# Packaging Designer
## Lesson 4: Modelling and Designing

### Australian Curriculum: Mathematics (Years 8 and 9)

ACMMG195: Choose appropriate units of measurement for area and volume and convert from one unit to another. (Year 8)
ACMMG197: Investigate the relationship between features of circles such as circumference, area, radius and diameter. Use formulas to solve problems involving circumference and area. (Year 8)
ACMMG217: Calculate the surface area and volume of cylinders and solve related problems. (Year 9)
ACMMG222: Investigate Pythagoras' Theorem and its application to solving simple problems involving right angled triangles. (Year 9)
ACMMG224: Apply trigonometry to solve right-angled triangle problems. (Year 9)

### Lesson abstract

As many pairs as possible present the important features of their design (very briefly) orally or as posters, while other students evaluate the work against a set of criteria. Finally, students think again about how mathematical modelling contributes to design work.

### Mathematical purpose (for students)

Mathematical modelling is often an important part of designing

### Mathematical purpose (for teachers)

This lesson focuses on communication of mathematical ideas, by providing students with the experience of presenting, having their work critiqued by others and in turn providing feedback on the work of others. Teachers can choose to highlight any of the multiple opportunities for detailed mathematical discussions (e.g. involving geometry, area, volume, trigonometry, proportional reasoning, algebra). In the final section, the various roles that mathematical modelling has in design work are revisited. Amongst other things, mathematical modelling tests ideas which are hard to test in practice, enables planning, and provides precise specifications for manufacturers to use.

Lesson Length 50 minutes approximately

Vocabulary Encountered
- criteria
- critique

Lesson Materials
- Slideshow ST7_Packaging_4a.pptx
- Student Sheet: Evaluation Criteria (1 per student, or more if you wish students to make notes on each presentation on them)

We value your feedback after these lessons via https://www.surveymonkey.com/r/J8GPD7Z

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## Lesson Structure

- Whole-class discussion/collaborative small-group work: presenting and critiquing (35 minutes)
- Whole-class discussion/collaborative small-group work: Reviewing modelling and design (15 minutes)

# Presenting and Critiquing

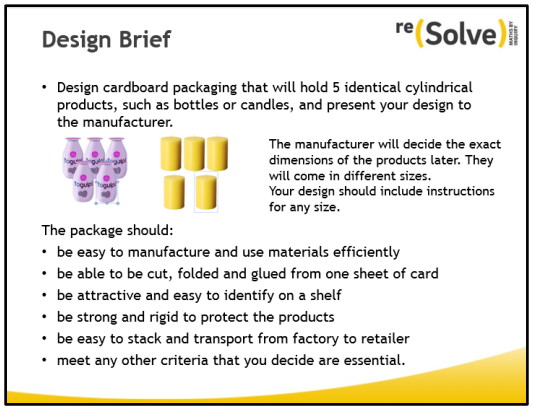
The major part of this lesson should be run in a way that mimics the type of activity that designers such as architects experience when peers critique their work and suggest ways that it might be improved.

This is to be carried out in a considerate and supportive way so that all understand how they might improve. Some principles for conducting such a discussion are outlined in the *Mathematical Modelling Teachers' Guide*, supplied in this package.

Organise the class to make their presentations.

- How you organise the class will depend on whether you have decided to use posters, slide shows or oral presentations and on other local constraints.
- Oral presentations to whole class.
    - According to the amount of time available, choose pairs of students to present their ideas. Make sure that a range of different designs are presented. It is probably best to allow about 7 - 10 minutes for each pair to present (including other students' questions), so that presentations can be done thoroughly rather than have many more but superficial presentations.
- Poster Presentations arrangement.
    - Display posters around the room. One person per pair could be at the poster while the partner visits others. Students could be allocated several posters (2 or 3) to critique. Set aside enough time to critique a few posters as a whole class.

Show the slide Design brief to remind students about the design brief.




The important thing about this phase of the modelling task is that students:

- Practise articulating their own ideas
- Engage with one another's ideas.

Show the slide Packaging designer presentation, which lists the main points from the original design and report brief (Lesson 2) for a poster or oral presentation. Only the main points are likely to be able to be included, due to time limitations.

Tell students that when presenting they should:

- Make it clear that the design meets the design brief.
- Explain why it is a 'best fit' design that is stylish, easy to manufacture and is convenient to use. Multiple factors contribute to all these attributes.

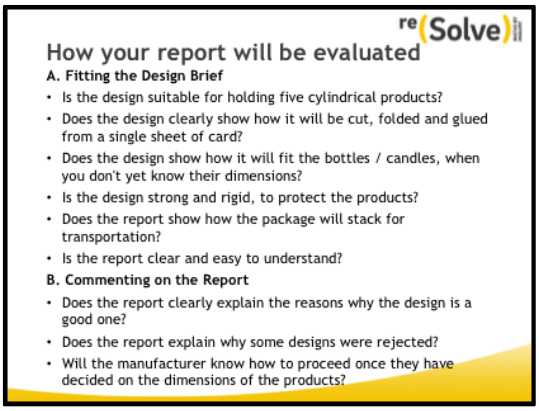
Provide each student with a copy of the Student Sheet: Evaluation Criteria. (Or more than one each if you wish students to write notes on each presentation there.)

