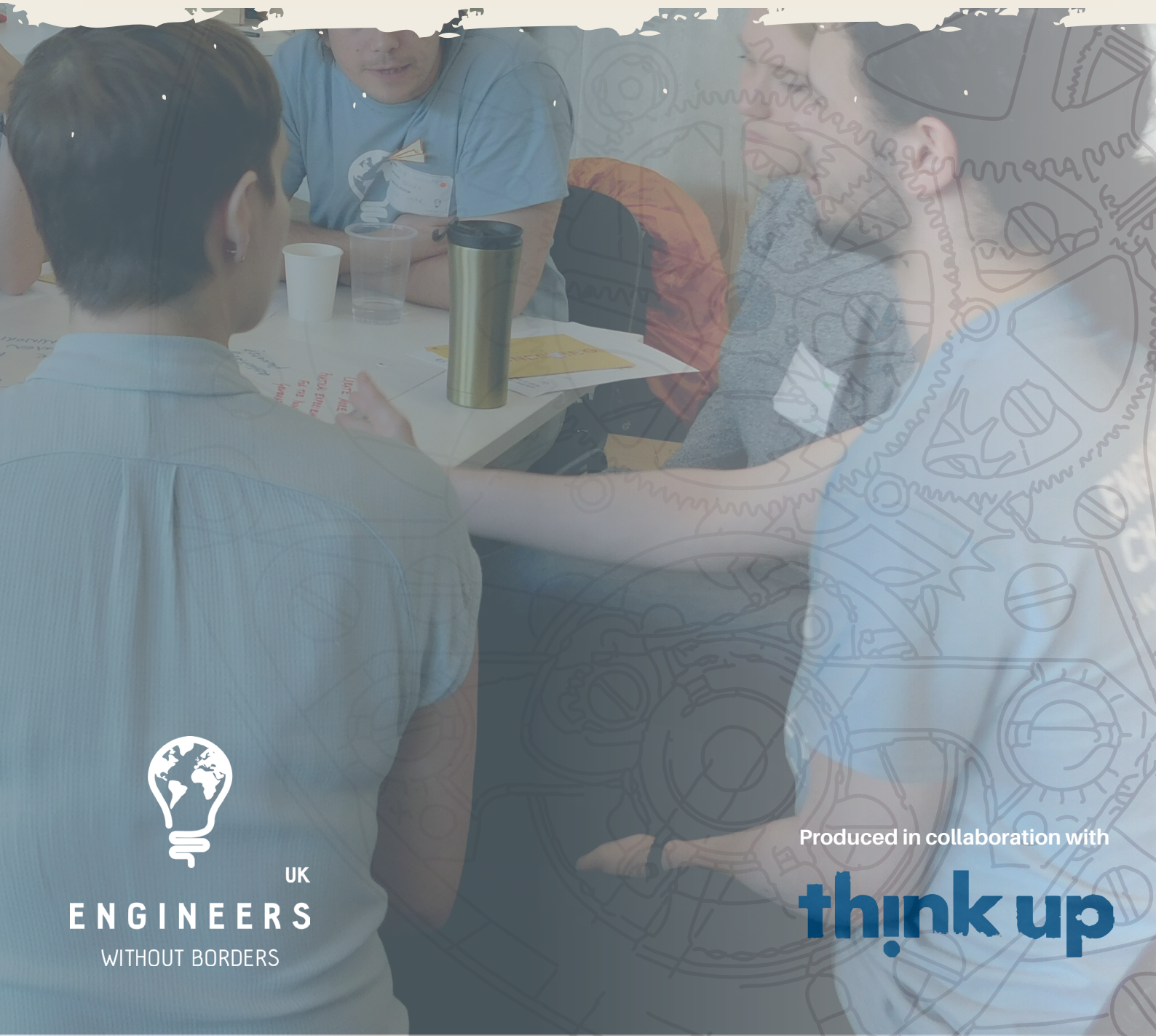
THE ENGINEERING FOR PEOPLE DESIGN CHALLENGE

DELIVERING PROJECT BASED LEARNING:

Teaching resources and guidance for academics



UK ENGINEERS WITHOUT BORDERS

Produced in collaboration with think up

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DOCUMENT OVERVIEW

We have created this guide to support teaching staff in the delivery of the Engineers Without Borders UK Engineering for People Design Challenge; an award-winning inter-university design programme that encourages engineering undergraduates to place importance on their global responsibility to society and the planet as engineers. Our aim is to provide teaching staff in engineering education with concepts that they can use in their teaching as well as activities they can use, adapt or give to students to run for themselves.

The resources have been developed in partnership with Think Up, an engineering education consultancy, and are based on the work we do with universities and engineering practice to help students and practising engineers develop their design skills.

The guide begins with a section introducing the overarching concepts that are relevant to the whole design process, after which it is then split into four sections which broadly map to the four key stages in a design process:

1. Analysing the context
2. Defining the problem and the design criteria
3. Exploring lots of options
4. Justifying your recommendations and explaining how it works.

This guide contains a mixture of concepts that can help teaching staff develop their own material and exercises that can be adapted or modified for use with students.

ABOUT ENGINEERS WITHOUT BORDERS UK

Engineers Without Borders UK leads a movement to enable engineers, everywhere, to apply a globally responsible mindset to all that they do and invest their skills and talent in engineering that benefits our global community.

We want you and your students to be a part of it.

Through becoming a part of our movement, you'll be joining a community of like-minded academics, students and engineering professionals who are championing the inclusion of global responsibility in engineering education. You'll learn how engineers are changing the world, discuss your ideas with others, and then decide how best to act.

Together we will:

- Change how engineering is perceived so that a diverse cohort of engineering talent who are passionate about addressing global issues is attracted into the industry.
- Embed the principles of global responsibility into engineering education so that future engineers can deliver engineering for good.
- Support and incubate innovation in engineering around the world to deliver products, infrastructure, services and practice on issues that matter for the good of everyone.

