ENGINEERING DRAWING

Module 3: 3-View Drawing

Teacher Facilitation Guide

Grade: 6th–8th

Duration: ~1 Week (5 Class Periods)

Module Overview

In Modules 1 and 2, students built vocabulary for 3D objects, explored observation sketching, and discovered through nets and partner activities that informal drawing cannot reliably communicate a complete 3D design. Module 3 introduces the engineering solution: 3-View Drawing, the standard method engineers use to show complete, accurate information about a 3D object using three separate 2D views.

BY THE END OF THIS MODULE, STUDENTS WILL BE ABLE TO:

- Draw the 3 standard views (Top, Front, Right) of a cube structure using engineering notation
- Use shading to identify changes of plane in a multi-cube structure
- Apply solid lines and hidden (dashed) lines correctly in engineering notation
- Reconstruct a 3D structure from a classmate's 3-view drawing

MATERIALS

- Wooden cubes — 2 to 8 per student (1" size)
- Large (4") class demonstration cubes
- Graph paper, pencils, small rulers
- Flash cards (optional — for differentiation)

MODULE STRUCTURE

- Activity 1 — Intro to 3-View Drawing (1 day)
- Activity 2 — Changes of Plane: Shading (1 day)
- Activity 3 — Engineering Notation Practice (1–2 days)
- Activity 4 — Draw and Build Challenge (1 day)

Standards and Learning Dimensions

Standard	Details
Georgia Standards of Excellence	Grade 6: EET-1, EET-7 | Grade 7: II-3, II-7 | Grade 8: TS-2, TS-7
NGSS Standard	MS-ETS1: Engineering Design https://www.nextgenscience.org/dci-arrangement/ms-ets1-engineering-design
Performance Expectation MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
Performance Expectation MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
Performance Expectation MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Learning Dimension	Classroom Connections
Science and Engineering Practice *Constructing Explanations and Designing Solutions:* Students learn and apply engineering 3-view drawing conventions as a structured solution to the problem of communicating 3D designs in 2D. They use shading as an intermediate step, then transition to the formal engineering notation of solid and dashed lines.	In Activities 1–3, students progress from drawing simple cube structures to complex multi-cube configurations using engineering notation. In Activity 4, they apply the complete convention to communicate an original design to a partner, testing whether their drawings contain sufficient information for reconstruction.
Disciplinary Core Idea *MS-ETS1-1: Defining and Delimiting Engineering Problems* The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. *MS-ETS1-4*: Developing Possible Solutions A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.	Students apply the constraint that engineering drawings must be complete and unambiguous — the information must be sufficient for another person to reconstruct the original structure without additional guidance. In Activity 4 (Draw and Build Challenge), students test their own drawings by having a partner attempt reconstruction, directly evaluating whether the drawing met the communication requirement.
Crosscutting Concept *Patterns:* Patterns can be used to identify cause-and-effect relationships. Engineering drawing conventions (solid lines for visible changes of plane, dashed lines for hidden changes) are a systematic pattern that allows any trained reader to reconstruct a 3D object from a 2D drawing.	Students learn to read and apply the conventions of engineering notation as a pattern system. Activities 2 and 3 focus on recognizing changes of plane and mapping them correctly to solid or dashed lines — building pattern recognition skills that are fundamental to reading engineering drawings in any context.

Engineering Skill Learning Goals

- Students create multi-view sketches of 3D cube structures to communicate complete shape information.
- Students apply engineering notation conventions (solid and dashed lines) to represent visible and hidden changes of plane.
- Students iteratively refine their drawings based on feedback from the Draw and Build Challenge.
- Students test drawings by attempting to reconstruct a partner's structure, evaluating whether the drawing communicates sufficient information.

Key Vocabulary

Review these words before you start. You may introduce each one as it appears naturally in the activities.

