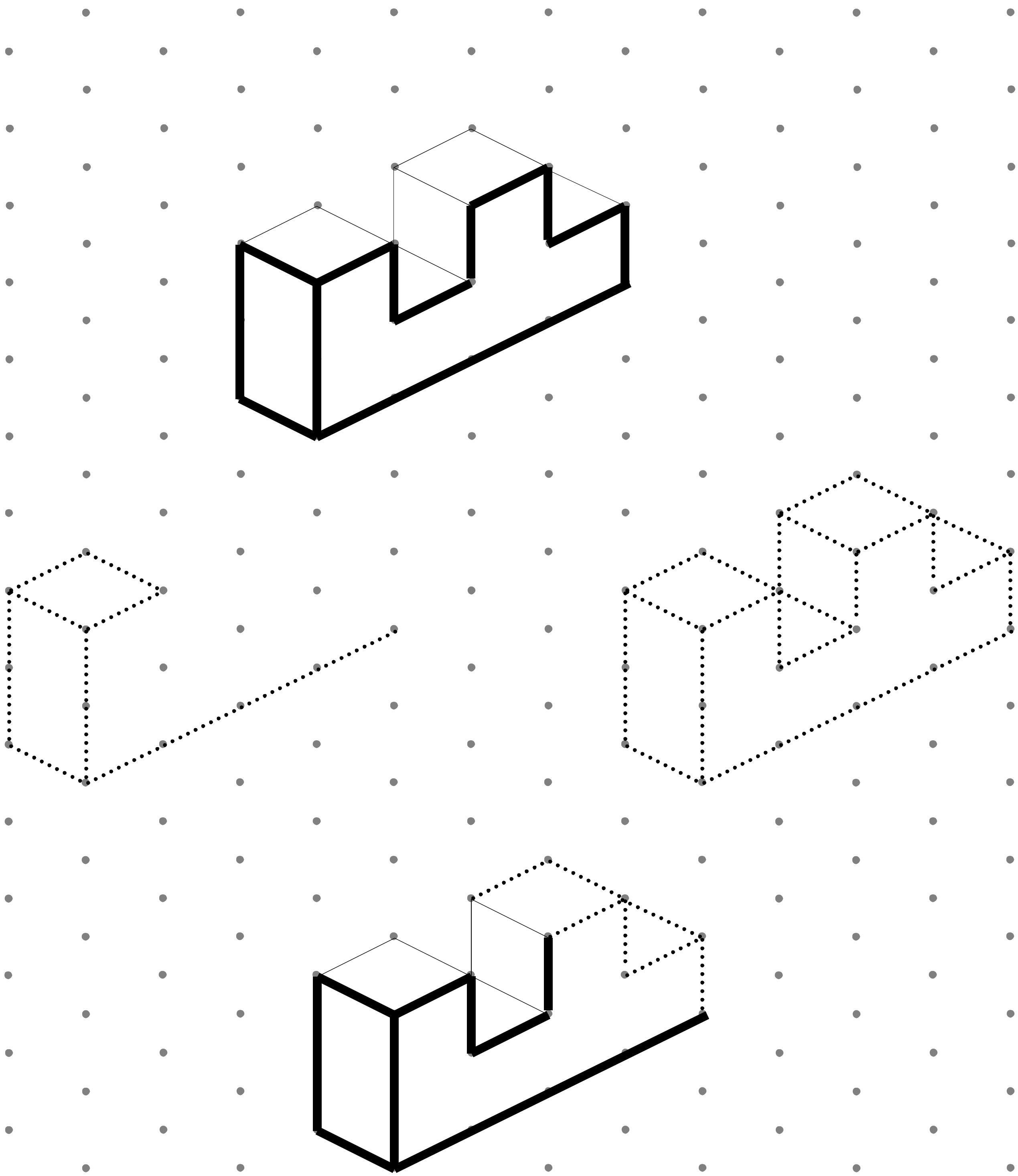
Lesson One
Learning The Scientific Approach



Class Setting:

To help the Students have fun with this exercise, have them pretend that they are all computer engineers working on a research program to understand the placement of computer chips on the motherboard within a new micro-computer. Space is extremely limited and getting the pieces to all fit on may be difficult… This theme will be used throughout the different lessons to help them see that what they learn will apply to the real world. The JENZAC™ puzzles pieces will represent the computer chips and the solution grids will serve as the motherboard.

