THE MATHEMATICAL ASSOCIATION OF VICTORIA

Biarri COMMERCIAL MATHEMATICS TEACHER NOTES

MATHEMATICS IN CAREERS

Investigation - Panel cutting problem

Key career focus for this investigation: Software engineer, coding, information technology
Related career areas: Operations research, mathematical modelling, decision support systems

THINKING ABOUT CAREERS

- Brainstorm information technology professions you can think of where maths is frequently used. Use https://joboutlook.gov.au to explore information technology related career pathways that include use of mathematics. *How is maths used in these scenarios? What maths is used in these scenarios?*
- This task focuses on how maths is used in planning or operations.
- Explore careers such as software engineer, robotics engineer, to discover how maths is used in these. For a more extensive list of careers related to this task, with a maths/science focus, refer to the table at the end of the task and explore the maths used in these jobs.

MATHEMATICS IN EVERYDAY LIFE AND CAREERS

Mathematical focus for this investigation

- Using formulas to solve problems.
- Implement algorithms
- Using authentic situations to apply knowledge to solve real world problems

Scientists including information technology professionals use various formulae and algorithms. They apply their mathematical thinking and problem-solving skills in various situations. In this case specifically using mathematical modelling in planning and operations.

- Many people use various formulae and algorithms every day. For example, cooking recipes, long division and using a computer search engine all utilise algorithms. An algorithm is a well-defined set of instructions designed to perform a particular task or solve a type of problem. Anything that follows a set of specified instructions is an algorithm.
- Brainstorm and share scenarios where this mathematics may be used in information technology professions to solve problems.

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

TEACHER INFORMATION

LINKS TO VICTORIAN CURRICULUM

Mathematics links to Victorian Curriculum Level 10	Application to work and life
Patterns and Algebra Implement algorithms using data structures in a general-purpose programming language (VCMNA334)	Many people use various formulae and algorithms every day. For example, cooking recipes, long division and using a computer search engine all utilize algorithms. An algorithm is a well-defined set of instructions designed to perform a particular task or solve a type of problem. Anything that follows a set of specified instructions is an algorithm.
Further example of other maths used Level 9 Apply set structures to solve real-world problems (VCMNA307)	For example a sorting algorithm can be used to find the median from a set of values.

PROFICIENCY FOCUS: VICTORIAN CURRICULUM

This investigation focuses on: Reasoning, Understanding, Problem Solving

Reasoning refers to students developing an increasingly sophisticated capacity for logical, statistical and probabilistic thinking and actions, such as conjecturing, hypothesising, analysing, proving, evaluating, explaining, inferring, justifying, refuting, abstracting and generalising.

This investigation focuses on:
- Students explaining their thinking
- Deduce and justify strategies used and conclusions reached
- Adapt the know to the unknown
- Transfer learning from one context to another

Understanding refers to students building a robust knowledge of adaptable and transferable mathematical concepts and structures.

This investigation focuses on:
- Describe their mathematical thinking

Problem Solving is the ability of students to make choices, interpret, formulate, model and investigate situation, select and use technological functions and communicate solutions effectively.

This investigation focuses on:
- Students designing investigations and planning their approaches
- Verifying their answers are reasonable.

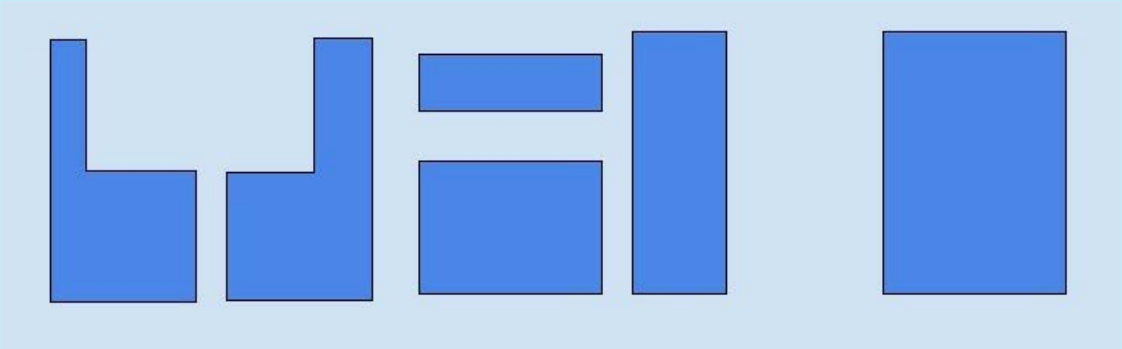
Information and Communication technology

Information Communication Technologies (ICT) are powerful tools that can support student learning. Students can develop and demonstrate their understanding of concepts and content in mathematics using a range of ICT tools. It is also important that students know how to use these ICT efficiently and responsibly, as well as learning how to protect themselves and secure their data.