It is only through working together that we can drive this movement for change forwards and lead engineers to deliver a better future for everyone.

Together we can engineer this change. Join the movement today at www.ewb-uk.org.

ABOUT THE ENGINEERING FOR PEOPLE DESIGN CHALLENGE

Engineering should be at the heart of addressing the global challenges of the 21st century.

The award-winning Engineering for People Design Challenge delivered by Engineers Without Borders UK prepares your students, the engineers of the future, to become globally responsible engineers. Through working on real world issues and putting people at the forefront of engineering design, your first or second year students will demonstrate how they understand context, identify engineering issues and justify their recommended design ideas. At the end of each year, we hold an inter-university competition to celebrate the best teams from around the country and showcase emerging engineering talent.

Delivered as part of the undergraduate curriculum, this project-based learning programme contributes to the Engineering Council requirements for students on accredited degrees to demonstrate understanding of the design process and have a broad awareness of the economic, legal, social, ethical and environmental context of engineering activity.

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AUTHORSHIP

This guide has been compiled in partnership with Oliver Broadbent, Royal Academy of Engineering Visiting Professor in Experience-led learning at Imperial College and Director of engineering education consultancy Think Up. Oliver works with university staff to develop novel approaches to delivering engineering education. He has a specialism in design teaching, both in universities and in industry, and this guide is drawn from his many years' experience of helping engineers develop their design skills.

SUPPORTERS

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INTRODUCTION TO PROJECT-BASED LEARNING

This first part of the guide provides some general principles that should help as you start to think about how you want to approach the overall delivery of the Engineering for People Design Challenge.

PROJECT-BASED LEARNING OVERVIEW

The Engineering for People Design Challenge is based on a project-based learning pedagogy, itself a subset of a broader range of teaching methods known as inductive learning. According to Prince and Felder[1] in their review of inductive teaching methods in engineering education:

- Inductive learning has a completely different starting point from traditional learning that coincides much more closely with how people learn in practice.
- Inductive learning starts from the specifics of the real world rather than from general principles and then moves towards theory.
- Learners are usually given some sort of initial stimulus: experimental data to interpret, a situation to make sense of, a brief to respond to.
- As they grapple with the stimulus they generate a need for new knowledge, guiding principles and underlying theory. They then either find out what they need themselves, or they are guided towards finding it.
- There is then a of presentation of work that the students have been able to do, or conclusions they have been able to reach as a result of their studies.

Within this broad framework, project-based learning has the following characteristics:

- It begins with students being set the challenge of producing some sort of final product, be that a model, a prototype, a simulation, even a presentation of a concept.
- The end point is the presentation of this product, ideally (but not always) to a group of people who have some real stake in the outcome.
- Alongside this product, students also reflect on the learning process they have gone through to reach this final product.

Teaching staff therefore become facilitators in the student learning process. Facilitators need to strike a balance between how much freedom they give students in defining the problem to be solved and how much they want students to focus on specific learning outcomes. Now more than ever in an era of openly available online resources, giving students an open brief gives them the chance to develop the ability to identify what knowledge they need, how to access it and how validate it. This last skill is important part of developing their ability to apply judgement in their work; a key professional competency.

Prince and Felder (2006) describe three categories of brief:

- **Task project:** project is defined by the instructor; largely instructor-prescribed methods.
- **Discipline project:** instructor defines a subject area of projects and specifies in general terms the approaches to be used (which normally involve methods common in the discipline of the subject area), but students identify the specific project and design the particular approach they will take to complete it.
- **Problem project:** Near complete autonomy for the students on what project to choose and how to complete it.

The task project approach is typically how problem-based learning is used in engineering education. It creates minimal student motivation and skill development. It is appropriate when an instructor has defined a set of skills that need to be learnt and wants to set an appropriate context in which to test those skills.

1 Prince, M.J., Felder, R.M., 2006. Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. Journal of Engineering Education 95, 123–138. doi:10.1002/j.2168-9830.2006.tb00884.x

The discipline project approach works well when the instructor wishes students to develop a broad set of skills and knowledge in a specific subject area. The problem project approach is appropriate for training students to be both problem identifiers and problem solvers, and supports the transition from university student to autonomous self-motivated individual ready for industry.

The design brief provided as part of the Engineering for People Design Challenge fits somewhere between a 'discipline project' and a 'problem project' depending on how much freedom teaching staff give their students at their institution.

Research shows that inductive learning methods, such as project-based learning, are closely aligned with how people learn best. The Engineering for People Design Challenge represents a great opportunity for staff to experiment with and embed this high-impact pedagogy in their teaching.

PROJECT-BASED LEARNING AND THE DESIGN PROCESS

There are lots of different models for describing the design process. To help students develop and improve their design skills, it is useful to have a shared understanding of what design is. In the Engineering for People Design Challenge support resources, we describe design as four stage process:

1. **Analysing the context** - researching context, responding to initial stimuli.
2. **Defining the problem and the design criteria** - defining an initial problem.
3. **Exploring lots of options** - asking questions and developing ideas. Using new understanding to critique initial responses to the problem and to develop a more sophisticated response.
4. **Justify your recommendations and explain how it works** - new understanding to critique initial responses to the problem and to develop a more sophisticated response.

It is important to emphasise to students that the design process is iterative and not linear so moving through the process should always engage reflective practice. Using project-based learning will naturally develop and reinforce skills that will help engineers become effective designers.

DESIGN STAGE 1: ANALYSING THE CONTEXT

This is the part in the design process where we encourage students to research the context for which they will be designing.

HOW THIS DESIGN STEP CONTRIBUTES TO STUDENT LEARNING

From a project-based learning point of view, taking the time to analyse the context is a chance right at the start of the learning to find a problem topic that students want to work on, either because they find purpose in it, or interest, or both, all important factors in engaging students in the learning process. From a design point of view it is the chance for students to research the context so that they can develop a design that responds to a real need in an appropriate way.