Overview of The Scientific Approach:

Students need to know that all science and engineering is typically derived from a process called **The Scientific Approach or Method**. They are probably already evaluating and analyzing things using this logical method, but don't realize it. This exercise is intended to introduce them to the basic concept and terminology used in this universal approach to understanding the things around us. It will also help them familiarize themselves with the JENZAC™ puzzles pieces and help them begin to understand the concept of how it works.

The following review is very technical. We only want to convey the concept to the students and pick out a few words or phrases you think they can understand. Work with those, the other is just for your review. Remember, it's the concept we're trying to help them realize.

The Scientific Approach is simply using established techniques for investigating *phenomena* and acquiring new knowledge, as well as for correcting and integrating previous knowledge. It is based on gathering *observable*, *empirical*, *measurable* evidence, subject to the *principles of reasoning*.

> ***Our techniques will be a simple naming exercise, sketches and observation of how the JENZAC™ puzzle pieces interlock. Here we want the students to investigate the phenomena of building puzzle pieces from a combination of cubes and how the puzzles pieces can be arranged.***

Although procedures vary from one field of investigation to another, there are identifiable features that distinguish scientific investigation from other methods of developing knowledge. Scientific researchers propose specific *hypotheses* as explanations of natural phenomena, and design *experimental* studies that test these predictions for accuracy. These steps are repeated in order to make increasingly dependable predictions of future results. *Theories* that encompass wider domains of inquiry serve to bind more specific hypotheses together in a coherent structure. This in turn aids in the formation of new hypotheses, as well as in placing groups of specific hypotheses into a broader context of understanding.

> ***Through a series of small experiments, we want the students to begin to hypothesis about the JENZAC™ puzzle pieces, how they will interlock in other settings.***

Among other facets shared by the various fields of inquiry is the conviction that the process must be objective so that the *scientist* does not *bias* the interpretation of the results or change the results outright. Another basic expectation is that of making complete documentation of data and methodology available for careful scrutiny by other scientists and researchers, thereby allowing other researchers the opportunity to verify results by attempted reproduction of them. This also allows statistical measures of the reliability of the results to be established. The scientific method also may involve attempts, if possible and appropriate, to achieve control over the factors involved in the area of inquiry, which may in turn be manipulated to test new hypotheses in order to gain further knowledge.

> ***Communication is always one of the most critical elements of anything that we do. It is not different in an experiment or study. We want the students to take good notes, communicate well with each other and be able to use the other members on their team to help in the discovery process and use other teams to validate the findings.***

List of Materials Needed:

- 1 set of JENZAC™ pieces per group (team) of students
- Paper or Notebook (1 per student)
- Pens/Pencils

Activity Time Frame:

- Two hours or two one hour time blocks.

Environmental Setting:

- A classroom with semi-large tables with space enough to work as a group.

PASS Objectives:

The student will:

- Expand their vocabulary.
- Understand the concept of The Scientific Approach.

Project Objectives:

The students will:

- Learn to set up a scientific notebook, record their findings and convey their conclusions.
- Expand their scientific vocabulary.
- Improve team building skills
- Improve their sketching ability.
- Improve fine motor skills
- Reinforce an understanding of basic geometric shapes and their manipulation.
- Become familiar with the JENZAC™ puzzle pieces. This is important for future lessons.

Vocabulary Terms

- Phenomena - an observable event, particularly something special.
- Observable - a property of an object(s) that can be determined by some sequence of physical things you can see, measure, or record.
- Empirical - something that is dependent on evidence or consequences that are observable by our senses.
- Measurable - When by the act of assigning a number, e.g., a "size", "volume", or "probability", to something, you can track or account for it's behavior.
- Principles of Reasoning - The act of using reason to derive a conclusion from certain premises using a given methodology.
- Hypotheses - a suggested explanation of a phenomenon or reasoned proposal suggesting a possible correlation between multiple phenomena.
- Theory - a logically model or outline describing the behavior of a set of natural phenomena.
- Experiment - a set of actions and observations, performed in the context of solving a particular problem or question, to support or falsify a hypothesis or research concerning phenomena.
- Postulates - a logically self-consistent model or framework for describing the behavior of a related set of natural phenomena.
- Scientist - an expert in at least one area of science who uses the scientific method to do research.
- Bias - having a preference to one particular point of view or ideological perspective.

Background Knowledge:

Recording in Their Scientific Notebook – In addition to the date, time and who's on the team, each experiment should go from asking a question to finding an answer. Notebook records should:


Make a guess. - **Hypothesis**.


Take a look. - **Observations**.


Write it down. - **Data**.


