ENGINEERING DRAWING · MODULE 4: VOLUME AND SURFACE AREA

Planning Guide

Duration: ~1 Week (5 Class Periods) | Grades 6–8

Georgia Tech · STEM Innovation & Design

Activity Overview and Pacing

Activity	Name	Day	Time	Essential Question
1	Introducing Volume and Surface Area	Day 1	~45 min	How can we use cube drawings to measure the space an object takes up and its outside area?
2	Station Rotations: Calculate Volume and Surface Area	Days 2–3	~60 min	How do volume and surface area change when a structure changes shape?
3	Using 3-View Drawings to Calculate	Day 4	~45 min	How can a 2D drawing help us calculate volume and surface area?
4	Connecting to Design Decisions	Day 5	~30 min	How do volume and surface area affect engineering design?

Activity Descriptions and Materials

Activity 1 — Introducing Volume and Surface Area | Day 1 | ~45 min

Essential Question: *How can we use cube drawings to measure the space an object takes up and its outside area?*

Real-life framing (packing a truck, wrapping a present) grounds the difference between volume and surface area. Students count unit cubes to find volume in cubic inches and count exposed faces to find surface area in square inches, building structures of a given volume and using the Module 2 net idea — unfold and count the squares — as a face-counting strategy.

Materials:

- Wooden cubes (1") — 4–8 per student
- Graph paper and pencils
- Student journals

Activity 2 — Station Rotations: Calculate Volume and Surface Area | Days 2–3 | ~60 min

Essential Question: *How do volume and surface area change when a structure changes shape?*

Students rotate through 4–6 numbered cube-structure stations of varying complexity — from two cubes in a row to 7+ cubes with multiple changes of plane — calculating volume and surface area for each on the Student Recording Sheet. Going view by view (Top, Front, Right, Left, Bottom, Back) gives a systematic method that connects directly to the 3-view skills from Module 3.

Materials:

- Wooden cubes (1") — pre-built station structures, numbered
- Handout 1 — Student Recording Sheet
- Pencils

Activity 3 — Using 3-View Drawings to Calculate | Day 4 | ~45 min

Essential Question: *How can a 2D drawing help us calculate volume and surface area?*

Students use their 3-view drawings as a calculation tool, not just a communication tool: a good drawing shows every change of plane, so counting faces view by view gives total surface area. They then rearrange a fixed set of four cubes and discover that volume stays constant while surface area changes — a powerful engineering design insight.

Materials:

- Wooden cubes (1") — a 5–8 cube structure, plus 4 cubes per student
- Graph paper and pencils
- Student journals

Activity 4 — Connecting to Design Decisions | Day 5 | ~30 min

Essential Question: *How do volume and surface area affect engineering design?*

A design-scenario discussion asks students to reason about a storage container built from eight unit cubes — which arrangement maximizes usable space, which minimizes protective coating (least surface area), and what other factors matter. A journal reflection has each student report the volume and surface area of a chosen structure and connect the measurements to real design decisions, wrapping up the full Engineering Drawing sequence.

Materials:

- Wooden cubes (1") — 8 per student or group
- Completed Student Recording Sheets from Activity 2
- Student journals

Standards Alignment

This module was designed to support the Next Generation Science Standards (NGSS) Engineering Design performance expectations and Science & Engineering Practices, the Georgia Standards of Excellence, and the Common Core State Standards for Mathematics. The tables below summarize the strongest alignment points and where they show up in the module.

NGSS Engineering Design Performance Expectations

Standard	Description	Where It Shows Up	Classroom Connection
MS-ETS1-1	*Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution.*	*Activities 1–4*	*Students use volume and surface area as measurable criteria and constraints when reasoning about material use and design trade-offs.*
MS-ETS1-2	*Evaluate competing design solutions using a systematic process to determine how well they meet criteria and constraints.*	*Activities 3–4*	*Students compare configurations of equal volume but different surface area to evaluate which best fits a design goal.*

Science and Engineering Practices & Crosscutting Concepts

Learning Dimension	Where It Shows Up	Classroom Connection
SEP: Using Mathematics and Computational Thinking	*Activities 1–4*	*Students use counting strategies to calculate volume (cubic units) and surface area (square units) and apply them to evaluate design trade-offs.*
DCI: 6.G.A.2 — Volume of Right Rectangular Prisms	*Activities 1–2*	*Students treat each 1-inch cube as a unit of volume, extending volume reasoning to irregular cube structures.*
DCI: 6.G.A.4 — Surface Area Using Nets	*Activities 2–3*	*Counting exposed faces from all six views provides a systematic method for surface area, linking engineering drawing to mathematical measurement.*
CCC: Scale, Proportion, and Quantity	*Activities 1, 3*	*Holding volume constant while changing shape shows how surface area varies — building proportional reasoning about 3D structures.*

Aligned Content Standards

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 — MS-ETS1: Engineering Design; MS-PS1: Matter and Its Interactions	*Performance Expectations MS-ETS1-1 and MS-ETS1-2 (see table above).*
Common Core Mathematics — 6.G.A.2	*Find the volume of a right rectangular prism by packing it with unit cubes.*
Common Core Mathematics — 6.G.A.4	*Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures.*

This STEM Innovation and Design module was produced by Georgia Institute of Technology's Center for Education Integrating Science, Mathematics, and Computing with support from National Science Foundation Award #2101441.