

**Some Thoughts about Criteria & Constraints**

**Criteria:**

**Desired specifications (elements or features) of a product or system.**

**Students should specify the design requirements**.

**Example**: Our growth chamber must have a growing surface of 10 square feet and have a delivery volume of 3 cubic feet or less.

In professional engineering practice, *criteria* are usually stated by the customer as specifications and stated in the positive.

For example, the airplane must be able to achieve a speed of Mach 2 in 30 seconds, have an in-flight turning radius of 30 feet, a range of 1000 miles on one tank of fuel, and weigh less than 500 lbs (I’m making these specs up and some are totally unrealistic, so don’t use them in an exercise!!).

In short, criteria state how the designed object is expected to perform so that success can be evaluated. Because different teams will come up with different designs, the criteria also afford the means of first evaluating objective success (did the object meet each one or not?), then evaluating the “betterness” or “worseness” of each design by providing variables to trade off against each other.

* For example, airplane design A has a tighter turning radius than airplane design B, which means that its maneuverability is more nimble. We (the customer) value maneuverability more highly than the second most important criterion – the range – for which airplane B surpasses airplane A.
* In the tradeoff between maneuverability and range, airplane design A wins.
* There would be similar tradeoffs analyzed for each criterion and for each design until a “down-select” was made.

Even though each design met the criteria, the comparison of characteristics of each design against the others using those same criteria would lead to a decision about the best aircraft design for that customer’s needs.

**Constraint:**

**A limit to the design process. Constraints may be such things as appearance, funding, space, materials, and human capabilities.**

**Students should list the limits on the design due to available resources and the environment.**

**Example**: Our growth chamber must be accessible to astronauts without the need for leaving the spacecraft.

In professional practice, *constraints* emerge from the resources of the design situation. Resources mean not only material resources, but the resources of time, money, production capacity, and expertise.

* The best performing design won’t win if it’s prohibitively expensive (in terms of money, time, production capacity, and expertise) to build, operate, and/or maintain.
* In terms of classroom engineering, the materials and time available to engineer an object or procedure may be constraints imposed by the design circumstances.
* Constraints can be imposed by the customer or by the capacity of those doing the designing and building.

Furthermore, an engineer can uncover constraints during the design process, such as discovering that the design of an assistive device for a human arm must be constrained by the range of motion of that user’s arm. Not all constraints are known at the beginning of the engineering process, but the criteria for success usually are.

Adapted from LASER Shifting Instruction for the NGSS, presented by Ann McMahon, Co-Director, Washington State LASER; Craig Gabler, Regional Science Coordinator, ESD 113, NGSS Writing Team.