Term	What It Means
3-View Drawing	A drawing that shows a 3D object from three sides: Top, Front, and Right. Together, the three views give complete information about the shape.
Top View	What the object looks like when you look straight down at it from above.
Front View	What the object looks like when you look straight at it from the front.
Right View	What the object looks like when you look at it from the right side.
Plane	A flat surface. Think of a perfectly flat piece of glass. The faces of cubes are flat planes.
Coplanar	Two or more faces that are on the same flat surface. When cube faces line up flat, they are coplanar.
Change of Plane	Where the surface of a shape steps up, down, or back. This creates a line in engineering drawings.
Solid Line	In engineering notation, a solid line shows a change of plane that you can see from that view.
Hidden Line (Dashed)	A dashed line in engineering notation. It shows a change of plane that is hidden behind the object from that view.
Engineering Notation	The standard set of drawing rules that engineers use worldwide to show 3D shapes on paper.
Shading	A learning step: darker shading means a surface is closer to you. Used to identify planes before switching to engineering notation.

ACTIVITY 1

Introducing 3-View Drawing

Essential Question: How can we show all sides of a 3D object using 2D drawings?

TIME
~45 min

TEACHER NOTES

Setup: Set up 2 large cubes side by side at the front of the room. Label the faces: Top, Front, Right, Left, Back, Bottom. Prepare graph paper and rulers.

Part 1 — Review and Problem Setup (10 minutes)

Begin by reviewing Modules 1 and 2. Remind students that in their observation sketching and partner challenge activities, no single drawing from one angle was enough to fully describe a 3D structure. Pose the question:

> *"In Module 1, when you tried to sketch a structure for your partner, could they always tell what was happening on the back side? Imagine someone took a bite out of the back of this cube. From your sketches alone, would your partner have been able to tell?"*

The answer is no — neither method shows the back. This is the problem 3-View Drawing solves.

Part 2 — What is 3-View Drawing? (10 minutes)

The Big Idea: Three Views = Complete Information

A 3-View Drawing shows a 3D object from three directions at the same time:

- Top view — looking straight down
- Front view — looking straight at the front
- Right view — looking from the right side

Each view is flat and drawn to scale. The three views are arranged in an 'L' shape on the page.

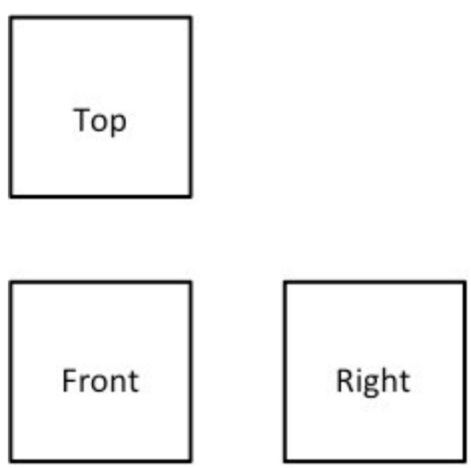


Figure 1. 3-vew drawing arrangement

TEACHER NOTES

Demonstration tip: Physically stand next to the cube structure and model each view. Point to the Top and say 'This is what it looks like from above.' Then move to Front, then Right. This kinesthetic connection helps students understand what each 2D view represents.

Scaffolding: Have students label the faces of their own small cube (Top, Front, Right) before drawing. Ask: 'Put your cube on the desk. Look straight down — what do you see? Draw just that.'

Part 3 — Draw It: 1 Cube, 3 Views (10 minutes)

1. Start with your small wooden cube on the desk. Label the faces if helpful: Top, Front, Right.
2. On your graph paper, draw the TOP view (looking straight down). It is a square.
3. Below the Top view, draw the FRONT view. Also a square for a single cube.
4. To the right of the Front view, draw the RIGHT view. Also a square.

Part 4 — Draw It: 2 Cubes, 3 Views (10 minutes)

Set up 2 cubes side by side. Have students draw the 3 views in their journals. This carries into Activity 2.

