Tenets of Static Equilibrium
(aka. Structural Zen)

1) sum of forces = 0 ($\sum F = 0$)
2) sum of moments = 0 ($\sum M = 0$)

Steps Required To Solve Statics Problems
(using the Tenets of Static Equilibrium)

1) Draw a free-body diagram of the problem
2) Draw all known forces (i.e. actions)
3) Draw all unknown forces (i.e. reactions)
4) Apply the 1st tenet (sum of forces=0)
5) Apply the 2nd tenet (sum of moments=0)
6) Solve for unknown forces

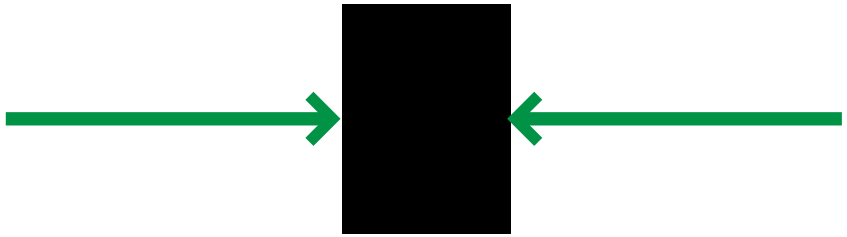
(Note: Problems that can be solved with these steps are called “statically determinate”)

Tenets of Static Equilibrium (aka. Structural Zen)
so far just one:

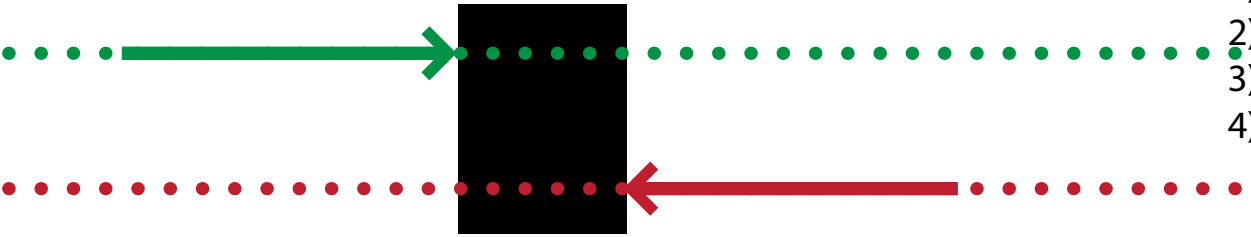
1) sum of forces = 0 ($\sum F = 0$)

Line of Action (of a force)

So we're ok with this.



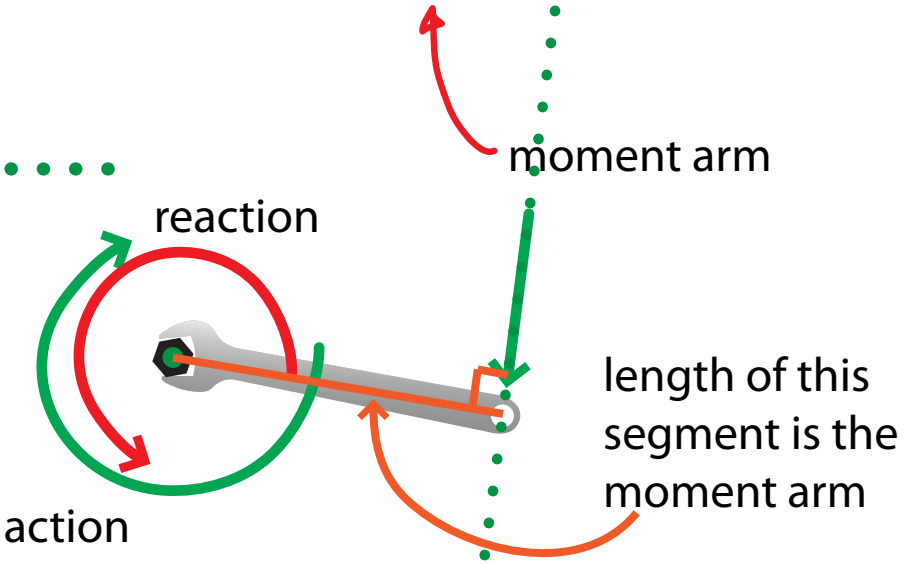
But what about this?



What happens to this object?