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

INVESTIGATION BACKGROUND

Your customer imports large prefabricated panels which are used for building walls. These panels provide very high insulation and buildings constructed with this material are very energy efficient. These panels need to be cut to size before they can be used in construction. The panels arrive in shipping containers and can be sized up to 2.4m x 6m. The panels must be cut into segments defined by the construction plans. The shapes of the panels will vary based on the construction job and could be cut to go above and below windows as well as non-rectangular shapes where the panel overlaps with window and door positions. The objective of pre-cutting these panels is that builders will simply attach panels to the building frame and no onsite modifications of the panels will be required.



YOUR INVESTIGATION

A given job could use many panels therefore there could be many ways in which we could cut the smaller panels from the larger blanks. You need to bear in mind that your customer would like you to:

- complete a job while using the minimal number of blanks
- minimise cost (inefficiently cut panels will mean that material is wasted and the cost of providing the pre-cut panels will increase)

There are several stages that need to be considered when providing a solution to this problem. When providing your solution, consider:

- Efficiency: Given a blank and a set of panels to be cut, what is the efficiency of the usage of the blank
- Feasibility: Given a blank and a set of panels to be cut, is there a feasible way to layout the panels so they can be cut. Even when the panel isn't fully utilised, it might be impossible to place the panels in a way where they can be cut.
    - Can you create an algorithm to search for feasible layouts?
- Optimality: Given an order that requires multiple panels (and multiple blanks) can you produce a cutting guide (like the above diagram) that use the fewest number of blanks.
    - Consider designing an algorithm that can produce these cutting guides so these guides can be produced in an automated way.

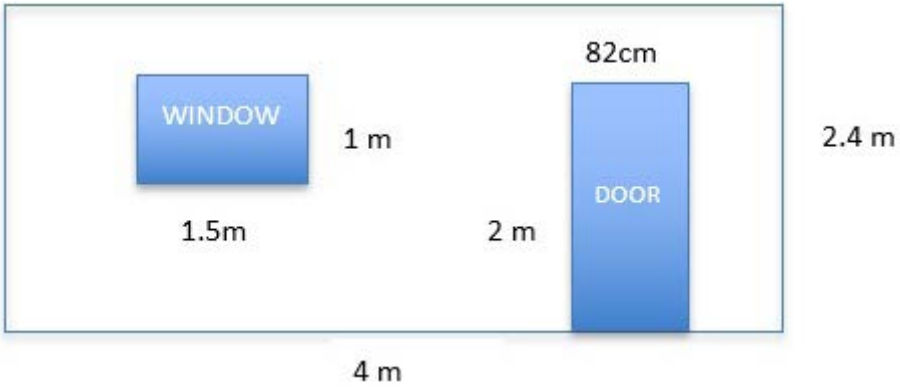
The key part of this investigation is developing the concept of the algorithm, not coding it up.
You can use some python coding to answer some of these questions.

MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

ENABLING PROMPTS

Highlight to the students that the size of the panels can not exceed 2.4 m x 6m.

To assist students in starting the activity provide them with a sample room to determine how the panel/s should be cut (see example below). Ask students to show how the larger panel/s would need to be cut based on the measurements for the sample room. Alternatively, students can measure their own room at home.