For the purposes of the Engineering for People Design Challenge 'context' refers to all the factors that influence how people live their lives. Whilst people everywhere share many of the same needs, how people live is also affected by factors such as geography, politics, culture and the environment, all of which differ from place to place. Analysing the context is about understanding these factors and how they are interrelated, to determine how they will influence your decision making throughout the design process.

Students may be unfamiliar or uncomfortable with carrying out such open-ended self-led research. This project may also be the first time they have had to consider such a wide range of factors in an engineering design problem. The resources on the Engineering for People Design Challenge web pages provide starting points for research into the problem context and tools to help guide students' thinking. The activities in this section provide additional considerations for research and suggestions for how they make sense of what they find through activities you can facilitate.

SECTION SUMMARY

This phase, analysing the context, can be an exciting phase for students. It is a time in which new discoveries are made and new possibilities open up. It is a time in which students can discover the wide range of considerations an engineer has to make and the wide range of stakeholders an engineer has to engage with.

The support tools on the Engineering for People Challenge website provide useful guidance on what sort of research questions to ask and provide starting points for different aspects of the project. The activities in this section of the guide aim to encourage students to dig deeper, to help them organise the information that they find and to help them understand the importance of this research to the work of an engineer. And the Problem in the Problem exercise is intended to push students to ask difficult questions which they will find intellectually motivating.

Thorough work at this stage will lay the foundations for good design thinking and build student motivation through developing a sense of purpose and personal challenge.

ACTIVITIES

ASKING THE RIGHT QUESTIONS

The aim of this activity is to emphasise that before design development can begin, a really thorough understanding of need is required. Through simple questioning the designer can dig down to find the underlying need.

COLLATING YOUR RESEARCH

The aim of this activity is to encourage students to think about how they collate and present their research findings in an effective way that will help others in the group and support idea generation.

THE PROBLEM IN THE PROBLEM

In project-based learning students learn best when they find something difficult to solve. This activity pushes students to find not just a problem to solve, but what they regard as a difficult problem.

IN THE NEWS

The aim of this activity is to help students recognise that without thorough research, engineers risk getting their assumptions wrong. This can lead to devastating consequences for which they may be responsible as a future professional.

ASKING THE RIGHT QUESTIONS

ACTIVITY OVERVIEW

The aim of this activity is to emphasise that before design development can begin a really thorough understanding of need is required. Through reflecting on a simple questioning process the students can explore what type of questioning works well to dig down and find the underlying need.

LEARNING OUTCOMES

Recognise that before talking about solutions it is important to really understand the need.

Recognise that behind initial statements of need there are usually more fundamental drivers.

KEY INFORMATION

Type of activity: pair work
Duration: 30 minutes
Materials: paper

INSTRUCTIONS

When enthusiastic designers encounter a stakeholder it is all too tempting to engage the stakeholder in talking about possible solutions. In fact, what is needed at this stage is for designers to be in active listening mode. In this activity, students work in pairs to understand and interpret the needs of the client.

1. Ask students to pair up and take turns being a client with a problem they need to solve. The other person is a designer intent on understanding the underlying need.
2. Suggest they talk about a human need they can identify with, rather than role-playing a client from an imaginary situation (e.g. dealing with waste/human waste, getting enough water for their day to day lives).
3. The designer spends 10 minutes asking simple, non-judgemental questions to get them started. For example questions starting with what, how, and who - but not why, which invokes a statement of justification in response.
4. When students have spent five-to-ten minutes in one role, swap them round to discuss a different situation so both students have the opportunity to be the designer and the client.
5. Students should take some time to reflect on the experience of being client and designer, for example, as the client did they feel the questions they were asked helped them to explain the need? Are they confident there is no other information that the designer might find useful to solve the problem? Did they intentionally hold something back or find a question uncomfortable to respond to?

COLLATING YOUR RESEARCH

ACTIVITY OVERVIEW

In this activity, students work in teams to gather and organise relevant information that will support the main idea of the brief.

LEARNING OUTCOMES

Recognise research supports idea generation and justification.

Recognise the importance of structured thinking in design.

Recognise research continues all the way through the design process.

KEY INFORMATION

Type of activity: team work
Duration: 1 hour set up then follow up during the course
Materials: board, different colour post-its, pens and markers, drawing pins, string

INSTRUCTIONS

When enthusiastic designers encounter a stakeholder it is all too tempting to engage the stakeholder in talking about possible solutions. In fact, what is needed at this stage is for designers to be in active listening mode. In this activity, students work in pairs to understand and interpret the needs of the client.

1. Ask students to team up and find a large wall where they can pin up information. Their aim is to create a wall display of their on-going research findings.
2. They should find a way to capture all the aspects of the context that they have been researching.
3. Grouping the information is a good opportunity to talk about the content.
4. Suggest students use string to link together research outputs that are related.
5. Ask students to stand back and to see if they can find gaps in their research. Where information is missing, they can post questions on their wall to identify further research requirements.
6. As the project continues, suggest students keep this research wall live, adding new information to it, as well as the ideas that emerge.
7. Students can create a stop-frame animation as they add content, create connections, ask new questions and develop ideas. This is a great tool for presenting their thinking to other people.

THE PROBLEM WITHIN THE PROBLEM

ACTIVITY OVERVIEW

In project-based learning students learn best when they find something difficult. This activity pushes students to find not just to identify a problem, but to identify what they regard as the difficult aspects of the problem. It also encourages them to reflect on the value of working in teams to solve difficult problems. Depending on the demographic of your student group it may also help students recognise that working with people from diverse backgrounds can provide new insight..

LEARNING OUTCOMES

Be able to find a problem that will challenge the learner and motivate learning.

Understand all engineers deal with problems, but some are more challenging that others.

KEY INFORMATION

Type of activity: pair work
Duration: 30 minutes
Materials: paper

INSTRUCTIONS

Students pair up and interview each other about the research they are doing and help each other find a difficult problem to delve into.