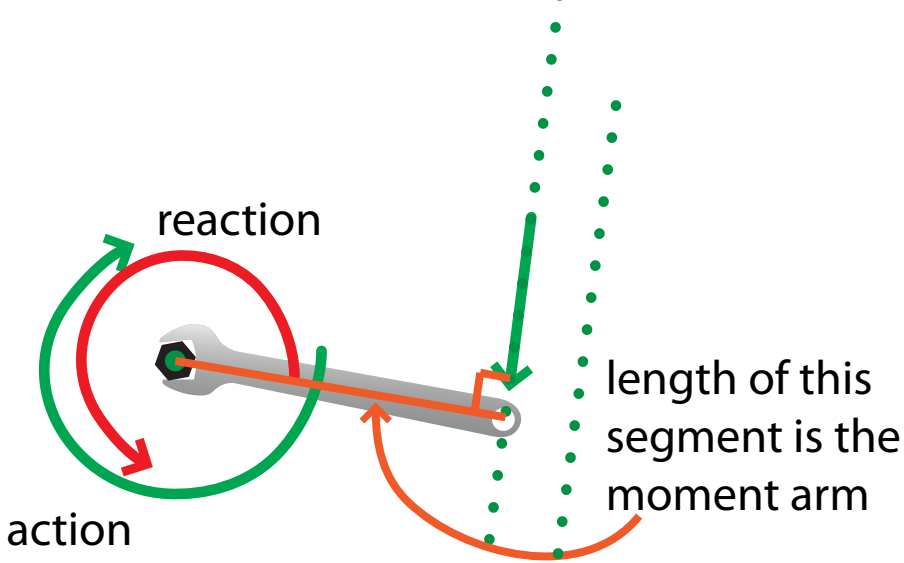
The Moment of a Force

Definition: $M = Fd$

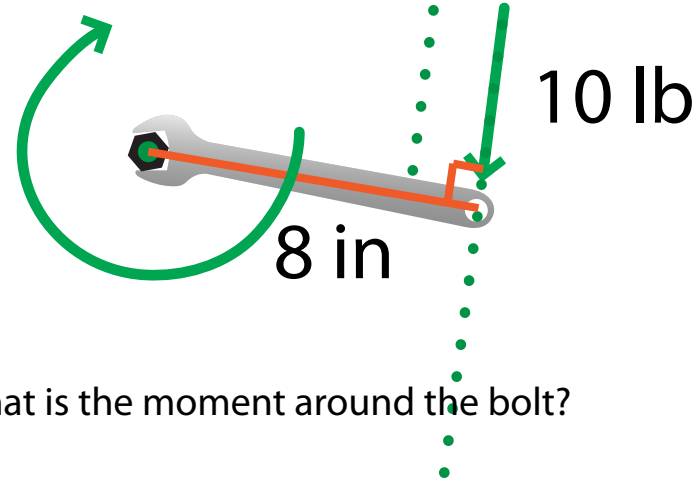


Moment of a Force needs:

1) a force
2) moment arm
3) point of rotation
4) direction of rotation
(either clockwise or counter-clockwise)



$M = Fd = 80$ in·lb clockwise

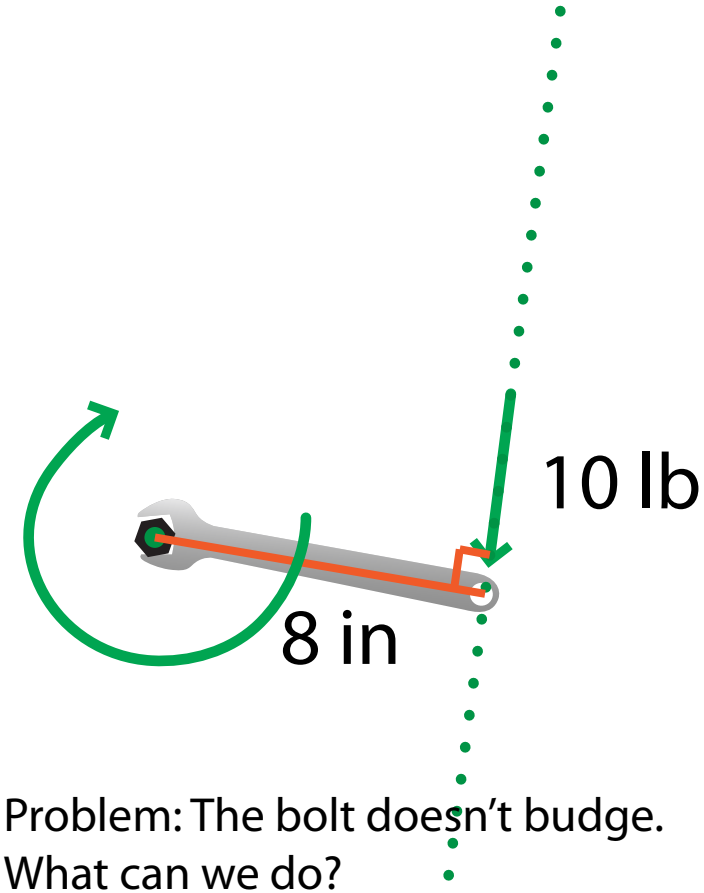


What is the moment around the bolt?

