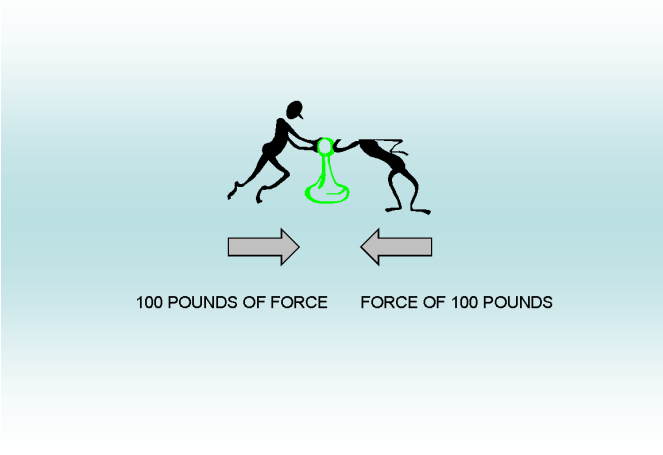
A STUDY in FORCE

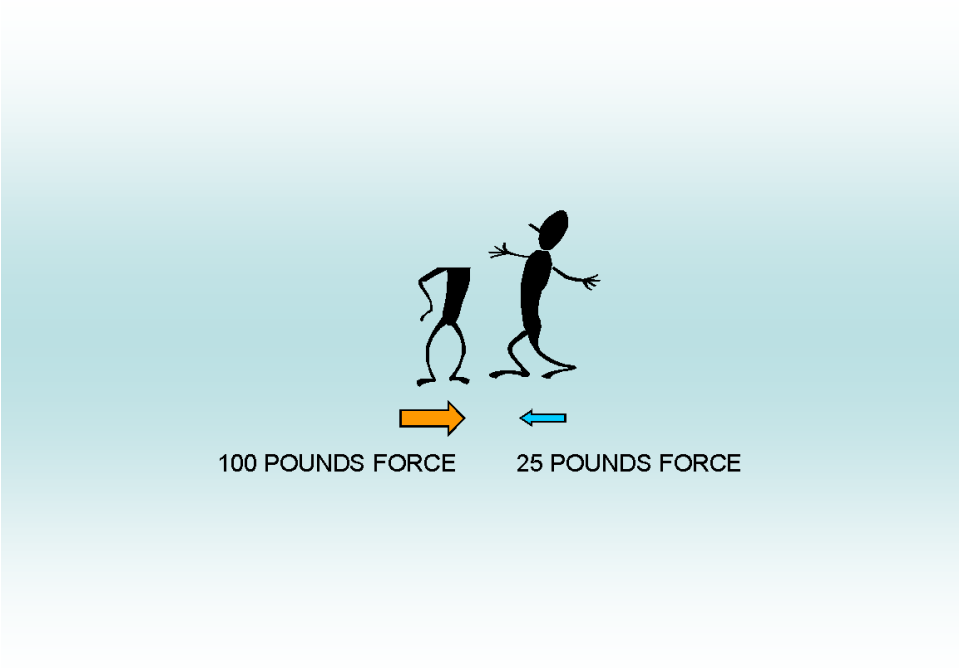
The go-kart will undergo many forms of force or stress. Some forces are good and some... well... not! How you design your vehicle to "anticipate" unwanted forces can be a good predictor of performance and safety. In simple terms, force can be...

a push or pull

Forces can come all directions and react in any number of actions. On a system, forces are moving about and cancelling each other out or causing movement. You sitting in a chair... you are exerting a downward force, but the chair is also exerting an equal upward force. If the chair did not do this, you would sink into the chair. Even though there is a downward force of "x" pounds and an upward force of "x" pounds, the "net-force" on the system is zero, since they cancel each other out.



However, if the forces are not equal, you have movement, and the net-force is no longer zero. The net-force in the panel below is 75 pounds to the right.