1. Ask students to pair up.
2. Explain that they are about to interview each other.
3. The interviewer begins by asking what potential problem the other student has focused on in their research. The interviewer then follows up by asking, 'What is the problem in the problem?' (in other words, the difficult bit to understand in the problem space).
4. Explain to the pairs that the aim is to get the interviewee to really try and identify the difficult part of the problem area they have identified.
5. The last question is what additional research would help them to understand this difficult problem area.
6. They get 15 minutes before swapping roles.
7. At the end they should reflect on how exploring and sharing the problem with someone else has helped them to identify the next step to addressing it.
8. Consider repeating the activity with people from a non-engineering background, e.g could students from anthropology, geography or a natural science such as biology provide additional insight?

IN THE NEWS

ACTIVITY OVERVIEW

The decisions that engineers make can have a profound impact on people's lives. Make the wrong assumptions and the consequences could be catastrophic. This activity encourages students to think about the importance of good research to underpin decision-making by getting them to think about what the newspapers would say if they got their assumptions wrong.

LEARNING OUTCOMES

Recognise that projects can fail because the designers get their assumptions wrong

Recognise that research can reveal important information that will lead to the success of a project

KEY INFORMATION

Type of activity: pair work
Duration: 60 minutes
Materials: paper

INSTRUCTIONS

In this activity, students work in pairs to draft a newspaper headline that might be used to draw attention to a failed engineering project and their assessment of the project successes and failures.

1. Ask students to pair up.
2. Ask the students to either pick their own engineering project through an internet search before the class, or you could provide them with one or a number of examples to pick from.
3. Allow the students 20 minutes to draw out what they think were the project failures and the project successes.
4. Now ask the students to put a journalists hat on and come up with a headline that they think would be used to draw people's attention to an article about this failed project.
5. Ask the students to write up the decisions of engineers that they think would be cited in the article, as contributing to the failure of the project.
6. Allow 10 minutes for students to work on their headlines and citations and then ask them to present to the rest of the group..
7. Use another 15-20 minutes to wrap up the activity by discussing the most common factors that caused failure/success in the projects presented and reflecting on how the students now recognise the importance of their underlying assumptions.

DESIGN STEP 2: DEFINING THE PROBLEM AND THE DESIGN CRITERIA

This is the part of the design process where we ask students to define the problem they are going to work on and the design criteria they will be applying.

HOW THIS DESIGN STEP CONTRIBUTES TO STUDENT LEARNING

Students defining their own problems is at the core of the project-based learning pedagogy. However, if facilitators feel that the problem the students have set for themselves is somehow inadequate, for instance it doesn't stretch them enough, then the facilitator should feel free to push the student go further.

A well defined problem and set of design criteria is at the core of good conceptual design. A key principle to introduce students to is that a design brief is never fully known or complete at the start of the project because of the Designer's Paradox: that a client never knows what they want until they know what they can get (McCann and Wise). The way to resolve the paradox is through iterative working: writing a brief, developing ideas, testing them against the brief and modifying the brief on the basis of new information that becomes available. The information provided on the Engineering for People Design Challenge web pages gives students a helping hand with problem definition by suggesting key issues that they may consider developing further. However, it is highlighted that these are not exhaustive and through their analysis of the context students may have uncovered other issues they feel are important to address. Whatever issue, or issues they choose to work on, they need to be able to provide logical and credible justification for why they think it is important..

The other key principle to establish at this phase is that the design criteria establish how the ideas generated later will be evaluated. The right set of design criteria leads to better decision-making later on. For the Engineering for People Design Challenge, we place an emphasis on ensuring that social, environmental and economic criteria form part of this evaluation.

SECTION SUMMARY

The activities in this section emphasise the importance of regarding design criteria as an evolving list of requirements which change as the design work continues. They respond to the design decisions that the engineer makes and become clearer as the design progresses. The final activity establishes the link between the design criteria and the testing phase in which the adequacy of design ideas is established. Establishing a proper understanding of the role of design criteria provides the groundwork for good design.

From a pedagogical perspective, the idea that students should set their own problem to solve is at the core of project-based learning. The activities in this section should help students to get a better understanding of the problem they have set for themselves.

ACTIVITIES

THE IMPERFECT BRIEF

The aim of this activity is to recognise that the information written in a brief is often incomplete for various reasons, and that the consequence is the possibility of misinterpretation.

DESIGNER'S PARADOX

The Designer's Paradox states that a client never knows what they want until they know what they can get. The Paradox applies equally to designers as well: a designer won't know what should be in the design criteria in until they start designing. This activity builds on the previous 'Imperfect Design Criteria' activity and gets students to co-develop a set of design criteria based on what they discover as they progress the design.

CRITERIA FOR SUCCESS

The aim of this activity is to reinforce the idea that the design criteria represent a series of tests that their ideas need to pass in order to be chosen. Students are encouraged to jump forward to the testing process to think about how it might influence their thinking, and how it might lead to further research.

THE IMPERFECT DESIGN CRITERIA

ACTIVITY OVERVIEW

The aim of this activity is to recognise that the information written in a set of design criteria is often incomplete for various reasons, and that the consequence is the possibility of misinterpretation.

LEARNING OUTCOMES

Recognise that the design criteria supplied by a client are never complete.

Recognise that design criteria need to develop over time as the project develops.

KEY INFORMATION

Type of activity: pair work
Duration: 40-60 minutes
Materials: paper

INSTRUCTIONS

In this activity, students work in pairs to deliberately and provocatively misinterpret a set of design criteria..

1. Ask students to pair up.
2. Ask them to write a short set of design criteria for a familiar object (eg: a shoe, a backpack or a bicycle). The list should be short, for example a maximum of five bullet points. They should not tell their partner what the object is.
3. Once the students have written their individual design criteria, ask them to swap lists with their partner, and then to quickly sketch responses to the design criteria that they have received.
4. Bring an interesting element to the dynamic by suggesting to students that they can try to subvert the exercise by inviting them to create responses which, while technically satisfying the wording of the design criteria, are in fact either ridiculous responses or deliberate misinterpretations of the criteria.
5. If students are having difficulty with this activity you can suggest they try to exploit double meanings or ambiguities in any of the words used in the criteria to find opportunities for misinterpretation.
6. Students must then present their responses to one another.
7. Ask the students to reflect on how the design criteria they wrote yielded the response they received from the designer and how as the designer they interpreted the criteria provided.
8. Encourage the students to reflect on what else they might have done to develop the design criteria and ensure that the response really did meet the needs of the client.