Make it a picture. – **Graphs or Sketches**.


Decide what it means. - **Conclusions**.

Additional Comment: Students may be too young to have hands on exposure to chemicals, electricity or fire used in many experiments; but, the concept and outline above is the same. Some of the biggest discoveries in science have been made through simple exercises. The Periodic Table was discovered by Dmitri Mendeleev, a chemist professor at St. Petersburg University, while trying to organize information about the chemical elements for his students. Have the students look up the Periodic Table on the internet… it all started with a simple approach to understanding a complex puzzle.

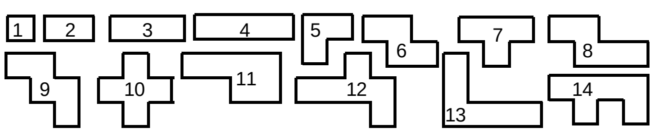
Activity Procedures

Hour One: Give each team of students a JENZAC™ set. Explain their role as computer engineers… Teach the students the definition of The Scientific Approach.

- Have the students name each of the pieces (i.e. the "F" piece or the Oklahoma Piece etc.). In this case, since we are using the pieces as computer chips, they may refer to them as chips rather than puzzle pieces. Have the whole class agree to the names of each "chip". *(This is intended to be FUN and have lots of energy.)*
- Show them how to set up their Notebooks (Refer to the Recording in Their Notebook above.) *(This is intended to calm them down and work on them following instructions.)*
- Go through the basic ways to sketch the pieces (Re: Sheets A, B, D). *(This is intended to provide more instruction with them doing what you do as you go.)*
- Review vocabulary words they may already know to make sure no one is left behind: square, rectangle, and cube. Maker sure they understand the terms used in sketching: plan view, elevation, and isometric view. *(This is intended to make sure everyone is on the same page and focused on the importance of communication.)*

Hour Two: Give each team of students a JENZAC™ set. Review The Scientific Approach. Now it's time for the first experiment. "How are the pieces proportioned? Are all the pieces made from the combination of cubes and how many cubes are used in the whole JENZAC™ set?"

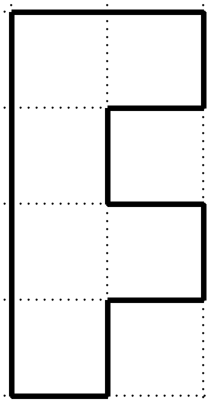
- With each team, divide the JENZAC™ set into groups of pieces to allow each person on the team to have a group of pieces. The following divisions may be used:



  - Team of 2 – Use pieces (1, 3, 5, 7, 9, 11, 13) and (2, 6, 8, 10, 12, 14)
  - Team of 3 – Use pieces (1, 4, 7, 10, 13), (2, 5, 8, 11, 14), and (3, 6, 9, 12)
  - Team of 4 – Use pieces (1, 5, 9, 13), (2, 6, 10, 14), (3, 7, 11) and (4, 8, 12)
  - Team of 5 – Use pieces (1, 6, 12), (2, 7, 13), (3, 8, 14), (4, 9, 11) and (5, 10)

- Have each student sketch each piece and count the cubes in each piece. (Sheets C, E). *(This is intended to show them that each piece is made up of cubes and improve their sketching skills.)*
- Put the student back together. Have them compare findings and calculate the total number of cubes for the complete JENZAC™ set. *(This is intended to improve communication, reinforce the scientific method outline and improve team work.)*
- Have each team collaborate and compare notes with the other teams to confirm their finding. Then have the class agree to the number of cubes in each JENZAC™ set. *(This is intended to focus on the importance of communication and collaboration to check your work.)*

This is a Plan View of the No. 14 piece drawn on an rectangular grid. You can draw the puzzle pieces by counting the cubes and using the grid.



