

HOW TO DRAW A FREE BODY DIAGRAM

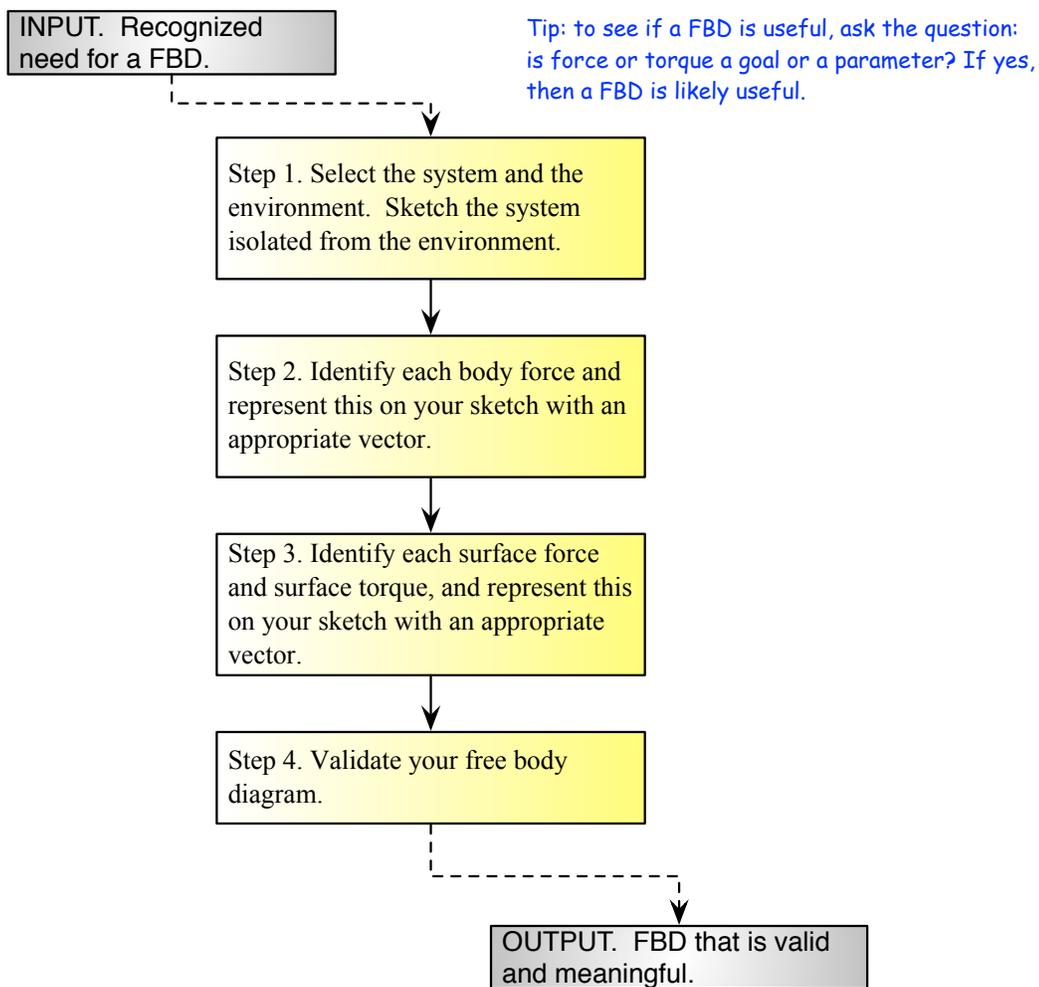
What? A FBD is a sketch that shows shows external forces, external moments, and key data (dimensions, angles, ...) for a system.

Why? Visualize (see) what is going on. Easy way to do a problem. Makes forces meaningful

When? When force or moment equilibrium is applied. When Newtons 2nd law is applied.

Key Concepts. See next page.

Step-by-Step Process



Validating a FBD

If equilibrium--do forces and moments sum to zero?

If nonequilibrium--is Newton's second law ($\sum F = ma$) satisfied?

Is each surface force/moment represented?

Is each force caused by a push or pull of matter in environment?

Is each torque caused by matter in environment?

KEY CONCEPTS--DRAWING A FBD

Name of Concept	Meaning
System	A system is a collection of matter identified by the engineer.
Free Body	A free body is a system that is isolated "i.e. freed" from its surrounding environment.
Environment	The environment is all matter that is not part of the system.
Force	Force is an interaction between two bodies in the form of a push or pull. A "push or pull" is an interaction that can impose a change in velocity or an elastic deformation of a body.
Body Force Surface Force	All forces are either body forces or surface forces. A <u>surface force</u> (or contact force) requires that the two interacting bodies touch. A <u>body force</u> does not require that the two bodies touch.
External Force	An external force involves an interaction between matter in the system and matter in the environment.
Internal Force	An internal force involves an interaction between two bodies that are in the system.
Particle	A particle is chunk of matter of fixed identity that is infinitesimal in size.
Moment (a,k.a. torque)	A torque (a.k.a. moment) is a tendency of a force to rotate a body about an axis.

TIPS

1	Sketch your free body isolated from the system. Rationale: provides clear distinction between system and environment.
2	Be purposeful about selecting a particle (infinitesimal in size) or a system (finite in size which means larger than infinitesimal). Rationale: for a particle, dimensions don't need to added; for a finite system, dimensions are needed.
3	Make large sketches that are easy to read. Use clear labels. Use meaningful subscripts. Rationale: makes problem solving easier plus another engineer can follow your work.
4	Train yourself to follow a step-by-step process. Rationale: over time you will easily succeed on nearly every problem you encounter regardless of whether it is fluid mechanics, solid mechanics. You are on your way to becoming an "engineering rock star." Whoooo Hooooo!
6	Train yourself to recognize each force as "a push/pull of A on B." Example: Force O_x is a push of pin in the gate. Rationale: increase your physical insight.