DESIGNER'S PARADOX

ACTIVITY OVERVIEW

The Designer's Paradox states that a client never knows what they want until they know what they can get. The Paradox applies equally to designers as well: a designer won't know what should be in the design criteria in until they start designing. This activity builds on the previous 'Imperfect Design Criteria' activity and gets students to co-develop a set of design criteria based on what they discover as they progress the design.

LEARNING OUTCOMES

Recognise that the design criteria aren't fixed and evolve as the project develops

Recognise that the way to keep the design criteria relevant is to keep coming back to them.

KEY INFORMATION

Type of activity: pair work
Duration: 40-60 minutes
Materials: paper

INSTRUCTIONS

In this activity, students work collaboratively to understand and develop the list of design.

1. Ask students to pair up and review the design criteria they have written
2. One student goes first as the client, the other as the designer. The designer reviews each of the criteria in turn and tries to explain it back to the client.
3. For each criterion, they should try to find anything implied or assumed by what has been said that may lead to ambiguity. Together they should agree how the design criterion should be updated.
4. The designer then starts to sketch how they imagine the solution could look. At this point the client reacts. If the design is different from how they envisaged it, they should consider whether their design criteria need updating.
5. After 20 minutes the students should swap roles
6. Finally, ask pairs to reflect on they reached greater understanding of the design criteria by progressing the design, and how the design criteria became modified.

CRITERIA FOR SUCCESS

ACTIVITY OVERVIEW

The aim of this activity is to reinforce the idea that the design criteria represent a series of tests that their ideas need to pass in order to be chosen. Students are encouraged to jump forward to the testing process to think about how it might influence their thinking, and how it might lead to further research.

LEARNING OUTCOMES

Explain that the design criteria represent a series of tests that ideas need to pass.

Recognise that defining the tests may require more background research.

KEY INFORMATION

Type of activity: group work
Duration: 30 minutes
Materials: whiteboard / large paper

INSTRUCTIONS

Explain that this exercise explores the relationship between the design criteria and the tests they will apply to their ideas to see if they are good enough..

1. Ask students to create a large table on their whiteboard/large piece of paper with three columns.
2. In the left-hand column they should write down each of their design criteria.
3. In the second column, next to each of the criteria, they must write down a test that corresponds to understanding if their idea satisfies this criteria. For example, if a criterion is 'must be affordable', what is the threshold for affordability that they must apply?
4. In the third column, students write down what further research they need to do in order to establish a good set of test criteria. To carry on with the example above, this could be that they need to establish average household income/disposable income to inform the identification of the affordability threshold.
5. Finally, they must review all their design criteria and see if they are still appropriate.
6. Suggest to students that they keep this list of design criteria, tests and research on the wall as a live document that they can update as they progress with the project.

DESIGN STEP 3: EXPLORING LOTS OF OPTIONS

This is the part of the design process where ideas are generated (divergent thinking) and tested against the brief (convergent thinking).

HOW THIS DESIGN STEP CONTRIBUTES TO STUDENT LEARNING

Idea generation is not on the whole a subject which is taught on engineering courses. What is presented here is based on In Think Up's teaching with engineers we use a simple model of idea generation. It builds on the concept that ideas happen when new connections form between existing elements in an individual's mind. To have more ideas we therefore have two options: to change the information in our minds; and to change the way we stimulate new connections.

Students who have been learning about analysis techniques might feel more comfortable with testing against the brief, but even so it is worthwhile pointing out the connection between the brief and the way their ideas are tested. Students may also be less familiar with applying subjective analysis to their engineering designs and dealing with uncertain parameters and imperfect information as can often be the case when dealing with real world issues. This is an opportunity to highlight that often engineers have to make judgements about the compromises/risks they are accepting and also what respective value/importance they may be placing on different design criteria to make their decisions. Three of the activities in this section address these two aspects of idea analysis.

From a project-based learning perspective, idea generation is the part of the process where students really start to take ownership of their work. When they evaluate their ideas, they are effectively evaluating their thinking - done properly this is a reflective learning process in which students can see how they are learning about the problem space.

SECTION SUMMARY

The idea generation part of design is a rich opportunity for learning. Students can guide themselves towards what they are interested in and then they can reflect on what they are learning through this process. Some students may find this freedom disorientating so you can help them by providing some structure: the conceive, model, test approach advocated here is one way to do this. Such a model provides scaffolding within which they are free to think.

ACTIVITIES

DRAWING ON OUTSIDE INTERESTS

The purpose of this activity is to encourage the generation of new ideas by bringing totally unrelated knowledge to the discussion, and seeing what connections are formed. Having a wide range of interests is therefore a valuable asset for idea generation.

ASKING WHAT IF?

The aim of this activity is to stimulate the generation of new ideas which we might not otherwise have thought of, by adopting different perspectives..

MODELS AND THEIR TESTS

This activity follows on from the 'Criteria for Success' activity and aims to show students that in order to carry out a comprehensive set of tests they will need to create a range of different models of their design.

CONVERGENT DESIGN THROUGH ITERATIVE MODELLING AND TESTING

The purpose of this activity is to familiarise students with a way of thinking that would trigger an iterative development of ideas.

SUBJECTIVE DECISIONS AND PERSONAL VALUES

The purpose of this activity is to help students develop their self-awareness when their values might be different to the values of the people they are working with..

DRAWING ON OUTSIDE INTERESTS

ACTIVITY OVERVIEW

The purpose of this activity is to encourage the generation of new ideas by bringing totally unrelated knowledge to the discussion, and seeing what connections are formed. Having a wide range of interests is therefore a valuable asset for idea generation.