✏️ **JOURNAL PROMPT**

- *"What did you find difficult about today's 3-view drawing? What strategy did you use to figure out each view?"*

ACTIVITY 2

Changes of Plane – Shading

Essential Question: How do we show a step or ledge in a flat drawing?

TIME
~45 min

In Activity 1, all cube faces lined up flat. Now students work with structures where the faces are NOT all on the same flat surface — introducing changes of plane.

CORE CONCEPT: CHANGE OF PLANE

When the surface of a cube structure steps up, down, or back, there is a **change of plane.** Think of a staircase: each step is on a different plane. In a drawing, we need a way to mark where those changes happen.

Part 1 — Review and Problem Introduction (10 minutes)

Set up a 3-cube structure where one cube is on a different level (e.g., 2 cubes side by side and 1 stacked on top of one of them) (Figure 1). Have students try to draw the Top view.

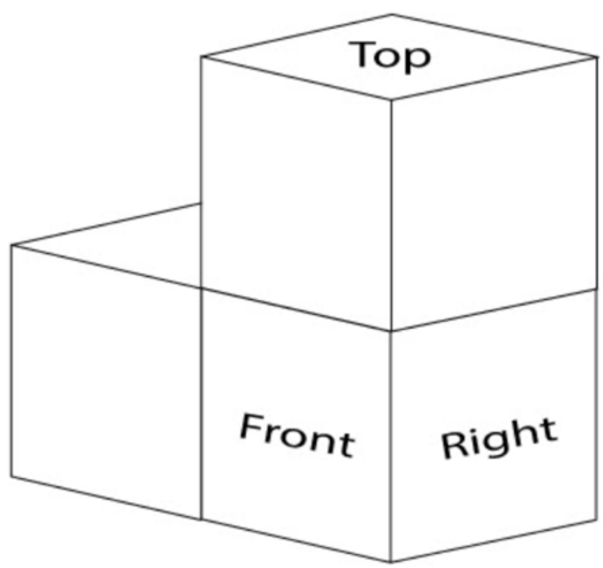


Figure 1. 3-cube structure

TEACHER NOTES

What to watch for: Students will struggle with the Top view because the two top surfaces are on different levels — they are not coplanar. Demonstrate by trying to balance a flat sheet of paper across both top surfaces — it will only rest flat on one of them.

Part 2 — Introducing Shading (20 minutes)

Shading is a stepping stone — it helps students identify changes of plane before they learn engineering notation. Darker shading = closer to the viewer.

HOW SHADING WORKS

- Look at your 3-view drawing. Where do two cube surfaces sit on different planes?
- Shade the surface that is closer to you (darker = closer). Leave the farther surface unshaded.
- Pick one shading convention and use it consistently across all your drawings.

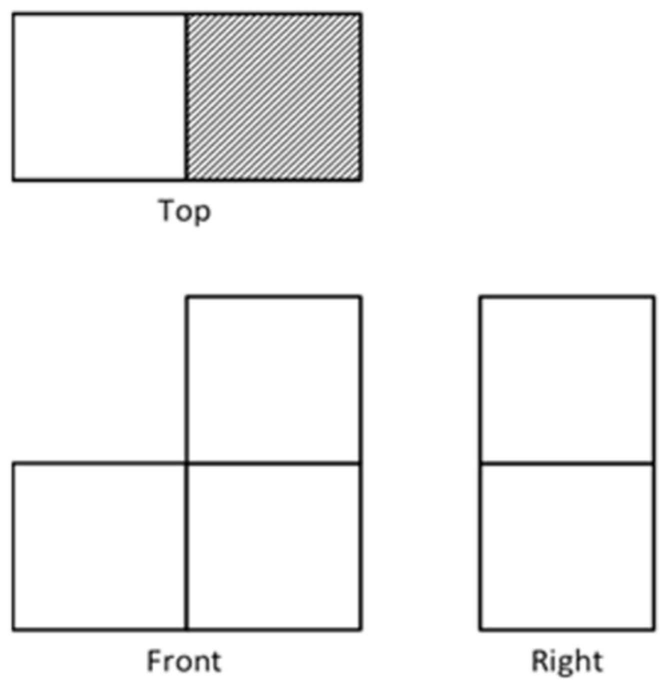


Figure 2. 3-view solution

- Note that the taller cube on the top face is shaded, indicating a change of plane.