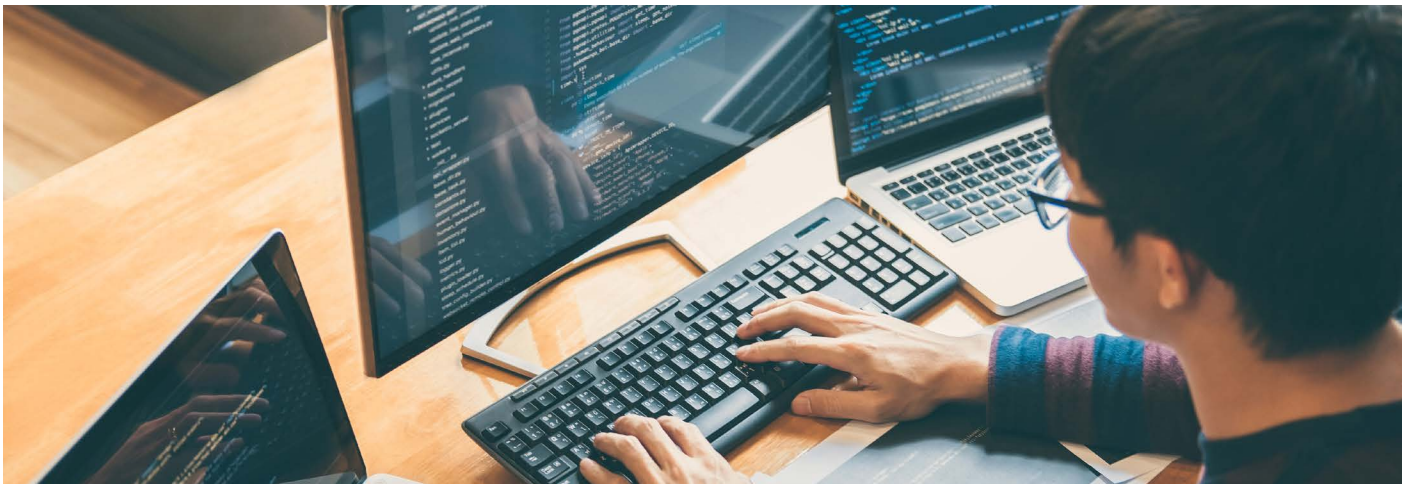
Provide the students with some coding, such as python coding and some basic starting code to be able to answer some of the questions. Whilst Python coding is recommended, students are not expected to have significant experience using it. NOTE: the important part of exercise is developing the concept of the algorithm, not coding it up.

EXTENSION OR ADVANCED INVESTIGATION

The customer has some additional requirements. When cutting panels these panels are stacked on pallets which are then shipped to the building site. The builders require that panels are in order of installation. For example, if panel 1 and 2 are located next to each other when installed, then panel 1 and 2 are stacked next to each other on the pallet. Given the manufacturer does not have unlimited warehouse space, panels that are installed close by need to be cut close by (for example, on the same blank or the one after it). How does this impact the solution approach, does it make it a harder problem to solve?

REFERENCE MATERIAL

Python coding.



MATHEMATICAL INVESTIGATION
PANEL CUTTING PROBLEM

CAREERS RELATED TO THIS INVESTIGATION

Refer to the student investigation, it provides:

- An extensive table of careers related to this investigation
- Further career references

CAREERS ACTIVITIES

Refer to the student investigation, it provides:

- A table of the top 10 rated jobs of 2021. This data comes from careercast.com. Have students investigate the jobs specific to this investigation.

INDUSTRY PARTNER

This project was produced collaboratively between The Mathematical Association of Victoria (MAV) and Biarri.

Biarri uses mathematical modelling to support better business decisions. The team at Biarri work on the most challenging business intelligence and analytical problems, from using Mathematics and Operations Research, to using advanced web development approaches and user experience design to provide simplified solutions. We solve the most diverse problems whether it is helping a customer to maximise revenue or to minimise scheduling delays.

At Biarri, we are an innovation hub and invest in the development of intellectual property. The team at Biarri love to challenge the status quo and the more challenging the problem, the better. In less than ten years, Biarri Optimisation has already spun off a few different businesses as we are a hub for innovation.

Biarri works with many industries including:
Supply chain — automate and optimise each stage of supply chain
Transport and logistics — keeping multi modal fleet utilised and efficient
Workforce — productive and efficient
Oils and gas — operations efficient and profitable
Banking and finance — using data to improve efficiency, and manage risk
Mining — efficient mine and assets
Telecommunications — automate and optimise the design of networks
Healthcare — improve planning, scheduling and predictive decisions
Predictive analysis — using data in a more effective and predictable way.