LEARNING OUTCOMES

Use outside interests as a source of inspiration for idea generation.

Recognise the value of talking to other people about their interests.

KEY INFORMATION

Type of activity: team work
Duration: 45 minutes
Materials: paper

INSTRUCTIONS

In this activity, students work in teams to incorporate new concepts into their ideas, by using outside personal interests.

1. Ask students to team up (this could be their project teams or it might work well mixing the teams up for this exercise).
2. To introduce the activity, ask students to think of examples of unrelated concepts that, when put together, produced new ideas (e.g.. sailing boats as an inspiration to create the Sydney Opera House, or the representation of sound through colour known as chromesthesia, etc.). Use this to highlight that a useful source of new input can be our own personal interests/ hobbies.
3. Students should spend 15 minutes sharing their outside interests, and together they should choose one to focus on.
4. Ask students to brainstorm what elements of this chosen interest could be applied in the context of the design project.
5. Promote creativity amongst teams and let them know that no idea should be considered too stupid or irrelevant at this stage.
6. Ask students to present their new ideas and how they incorporated the outside interest chosen.
7. Conclude the discussion by encouraging students to think about what other things they could use to stimulate creative discussion.

ASK 'WHAT IF?

ACTIVITY OVERVIEW

The aim of this activity is to stimulate the generation of new ideas, which we might not otherwise have thought of, by adopting different perspectives..

LEARNING OUTCOMES

Understand that the frame through which we drive inquiry influences the way we think.

Be able to change frame in order to change perspective and generate new ideas.

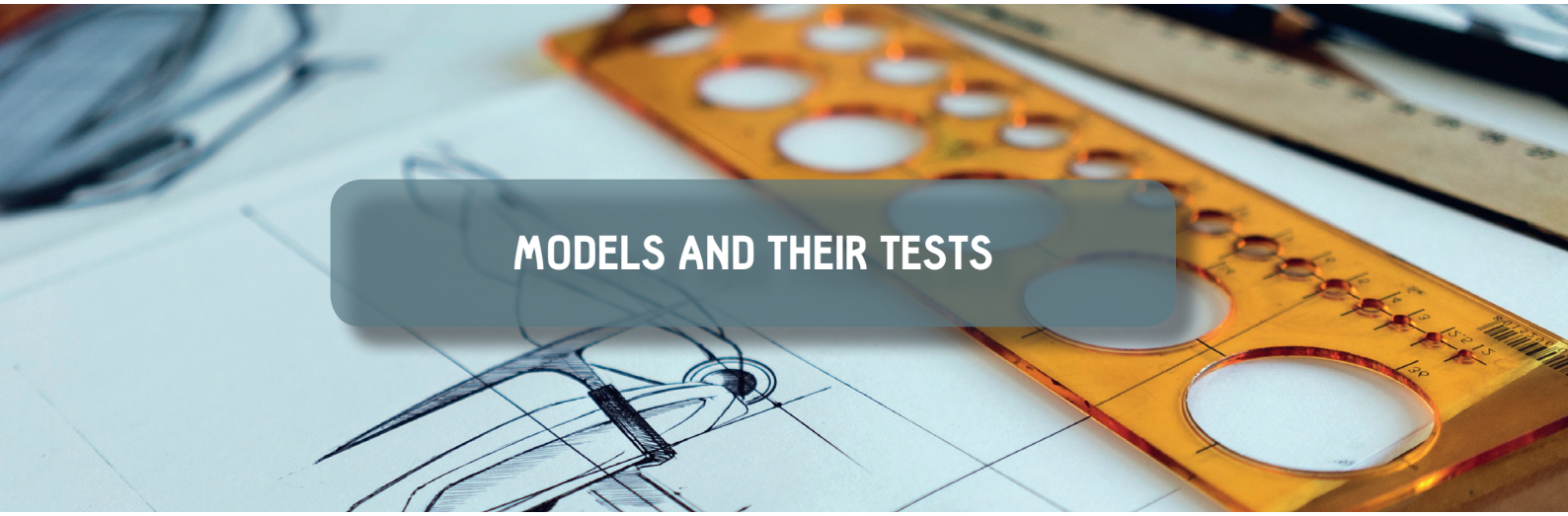
KEY INFORMATION

Type of activity: pair work
Duration: 35 minutes
Materials: paper

INSTRUCTIONS

In this activity, students work in pairs to purposely adopt a different approach to generate new ideas..

1. Ask students to pair up.
2. To introduce the activity, ask students to think of various scenarios of what if:
   a. what if money were no object?
   b. what if we have to complete the project tomorrow?
   c. what if the materials used had to be economically recoverable?
3. Let students spend 20 minutes discussing and writing down ideas resulting from considering such scenarios.
4. Ask students to present their new ideas and what was the new frame they used.
5. Conclude the activity by explaining that ideas should not be driven by one particular frame (like time frame, cost frame or technology frame) but on the contrary, they can be refined by adopting multiple frames.
6. Ask the students to reflect on their current list of design criteria and whether these need updating as a result of this activity.



MODELS AND THEIR TESTS

ACTIVITY OVERVIEW

This activity follows on from the 'Criteria for Success' activity and aims to show students that in order to carry out a comprehensive set of tests they will need to create a range of different models of their design.

LEARNING OUTCOMES

Understand that engineers use models to express their ideas and to test their adequacy.

Understand that engineers need to use a wide range of models - not just technical ones.