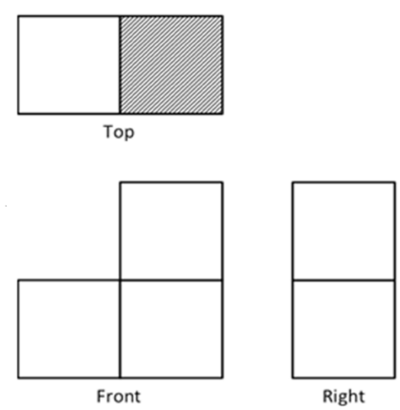
Part 3 — Introduction to Engineering Notation (15 minutes)

ENGINEERING NOTATION: TWO RULES

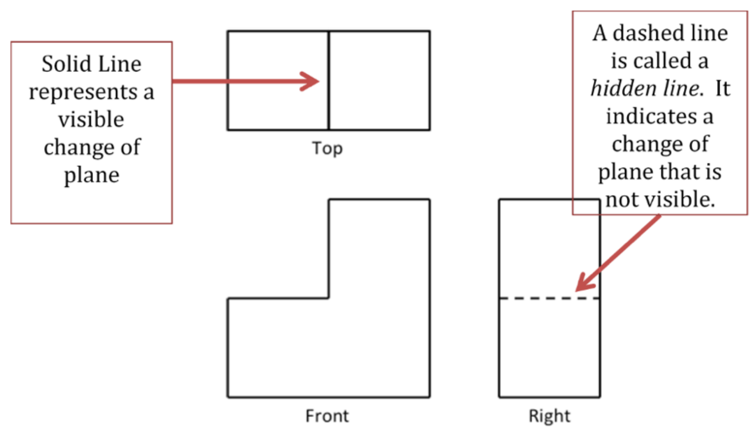
Solid line: marks a change of plane you can see from that view.

Hidden line (dashed): marks a change of plane hidden behind the object from that view.

Also: when cube faces are coplanar, draw only the outer outline — do not draw the individual cube edges between them.



Change of Plane: Shaded Version



Change of Plane: Engineering Notation

Figure 3. Shaded 3-view vs. 3-view with engineering notation

TEACHER NOTES

Scaffolding tip: Allow students to draw the shaded version first, then trace over it to produce engineering notation. Some students will need this intermediate step throughout the module.

Common confusion: Students often draw a solid line between two coplanar faces. Remind them: if two faces are perfectly flat and on the same level, the line between them disappears — only the outer edge is drawn.

ACTIVITY 3
Practice Problems
Essential Question: How do we apply engineering notation to more complex structures?

TIME
~1.5 to 2 days

Students deepen their understanding through a sequence of practice problems moving from simple to complex. This activity is designed to be differentiated — students who move quickly can advance, while others build confidence at earlier levels.

Part 1 — Review: Back, Left, and Bottom Views (15 minutes)

Students have been drawing the Top, Front, and Right views. Now they practice the other three using the same 3-cube structure from Activity 3.

Ask the class: "Does 3-view drawing give complete information? If I took a bite out of the back of this structure, could you show it?" Answer: Yes — a correctly done 3-view drawing can describe any 3D shape completely.

Part 2 — 7-Cube Challenge (30-40 minutes)

Set up a structure of 7 cubes (an incomplete 2x2x2 cube, missing one corner block) at the front of the room.

Ask students to draw the 3 standard views (Top, Front, Right) in engineering notation.

If helpful, draw the shaded version first, then convert to engineering notation.