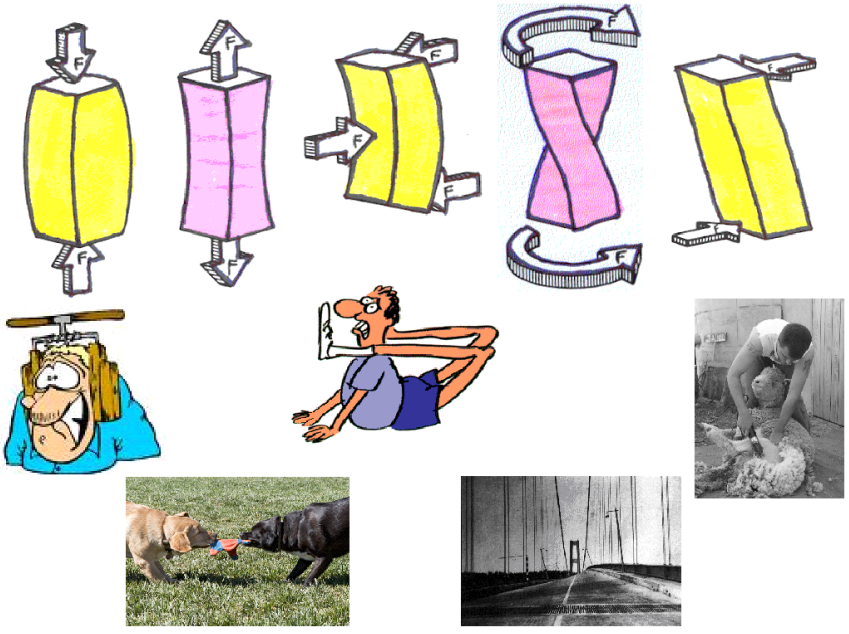
If this is the case, forces can cause "things" to happen. Below is such a scenario. A poorly designed vehicle T-Boned another vehicle, and this is the result. Notice the four 1/2" tubes of the forward part of the frame protruding towards nothing. They do not connect to anything. They just flop about during a rally. You can see one of them ending by the spectator's hand. What happened to the other car?

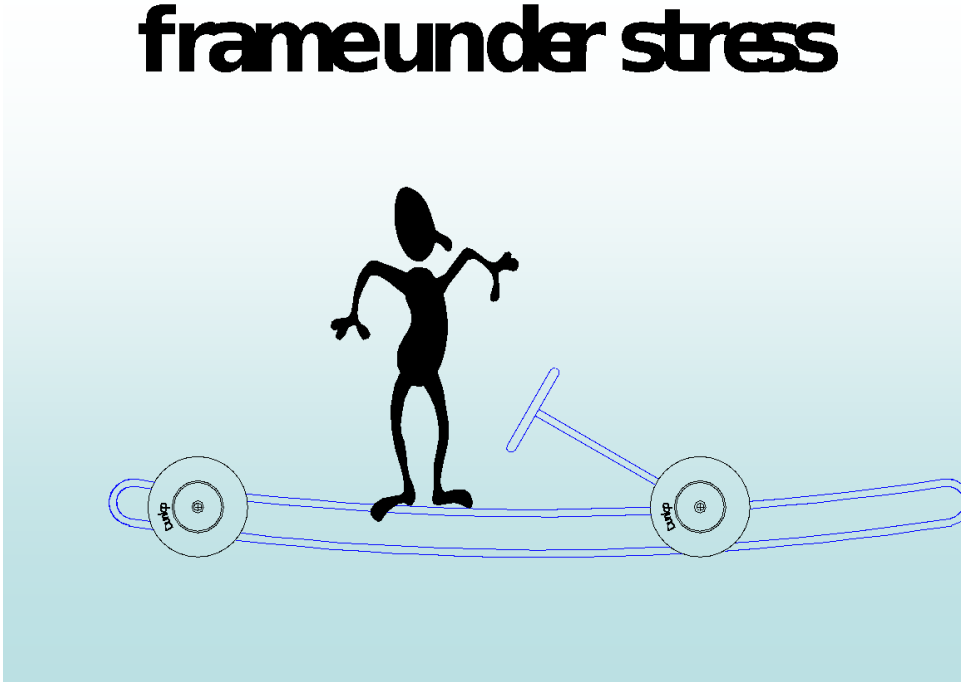
The "other" car is below. It sustained minimal damage. The Hawaiian car was traveling at 40 mph when it hit the Oregon car traveling about 10 mph. If you look closely, the damage consist of lifting the battery mount a little, bending the tie-rod, and a denting the body near the front wheel. Even though the Hawaiian car had more momentum, the difference in damage and forces applied are apparent. For movement to happen there must be sufficient force to overcome the resistance of that movement. If you weigh enough, you can exert enough force to cause the chair to move when you sit in it. If you do not weigh enough, your force has not overcome the force the chair is exerting... no movement. In the Oregon car's case, the 3/4" frame requires a certain amount of force to cause it to bend. The Hawaiian car did not impart enough force to bend the Oregon car, but it did submit enough force to cause its own demise.