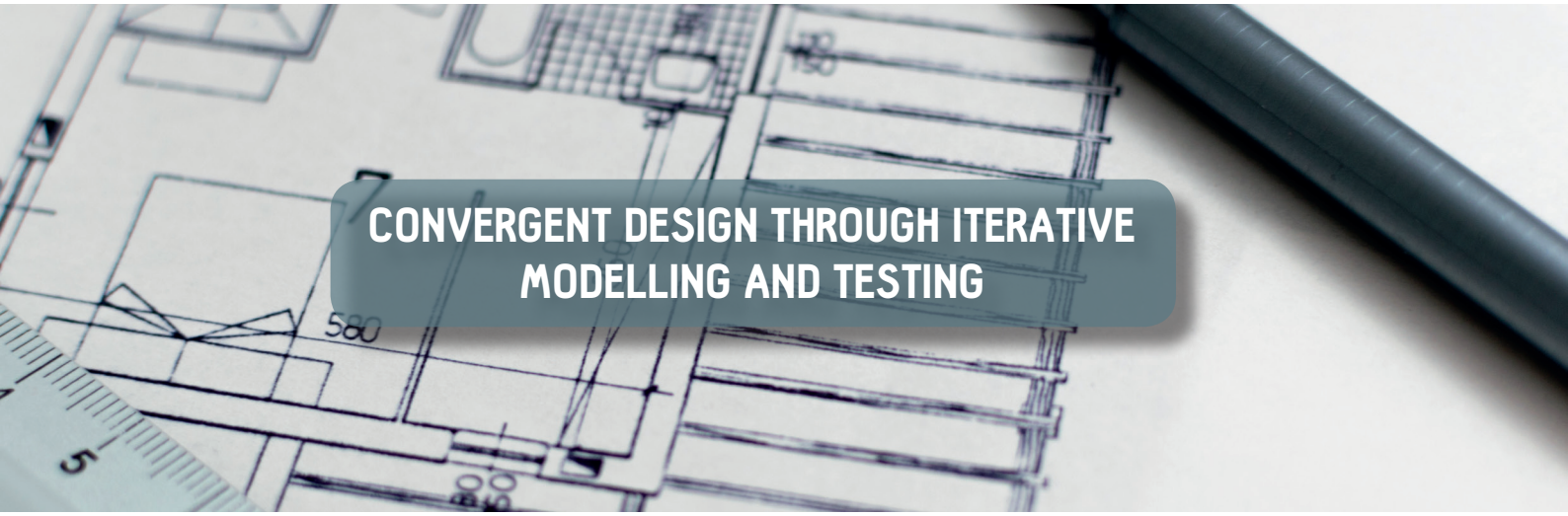
KEY INFORMATION

Type of activity: pair work
Duration: 30 minutes
Materials: paper

INSTRUCTIONS

This activity uses the table of design criteria and tests developed in the activity 'Criteria for Success'. Students add an extra column to this table to identify what models they need to create to carry out their tests.

1. Begin by introducing the concept of a 'model' by asking teams to think creatively about all the different ways they can communicate their ideas. Responses can be as simple as saying, 'I explain my ideas in words to another person' to 'creating a virtual reality model'.
2. Explain that models are the means by which engineers test their ideas against the design criteria as well as how they might communicate ideas more effectively within their team and to others.
3. Instruct students to add a fourth column to their table called 'models'.
4. For each of the tests listed in the table, ask students to suggest what model they would need to create in order to test their ideas. For example, a test of stability requires a mechanical model, a test of profitability requires a financial model.
5. Conclude by pointing to the wide number of models engineers need to be able to use in order to effectively test their ideas.



CONVERGENT DESIGN THROUGH ITERATIVE MODELLING AND TESTING

ACTIVITY OVERVIEW

The purpose of this activity is to familiarise students with a way of thinking that would trigger an iterative development of ideas.

LEARNING OUTCOMES

Use a systematic sequence to generate ideas.

Recognises that iterative thinking can help converge on a better idea.

KEY INFOMATION

Type of activity: team work
Duration: 45 minutes
Materials: paper

INSTRUCTIONS

In this activity, students work in teams to test an idea using a series of steps.

1. Ask students to team up.
2. Introduce the sequence below and ask students to use it as a guidance for the activity.
   a. Conceive an idea (or use one they are already working on).
   b. Test the idea against each of the requirements.
   c. Select one test that the idea fails and adjust the idea so that it passes.
   d. Retest iteration 2 of the idea.
   e. Continue until most tests have been passed.
3. Students should spend 20 minutes going through the sequence given and produce a table with their results. With each iteration, students update the table until either all the tests are passed, or they decide the idea is never going to pass all the tests simultaneously.
4. Once the students have reached a stage where their design passes all the tests that are requirements of the brief, ask them to judge whether the idea is an adequate response to the brief
5. Explain to students that they are judging the brief as much as the idea itself, because if the solution meets all the requirements, and it still feels like a bad idea, then the designer has to ask himself if the brief was adequate in the first place.
6. Conclude the discussion by highlighting good practices that may have come up in the activity.

SUBJECTIVE DECISIONS AND PERSONAL VALUES

ACTIVITY OVERVIEW

The purpose of this activity is to help students develop their self-awareness when their values might be different to the values of the people they are working with.

LEARNING OUTCOMES

Recognise the impact of personal preferences and perspectives on the design decisions designers make.

KEY INFORMATION

Type of activity: team work
Duration: 45 minutes
Materials: paper

INSTRUCTIONS

In this activity, students will write statements based on how they understand Political, Environmental, Social, Technological, Legal and Economic (PESTLE) factors have shaped their beliefs and how they place value on these factors when making decisions.

1. Introduce the activity by listing the following the PESTLE headings (Political, Environmental, Social, Technological, Legal, Economic). For each heading ask the students to write a statement of opinion that reflects their views on this topic and its relative value/importance compared to the other topics. For example: Technology: 'giving everyone access to broadband internet will alleviate poverty'; or 'giving people access to technology is more important than the impact it might have on the environment'.
2. Having spent 15 minutes exploring this, ask them to write their statements, and then pair up to see if they can identify the values or beliefs that underpin these statements. For example: continuing with the above there is an underlying belief that technology is how people's issues are addressed and addressing people's issues should be prioritised over environmental damage.
3. Ask the students to reflect on how their beliefs and assumptions have been shaped by their societal context. For example, some students will have grown up in 'WEIRD societal contexts' ones that are Western, educated, industrialised, rich and democratic.
4. Ask the students to reflect on their original opinion statements for each of the PESTLE headings and how they think this has been informed by their societal context. What do they think might change if they came from a different societal context?.
5. If possible, invite an anthropology academic to present on how different societies generate different human behaviours/values and how we can be more aware and self-aware of this as designers to ensure we are listening to the most relevant value system.