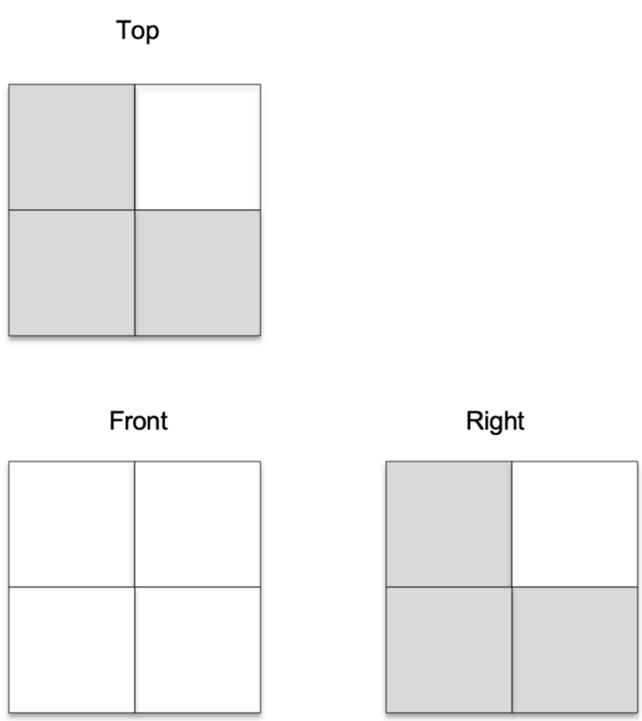


Figure 1. Shaded (transition step) 3-view drawing of the 7-cube structure

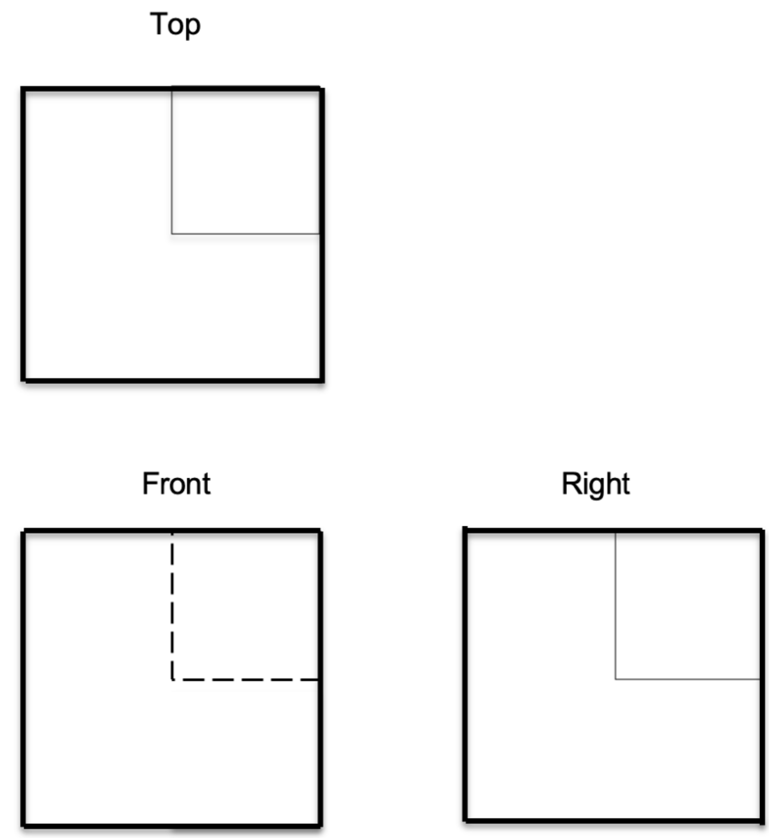


Figure 2. Engineering notation solution for the 7-cube structure

TEACHER NOTES

Flash cards for differentiation: Green dot = easiest, yellow = medium, red = challenging. Students build the structure shown on the grid side of the card, then check the 3-view solution on the back.