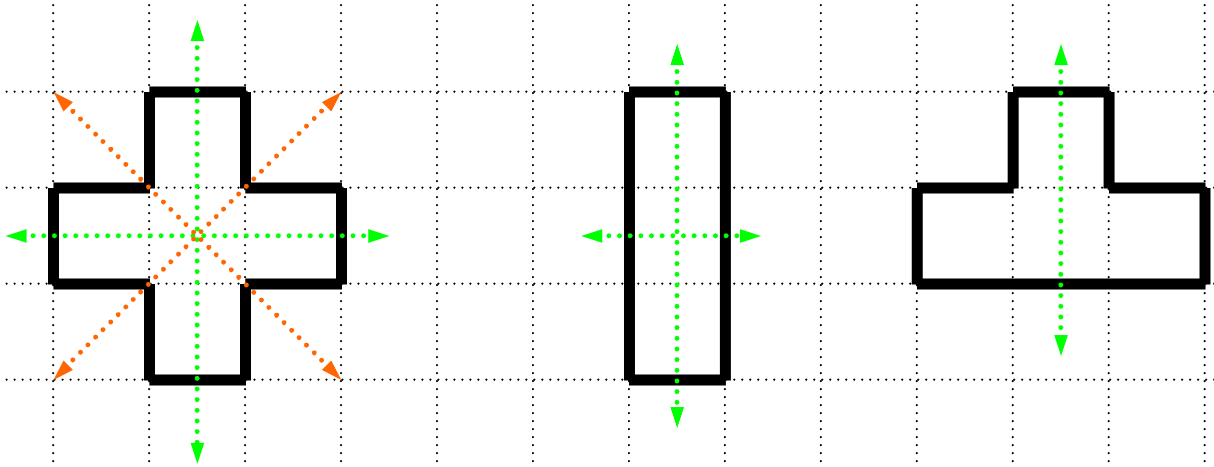
The **Plan View** of a shape is the view (or what you would see) if you were looking straight down over the top of an object. This is a Plan View of the No. 14 piece.

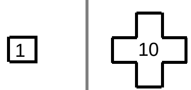
Not that it is laying flat and placed like the letter F. Most peaces will look different as they are rotated while laying flat or flipped over to the opposite side.

The number of different ways you can view an object in plan view is dependent on the symmetry of the object. If something is totally symmetrical, it will look the same no mater how you flip or rotate it.

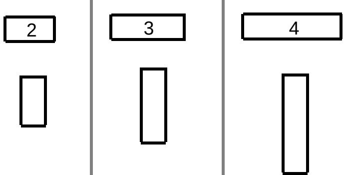
The **Axis of Symmetry** of a two-dimensional figure is a line such that, if a perpendicular is constructed, any two points lying on the perpendicular at equal distances from the axis of symmetry are identical. Another way to think about it is that if the shape were to be folded in half over the axis, the two halves would be identical: the two halves are each other's mirror image.

The No. 14 piece does not have an Axis of Symmetry. Some pieces, as shown below, have 4, some 2 and some only 1. The pieces with 4 axis look the same no mater how you turn them. Those with 2 axis will have 2 ways of looking at them. Those with 1 axis will have 4 ways. And Those with none will have 8. (Have the students cut out these shapes and fold them to see the different axis.

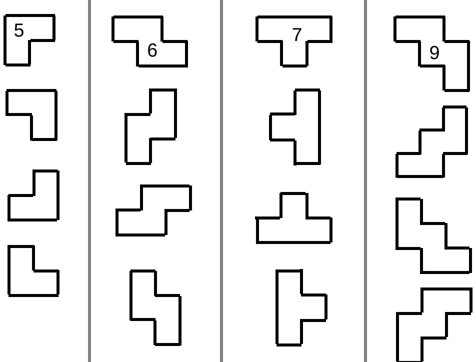




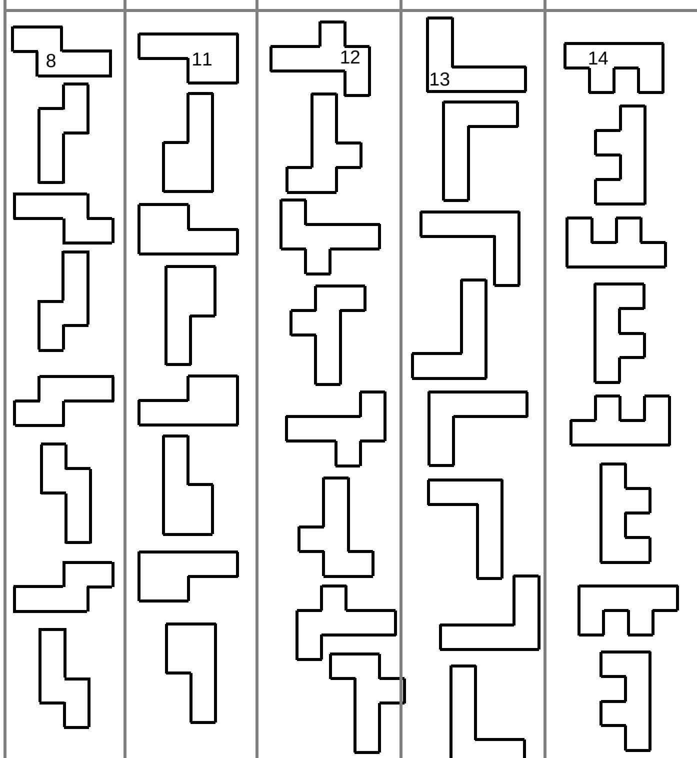
Four Axis of Symmetry: These shapes in 2-dimensions (laying flat) will always look the same no mater how you flip or rotate them.