DESIGN STEP 4: JUSTIFY YOUR RECOMMENDATION AND EXPLAIN HOW IT WORKS

This is the final part of the design process where students are asked to present their justification and reasoning for buy-in and critique by others.

HOW THIS DESIGN STEP CONTRIBUTES TO STUDENT LEARNING

From a design perspective the presentation phase reminds us that the design work is being carried out for real people, and if students can't convince others stakeholders of the merits of those ideas, then the ideas will never see the light of day. The final presentation is as important as the engineering analysis which underpins the thinking.

From a project-based learning perspective, the final presentation is the student's big moment: they have identified a problem topic, developed their own solution and now they have to justify their thinking. But the learning shouldn't stop when the presentation is over. It is important that the students reflect on the choices they made,the consequences, and what they learnt along the way.

SECTION SUMMARY

The activities in this section are intended to help students take a more creative approach to their presentations and to remind them of the importance of focusing on the needs of the audience member. Perhaps the most important point is that engineers need to be able to communicate their thinking otherwise their efforts on developing an amazing idea might be in vain if they cannot help others to understand it or support it.

ACTIVITIES

ETHOS PATHOS LOGOS

The purpose of this activity is to show students a creative way to build a presentation by using Aristotle's three artistic truths.

ELEVATOR PITCH EXERCISE

The aim of this exercise is to encourage students to develop a short, yet compelling, description of what they are designing.

PRESENTATION TECHNIQUE JEOPARDY

The aim of this exercise is to encourage students to try out different channels of communication for convincing stakeholders of the merits of their ideas.

ETHOS, PATHOS AND LOGOS

ACTIVITY OVERVIEW

The purpose of this activity is to show students a creative way to build a presentation by using Aristotle's three artistic truths.

LEARNING OUTCOMES

Recognise that making a convincing argument is more than presenting logical steps.

Be able to take steps to make a presentation suit the audience.

KEY INFORMATION

Type of activity: team work
Duration: 45 minutes
Materials: paper

INSTRUCTIONS

In this activity, students work in teams to test an idea using a series of steps.

1. Ask students to look for examples of online commercials that they like.
2. Ask students to work in groups to think what is it about these ads that they like, and share these characteristics with the rest of the class. Allow 15 minutes for this.
3. Present the three Artistic Truths:.
   - Ethos – 'nature or disposition', meaning to convince an audience of the author's credibility or character.
   - Pathos – 'suffering', meaning to persuade an audience by appealing to their emotions.
   - Logos – 'word or reason', meaning to convince an audience by use of logic or reason
4. Ask students to go back to their preferred commercials, and spend 10 minutes looking for elements of ethos, pathos and logos.
5. Ask students to consider how they will use ethos, pathos and logos to develop content for their own presentation.
6. Finally, ask students to present and critique one-another's presentations and, when in the audience, try to identify elements of ethos, pathos and logos in what they are being presented. When critiquing, it is important students are encouraged to take a learning approach rather than criticising one another, e.g. help students to frame their critique using 'what worked well...' and 'it would be even better if...'

ELEVATOR PITCH EXERCISE

ACTIVITY OVERVIEW

The aim of this exercise is to encourage students to develop a short, yet compelling, description of what they are designing.

LEARNING OUTCOMES

Be able to identify what information an audience needs to hear.

Be able to quickly and effectively synthesise and communicate an idea.

KEY INFORMATION

Type of activity: pair work
Duration: 45-60 minutes
Materials: chairs

INSTRUCTIONS

In this activity, students will use role-play to pitch an idea.

1. Begin by explaining what an elevator pitch is, and then set up a mock elevator area in the design studio. This needs be no more than a pair of chairs marking the entrance to the imaginary lift.
2. Explain to students that they will have a minute in the elevator with an angel investor in which they can explain their brilliant idea.
3. Ask students to pair up.
4. Give individuals 5 minutes to formulate their stories, and then start the role-play.
5. Invite each pair to role-play their stories, in front of the rest of the class.You should signal when time is up.
6. Once everyone has been through once, shorten the time in the elevator. See how short they can go again.
7. As students develop their pitches try to draw out what it is that they think is important to include in the pitch. Things to draw out:
   a. Briefly mentioning the context
   b. The salient parts of the design
   c. Why it is going to make a difference to the people the design is intended for?
   d. Why is it of interest to the person you are pitching to?
8. Conclude the exercise by asking students to identify the strengths in the pitches presented and areas for improvement

PRESENTATION TECHNIQUE JEOPARDY

ACTIVITY OVERVIEW

The aim of this exercise is to encourage students to try out different channels of communication for convincing stakeholders of the merits of their ideas.

LEARNING OUTCOMES

Recognise that there are a wide range of ways to present information.

Using an unusual presentation method can capture attention, especially if it suits the audience and the content well.

KEY INFORMATION

Type of activity: pair work
Duration: 40 minutes
Materials: board/paper

INSTRUCTIONS

In this activity, students will brainstorm a variety of communication forms.

1. Begin by asking the group about their preferred method for giving a client a presentation.
2. After a few students have participated, then ask if it wouldn't be more interesting/eye-catching/memorable to have some other approaches up our sleeves? Explain that they will need to present their ideas using different techniques and ask students to call out different topics. (Some suggestions: by twitter, in rhyme, in another language, using cardboard models, using only numbers, through mime.)
3. When all suggestions have been made, ask everyone to write their name next to one of the suggestions. The easiest techniques will go first. If students can't find a technique they want to use, then they should suggest an alternative which has not yet been chosen.
4. When students have given their presentations using the techniques they have chosen, the group should reflect on what worked about different techniques and what they might want to adopt themselves.

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