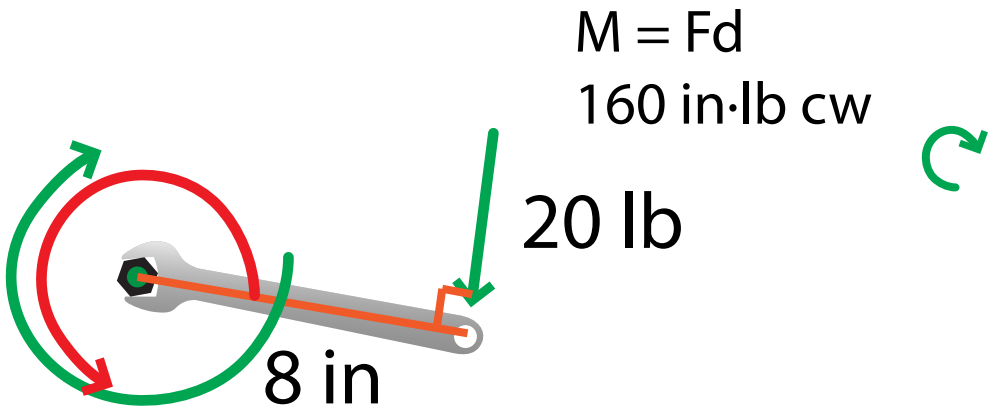
Units for moment
in·lb (divide by 12 to get ft·lb)
ft·lb (multiply by 12 to get in·lb)

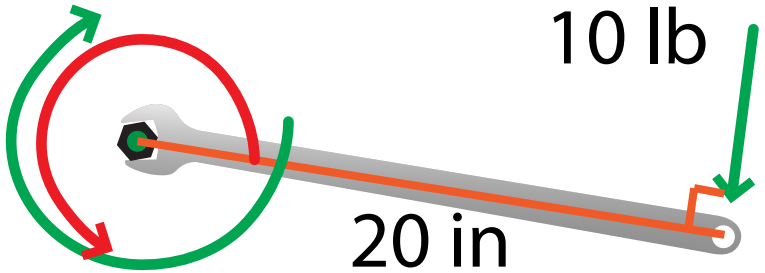
1000 lb = 1 kip
k·ft

$\sum F = 0$ means $F + F + F + F + \ldots = 0$
$\sum M = 0$ means $Fd + Fd + Fd + Fd + \ldots = 0$

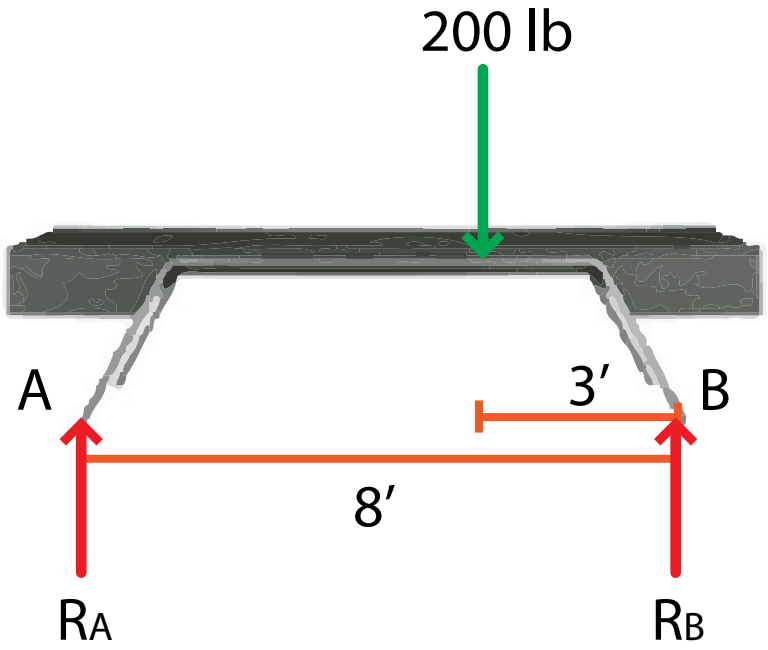


Problem: The bolt doesn't budge.
What can we do?
1) push harder (increase the force)
2) get a bigger wrench (increase the moment arm)





M = 200 in·lb cw



$\Sigma F = 0$ ↓ - ↑ +

$-200\ lb + R_A + R_B = 0$

$\Sigma M = 0$ ↻ - ↺ +

1) Choose a point of rotation

If we choose B:

$M_A = R_A(8')$

$M_B = R_B(0') = 0\ ft{\cdot}lb$

2)Apply the equation

$M_A + M_B + M_{DUDE} = 0$

↻ - ↺ +

$-R_A(8') + 0 + (200\#)(3') = 0$

$-8'{\cdot}R_A + 600\ ft{\cdot}lb = 0$

$-8ft{\cdot}R_A = -600\ ft{\cdot}lb$

$R_A = 75\ lb\ up$

After plugging back in to the original $\Sigma F=0$ equation.

$R_B = 125\ lb\ up$