ACTIVITY 4

Draw and Build Challenge

Essential Question: How do we go from 3D to 2D – and back to 3D?

TIME
~45 min

Students apply everything they have learned: they build a complex cube structure, draw it in engineering 3-view notation, and then a partner tries to rebuild the structure using only the drawing.

Part 1 — Opening: Sketching to Communicate (5 minutes)

> *"We draw to communicate. An engineering drawing should give someone enough information to build what we designed — even if they weren't there when we designed it. Today we test that."*

Part 2 — Build and Draw (25 minutes)

INSTRUCTIONS FOR STUDENTS

1. Take 8 cubes. Build a structure with at least two levels or a change of plane.
2. Draw the 3-view (Top, Front, Right) using engineering notation. You may use shading as a first step, but your final drawing should show only engineering notation.
3. When finished, put your structure out of sight and give your drawing to a partner.

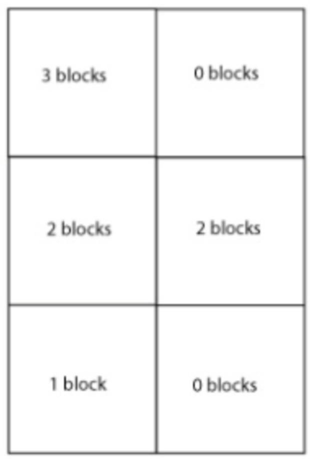


Figure 1. Example 8 cube setup

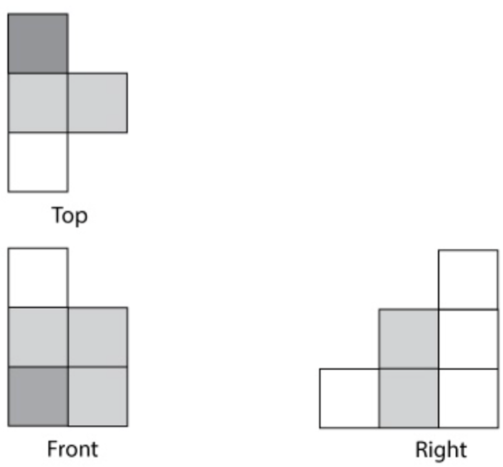


Figure 2. Shaded drawing

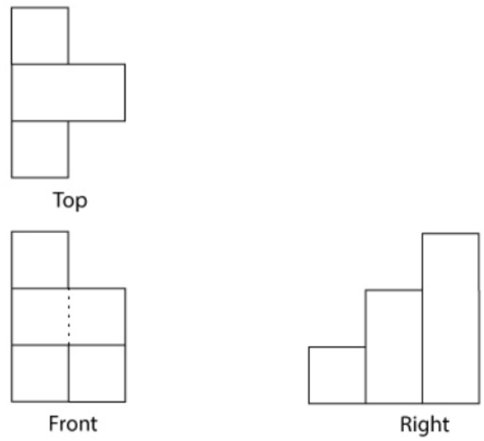


Figure 3. 3-view Engineering Notation: The closer the block face, the darker the shading

Part 3 — Build from a Partner’s Drawing (10 minutes)

Students try to rebuild their partner's cube structure using only the 3-view drawing. When both partners have finished, compare the rebuilt structure to the original. If they do not match, look at the drawing together — where was the information unclear?

Part 4 — Discussion and Reflection (10 minutes)

DISCUSSION QUESTIONS

- Was your partner able to rebuild your structure from your drawing? Why or why not?
- If they could not, what was missing or unclear in your drawing?
- Why is it important for engineers to have a shared drawing language?

Looking Ahead — Module 4

Students can now represent 3D shapes accurately using engineering notation. Module 4 uses those same drawings to calculate the volume and surface area of a 3D structure — connecting engineering drawing to real math and design decisions.

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