

THE STANDARD

Defining Design Problems

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.

ANCHORING PHENOMENON

The Mars Rover Design Brief

Before NASA built Perseverance, engineers wrote a design brief that specified every condition the rover had to survive. It had to survive Martian nights colder than -90°C while keeping its electronics between -40°C and $+50^{\circ}\text{C}$. It had to roll over rocks up to 40 cm tall. It had to land within a target zone smaller than a small town (a 7.7 by 6.6 km ellipse). It had to carry instruments under tight mass limits because every extra kilogram added enormous launch cost. The brief was hundreds of pages before any hardware was built. Students see the gap between "send a robot to Mars" and the precise spec that made the mission possible.

DRIVING QUESTION

"Why do real engineers spend so much time writing before they start building?"

INVESTIGATIVE 1

Two Product Listings, Same Product Category

Pull two real spec sheets for similar products. Two water bottles, two flashlights, two backpacks. They look like the same thing on the shelf, but their spec sheets reveal different criteria and constraints. One bottle is rated for boiling water, the other isn't. One flashlight is rated waterproof to 10 meters, the other to splash-resistant. Use this to sharpen the precision lens the anchor is pushing on: tiny spec differences cause real differences in what the product can do.

DRIVING QUESTION

"Why do two products that look the same end up with such different specs?"

INVESTIGATIVE 2

The School's Locker Request

A school is replacing the lockers in a hallway and the principal hands out a one-page request: "We need new lockers." Students read it and immediately realize the request is unsolvable as written. How tall? How many? How secure? Compliant with which safety codes? Within what budget? Same kind of vague-to-precise rewrite as the anchor, only the stakes are local instead of interplanetary.

DRIVING QUESTION

"What would a useful version of the principal's request actually say?"