Unit Overview: Packaging Designer

Summary of learning goals

These five lessons give students an experience of the processes of both design and mathematical modelling. Through four lessons, students think their way into the role of being a designer by considering the factors important in the design of packaging. They design an attractive and efficient container to hold five cylindrical products (e.g. candles, bottles) with exact dimensions not known. They consider the priorities of the manufacturer (e.g. easily manufactured/engineered and transported) and the perspectives of customers (e.g. durable package) and use mathematical modelling to test ideas, draw up plans and quantify attributes. Mathematical approaches can range from direct drawing and measurement of diagrams, to use of trigonometry and algebra to express how the design can be adapted for any dimensions of the products. Lesson 5 steps out of the sequence to highlight the interpreting and evaluating phases of the modelling cycle, in real situations involving mathematical rates.

Australian Curriculum: Mathematics (Years 8 -10)

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)

ACMMG216: Calculate areas of composite shapes. (Year 9)

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)

ACMNA188: Solve a range of problems involving rates and ratios, with and without digital technologies. (Year 8).
ACMNA208: Solve problems involving direct proportion. Explore the relationship between graphs and equations corresponding to simple rate problems. (Year 9)
ACMNA234: Substitute values into formulas to determine an unknown. (Year 10)

Summary of lessons

Who is this Unit for?

This unit is for any students who have completed *Mathematical Modelling Unit 1: Introduction to Modelling*. If that is not possible, the single introductory lesson *ST7_Modelling_QuickStartLesson.pdf*, (packaged with this unit) provides an alternative.

Students can choose either simple or complex mathematics to undertake the design task in this unit. Some students could work numerically throughout, others could measure scale drawings or there are many options to use algebra skills. Students should be familiar with nets of solids and how they can be physically cut, folded and glued to make solids.

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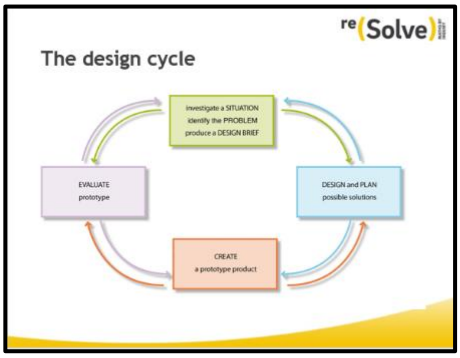
Lesson 5 Back to Reality stands apart from the sequence to highlight the interpreting and evaluating phases of modelling. This stand-alone lesson can be taught at any stage of the unit, or within any of the other *Mathematical Modelling* units.

Lesson 1: The Design Task

Students think their way into the role of being a designer by considering the factors that would be important in designing packaging. They consider the priorities of the manufacturer (e.g. easily manufactured and transported), the retailer (e.g. easy to display on shelves) and the perspectives of customers (e.g. attractive). They begin to design a container to hold five essentially cylindrical products, that will come in various sizes.



Lesson 2: Designing the Packaging

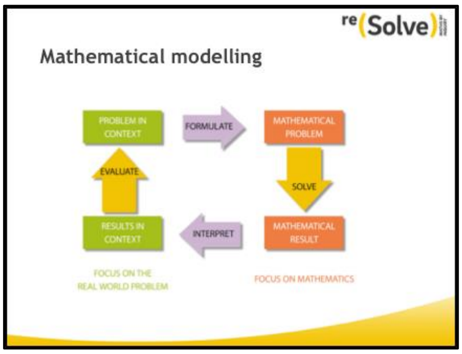
Students develop their packaging design. They consider how mathematics is useful in this task, and see the role of mathematical modelling in designing. They begin to prepare a report in which they communicate their work clearly.

Lesson 3: Critiquing Reports

Students are given three pre-prepared student reports on the packaging problem to critique. They work with a partner to understand, complete and correct a report, and identify the mathematical modelling involved. Then they explain their report to another pair. This task provides an opportunity to consider alternative approaches students might take to develop their own work further, and it enables them to see characteristics of a good report.

Lesson 4: Modelling and Designing

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.



Lesson 5: Back to Reality

Students undertake three short activities that highlight the interpreting and evaluating phases of modelling. Writing a commentary for a race using only a distance time graph, focusses on interpretation. Predicting running world records focusses on evaluating a model. Predicting future numbers of teachers focusses on selecting a model that uses the best available data, and appreciating which data influences the outcome most.

Reflection on this unit

Rationale

These lessons set students a design task, which is undertaken over 4 of the 5 lessons. Somewhat like mathematical modelling, creating a design for a product occurs through a cycle of phases. Like mathematical modelling the process begins with a phase of investigating the real world problem and understanding fully what is required of the design solution. The next phase creates some possible designs and investigates them. Then a prototype is typically made, and the degree to which the design meets all the criteria is evaluated. Again, like mathematical modelling, the design process is well represented by a cycle, since the design may need to be improved. Discussion of the two cycles, experienced through the practical design task of Lessons 1 – 4, increases metacognitive awareness of how mathematics is used. Lesson 5 (which can be undertaken at any point) aims to increase skill in the interpretation and evaluation phases of mathematical modelling, through three separate short activities.

reSolve Mathematics is Purposeful

This unit reveals how modelling Is involved in design. Students get practical experience of using mathematics to test ideas in situations where a practical test would be time consuming (e.g. how much space is wasted when five circles are arranged in a trapezium shape) and to draw up plans for geometric designs (e.g. specifying dimensions of a box). Mathematics is also used to quantify attributes of designs (e.g. measuring efficiency using the percentage of unused volume in the package). Once attributes are quantified, designs can easily be compared and rated on that attribute.

reSolve Tasks are Inclusive and Challenging

The design task allows students to use very different levels of mathematics. Some students may work only numerically, most will begin numerically and move to some algebra later, and a few might work algebraically from the start. There is considerable opportunity to increase complexity as required.

reSolve Classrooms Have a Knowledge Building Culture

One lesson involves critiquing the design reports prepared by unknown students. Through this activity, students build their capacity to offer constructive criticism, focussing comments on the content of the report and not on its writer. They see how the ideas of others can be used to improve their own work.