

# Engineering Mindset:

## Balance criteria and constraints that require trade offs



Engineers design solutions for the real-world. The problems are complex and engineers must consider and balance various physical, technical, economic, environmental, social, cultural, and ethical factors. In addition, they must attend to client preferences. As they define the problem they will address, engineers specify the parameters for a successful solution. They work with their clients to identify the criteria the solution must meet and the limiting constraints.

Criteria are the requirements of a design. Criteria for a baby gate that keeps young children from going up a staircase might include that: it can be adjustable to openings of various widths, it is a certain height, can support a child's weight up to 30 pounds, it cannot be opened by children under the age of 5, adults can open it without using their hands, adults can see what is on the other side of the gate, and it have bright colors and designs.

Constraints are limits that restrict the design. For the baby gate example, constraints might include the following: product needs be under a certain price, the design needs to be completed in 6 months, the gate cannot weigh more than 15 pounds, and the gate need to meet all U.S. and European safety requirements for young children.

Criteria and constraints are often in tension. A sturdier gate may weigh more. The cheapest or easiest way to open the gate may not be hands-free. Adhering to safety requirements may greatly limit material choices. As they generate ideas, engineers need to be aware of the many parameters and balance the tradeoffs to optimize a solution.

Articulating the criteria and constraints that define the project is usually an early phase of the engineering design process. Developing clear parameters helps engineers more efficiently create successful designs. However, during the design process it is common for new questions to arise and additional criteria and constraints to be identified.

Like engineers, youth's engineered solutions should be guided by a clear understanding of the task. Generating a list of the criteria and constraints and posting this on a wall for continued reference can enhance youth's designs. As new questions arise about the challenge and new parameters are negotiated, they can be added to the list.

Throughout the design process, the criteria and constraints should be referenced as the metric for success. Brainstormed ideas are winnowed as requirements are considered. The performance of a particular design should be evaluated against specified outcomes. As youth engineer, they will come to understand that any proposed solution cannot optimize all of the variables at the same time, but the role of engineers is to come up with the best solution possible within the full context of the problem.

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MILLION GIRLS MOONSHOT