When students are watching the presentations of others they should make sure that they understand the presenters' work and be prepared to ask questions if anything is not clear. They should use the evaluation criteria to help critique the work that is being presented.

Show and discuss the slide How your report will be evaluated.

As the students present their work, encourage others to ask questions from the Student Sheet: Evaluation Criteria.

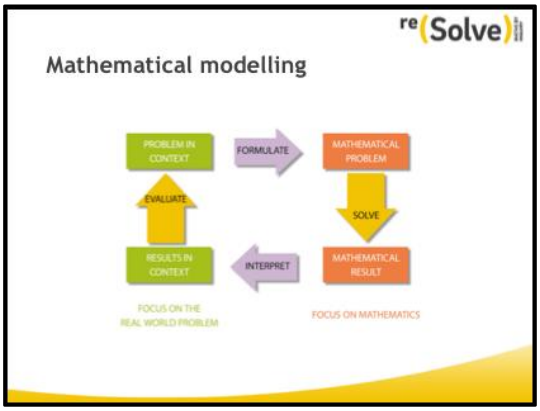
Conclude the presentations with a summary of your own observations.




# Sharing Thoughts About Modelling and Design

In whole-class discussion, reflect on issues of modelling and design and how the way in which the processes are different and the ways in which they are similar. Also consider how mathematical modelling contributes to design projects.

Show the slide Mathematical modelling.




Start by asking students to identify what they were doing in terms of the modelling cycle at different stages of their design work. Ask them to think of any time where they changed their design because of a mathematical idea.

## Expected student responses

- Using geometry to consider stacking of packages.
- Making assumptions about dimensions and how things fit together to make calculations easier. (Later generalising.)
- Making simplifying assumptions about the described shape of candle or package to make the design process simpler.
- Looking for alternative solutions – perhaps by considering different dimensions.
- Deciding on, and then calculating, measures of wasted card and space to compare efficiency of designs.

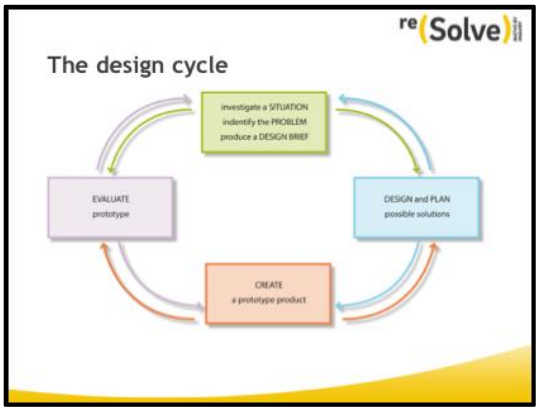
Try to get students to think about how they moved back and forward between different phases of modelling and maybe cycled more than once through the whole process.

- Frequently in the solving phase they will have realised they needed to make more or different assumptions about dimensions, shapes and relationships (so back to formulating).
- Frequently, in the interpreting and evaluating phase, they will have realised that the design could have been improved, and so begun another cycle.

How does mathematics help design?

- Highlight how although they have probably not actually created the package, their mathematical approach has allowed them not to waste time developing designs that are unlikely to work.
- Testing out ideas which would otherwise be hard to test in reality is a major role for mathematics in solving real world problems.
- Another key use for mathematics is for precise communication, e.g. to a manufacturer.

Show the slide The design cycle.




Ask students to think about the design cycle and consider which aspects of the design cycle they have been working on and which they have not.

In reality a designer will make a prototype package (or a number of different packages) before they submit their design to the product manufacturer.

Follow-up by asking

- How has mathematical modelling helped you?
- How could mathematical modelling be used in other design work? Can you give examples?

## Expected student responses

- To design a coffee table, you need to mathematically model the dimensions and the joints, the space it would take up in the room, perhaps features of the surface e.g. tiling.
- To design a frame for a photograph you need to consider the different sizes of photographs, the size of the border, and the way the corners fit together.
- You always need to consider the factors that contribute to cost, transport, environmental responsibility, style etc.

Show the slide Designs. This shows images of particular 'design icons' that might stimulate discussion.

Finally ask students what they think makes a good design and how this takes account of issues of:

- style and aesthetics
- ease of manufacture and
- convenience and efficiency
- how much customers are likely to pay.

Of course, it very much depends on what is being designed as to which of the different factors are most important. The last issue (how much customers are likely to pay) should remind students of their work in the *Mathematical Modelling unit 'Pricing for Profit'* where modelling showed that profit might not be directly proportional to selling price.

# Evaluation Criteria

Name: _____

## Fitting the Design Brief

- Is the design suitable for holding five ‘cylindrical’ products?
- Does the design clearly show how it will be cut, folded and glued from a single sheet of card?
- Does the design show how it will be made to fit the five products, when you don't yet know their dimensions?
- Is the design strong and rigid, to protect the products?
- Does the report show how the package is efficient (e.g. will stack for transportation, not too much waste)?

## Commenting on the Report

- Is the report clear and easy to understand?
- Does the report clearly explain the reasons why the design is a good one?
- Does the report explain why some designs were rejected?
- Will the manufacturer know how to proceed once they have decided on the dimensions of the products?

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