Two Axis of Symmetry: These shapes in 2-dimensions (laying flat) will have two different views depending on how you flip or rotate them.



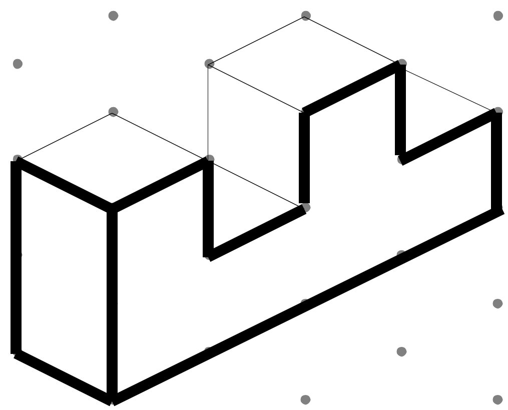
One Axis of Symmetry: These shapes in 2-dimensions (laying flat) will have four different views depending on how you rotate them. Flipping the pieces will only result in another view that could have been seen by just rotating the piece.

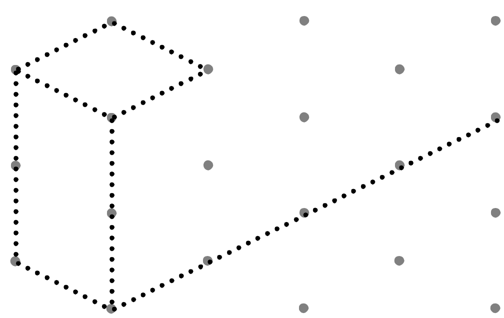


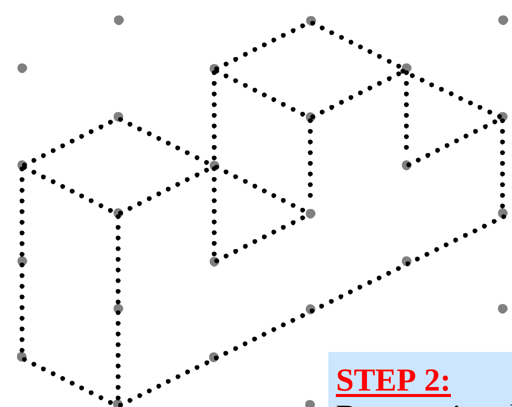
No Axis of Symmetry: These shapes in 2-dimensions (laying flat) will have eight different views depending on how you rotate them. Four view will be seen by rotating the pieces and the other views will be see by flipping the pieces and then rotating them.

This is an Isometric view of the No. 14 piece drawn on an Isometric grid. Below are three simple steps to use when drawing an Isometric Sketch of an object.

An **Isometric Sketch** is a three-dimensional view of an object. In an isometric sketch, the object's vertical lines are drawn vertically, and the horizontal lines in the width and depth planes are shown at 30 degrees to the horizontal. When drawn under these guidelines, the lines parallel to these three axes are at their true (scale) lengths. Lines that are not parallel to these axes will not be of their true length.

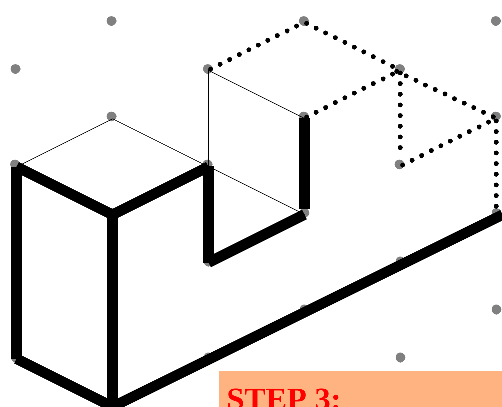






STEP 1:
Using a light or dashed line outline the top of the object, then down one side, and across the bottom. Remember you can count the dots to equal the number of cubes.

STEP 2:
By counting the dots corresponding to the number of cubes, complete the sketch.



STEP 3:
Go back over the lines with a heaver stroke. Then make the lines representing the front faces the darkest.