There are different forms of stress, and they all respond in different manners. How you design the vehicle is really an in depth exercise of trying to minimize unwanted movement. For anything to move, such as a frame, requires energy. You only have so much energy available to you to propel you through the rally. Every time your electric vehicle rattles, squeaks, rumbles, shakes, and bends over the many potholes, you are robbing your vehicle of precious energy. This includes fishtailing, skidding, and burning rubber. Stress is relative. Stresses; they depend upon your point of view, how you deal with them, and what implications are if you ignore them. You can build your car so stiffly that it is indestructible, but at what cost will this be? A heavy kart requires more energy to operate. If you can predict what kinds of stresses you will be dealing with, you can design a simple, light-weight, efficient go-kart that will resist unwanted movements.

Stress..... find a way to deal with it.

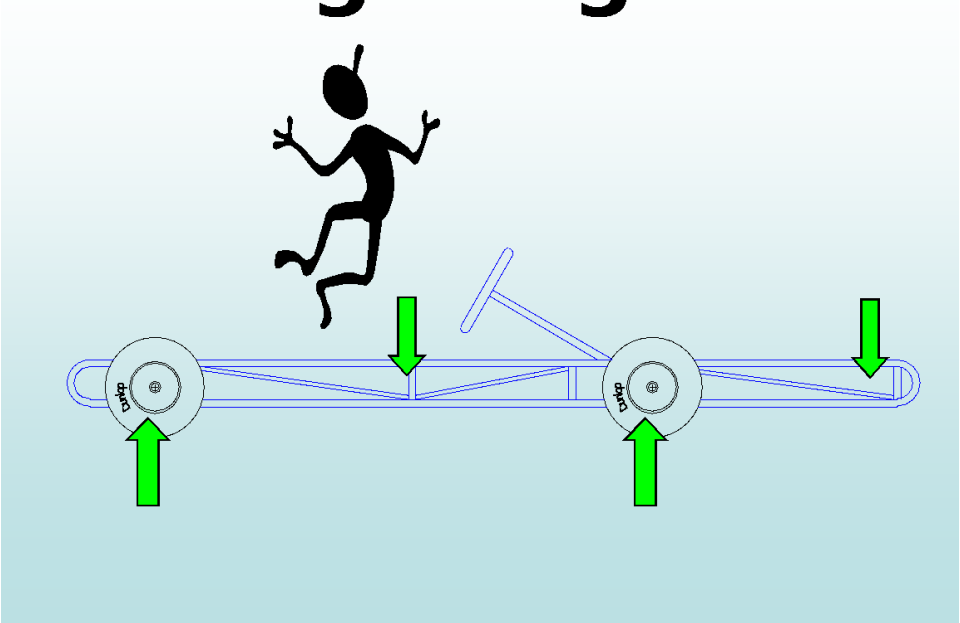
These are the five common stressors you will have to work with or against in any mechanical system. It is common for more than one stressor to act on a component at the same time. From left to right: Compression, Tension, Bending, Twisting, and Shearing. These stressors can also cause objects to move, accelerate, change direction, change shape, and stop.





If there is enough force implied, movement of some sort will occur. There are ways to resist or deal with stress. Some ways are better than others.

Adding triangulation



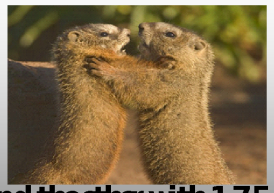
The triangle is the strongest shape you can incorporate into your vehicle. It is extremely important to understand how the triangles are to be developed. Direction is imperatively important. Think of pushing a rope versus pulling. You can't push a rope... it bends. The same is true of triangulation. Import substructures to work under "tension" to increase a component's strength. If the triangulation tubing on the frame is large enough and under "compression", sure, it will not bend... but the go-cart will weigh more than necessary.

QUIZ

1. What is a 'force'

2. What four things Can a forcedo?

3. If two prairie dogs are Pushing against each other (one with 2.0 pounds to the left and the other with 1.75 pounds to the right), what is the net force and direction?



4. Are the forces the prairie dogs exerting in balance or not?

ANSWERS

1. A force is a push or pull.

2. A force can cause movement or acceleration.

A force can cause a change of direction.

A force can cause the shape of an object to change

4. No, the prairie dogs' forces are not in balance since both exert different forces, and because there is movement.

ASSIGNMENT: I want you to find one example of each stressor in/on your electric go-kart. Identify the stressor, the component, and the condition under which it exist. I also want you to find one component that is undergoing more than one stressor at a time and its condition.

Compression:

Tension:

Bending:

Twisting:

Shearing:

Multiple Stressor: