2008 Heavy Duty Truck Rally

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HOW TO BUILD YOUR OWN BED

How To Build Your Own Bed

- Design Considerations
  - Load Balance
  - Features
  - Structure
- Fabrication
  - Ready Made Components
  - One-Off Components
- Lessons Learned
  - David Czetli
  - Henry Szymt

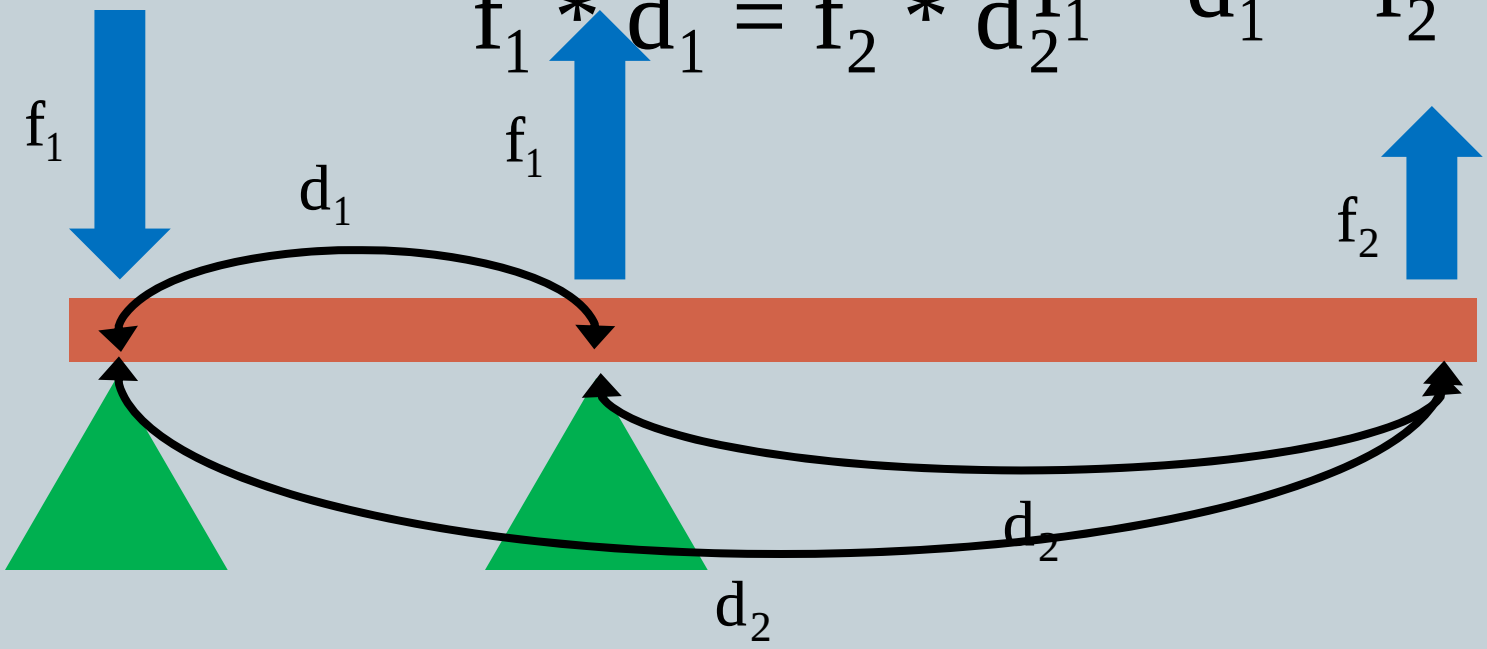
Load Balance

- Single Most Important Consideration is…
- What are the axle weights on the finished product?
  - With the trailer hooked up?
  - Running Bobtail?
- Step 1: Weigh the truck with a full load of fuel
- Step 2: Determine what you want for target weight
  - Excel Tool Available on RVNomad.com in the tools section

Load Balance

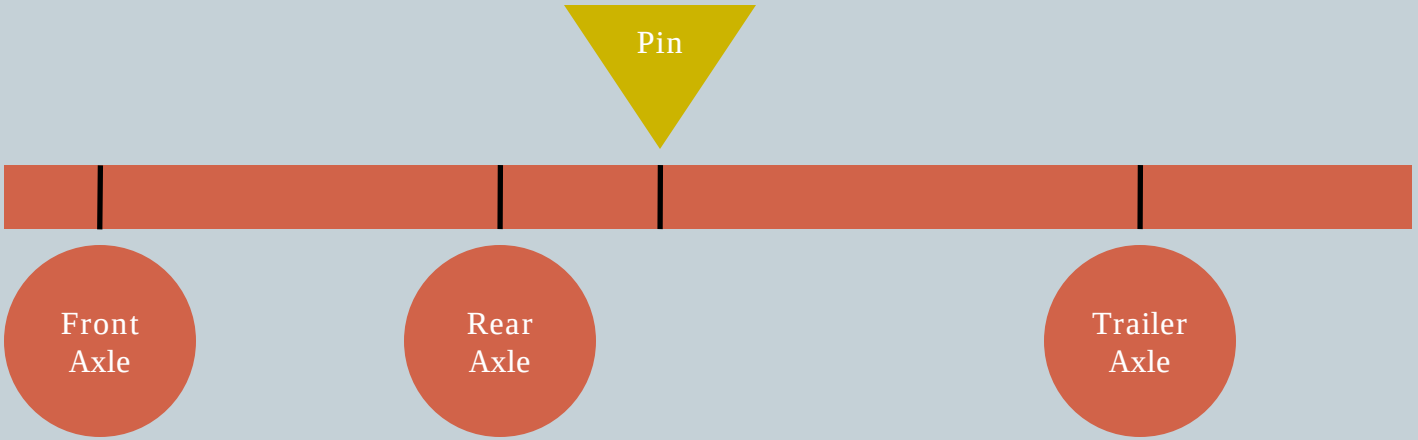
Load Balance – The Math

$$f_1 * d_1 = f_2 * d_2$$



The product of force, distance pairs on a lever are equal.
Forces on opposite sides of a fulcrum are in opposite directions.
Forces on the same side of a fulcrum are in the same direction.
Most of the time, we are solving for one of the forces.
So, if we are solving for f_1, $f_1 = (f_2 * d_2) / d_1$

Load Balance – The Math



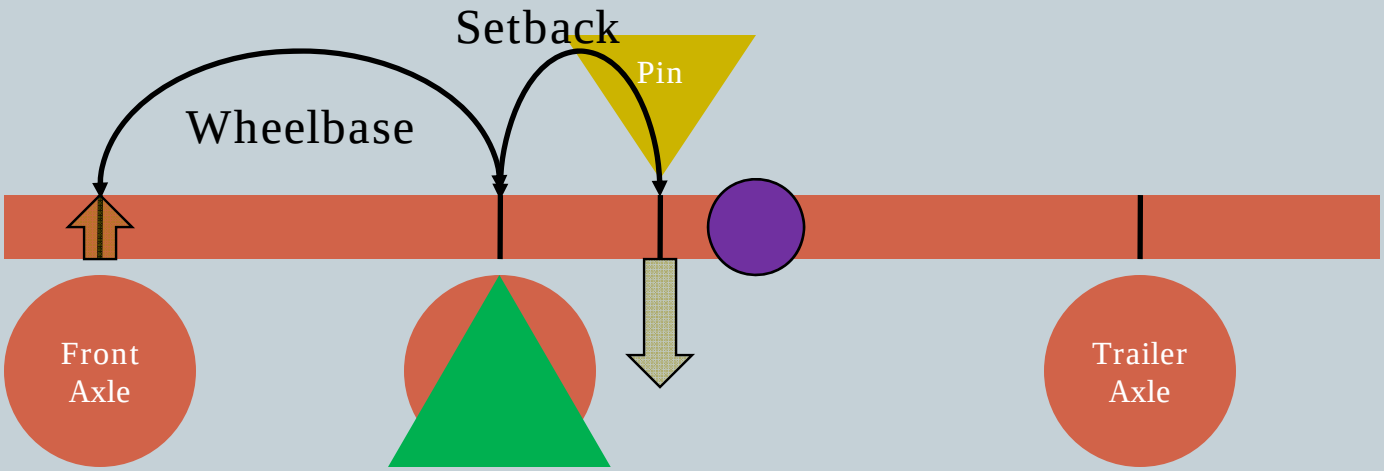
GCVW = Front Axle + Rear Axle + Trailer Axle

GVW_{Truck} = Front Axle + Rear Axle

$GVW_{Trailer}$ = Pin + Trailer Axle

Pin is weight is transferred to the Front Axle and Rear Axle

Load Balance – The Math - Pin



Rear Axle is the Fulcrum

Pin * Setback = f_{pin} * Wheelbase

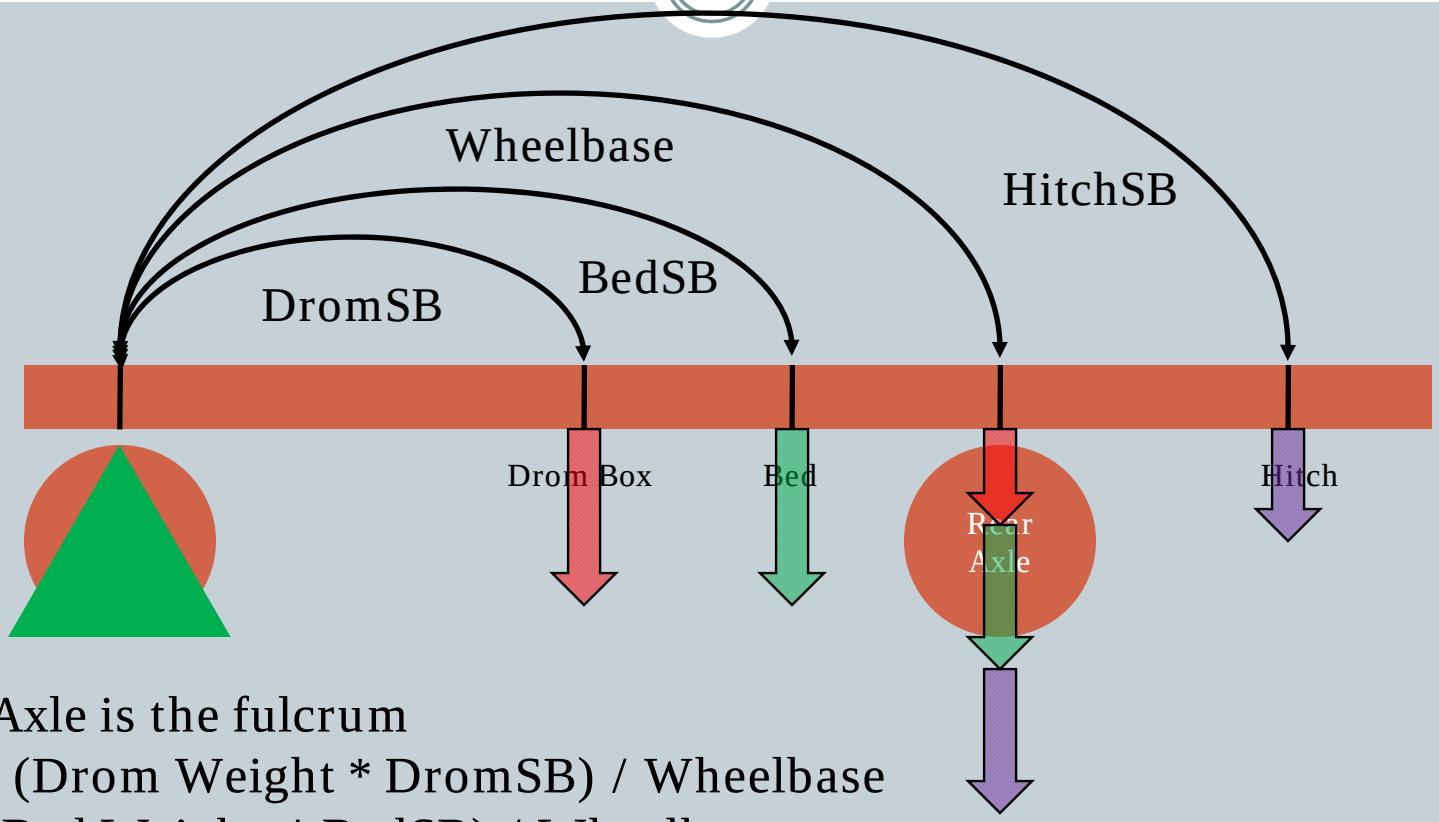
f_{pin} = (Pin * Setback) / Wheelbase

LFAW = UFAW - f_{pin}

LRAW = URAW + Pin + f_{pin}

GVW = LFAW + LRAW = UFAW + URAW + Pin

Load Balance – The Math – Rear Axle



Front Axle is the fulcrum

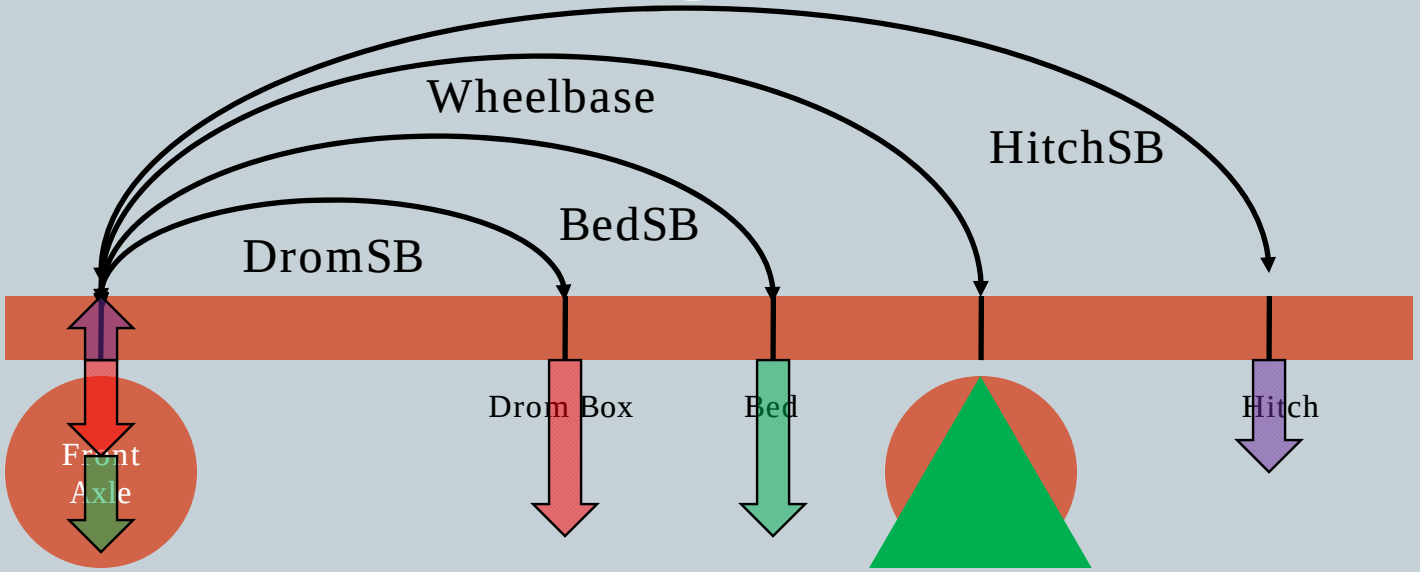
f_{Drom} = (Drom Weight * DromSB) / Wheelbase

f_{Bed} = (Bed Weight * BedSB) / Wheelbase

f_{Hitch} = (Hitch Weight * HitchSB) / Wheelbase

RAW_{Toter} = URAW + f_{Drom} + f_{Bed} + f_{Hitch}

Load Balance – The Math – Front Axle



Rear Axle is the fulcrum

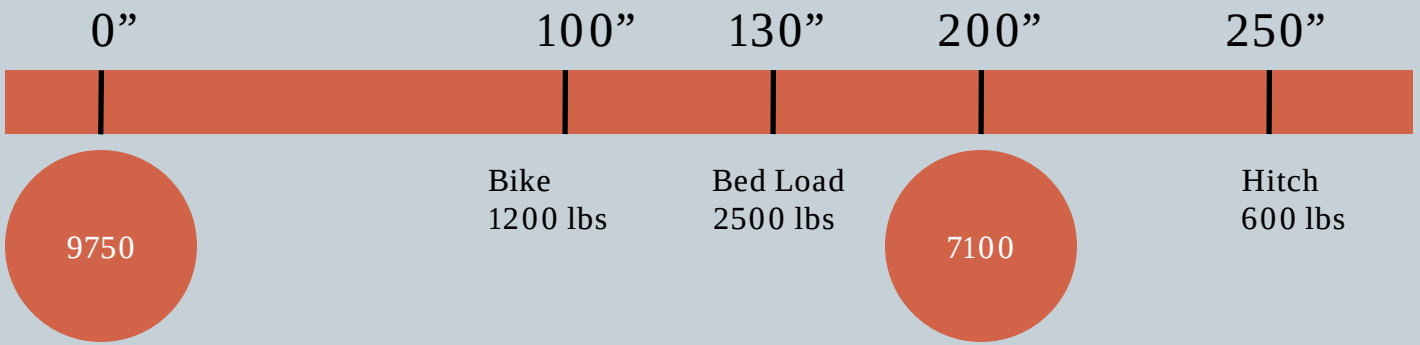
f_{Drom} = (Drom Weight *(Wheelbase – DromSB)) / Wheelbase

f_{Bed} = (Bed Weight * (Wheelbase – BedSB)) / Wheelbase

f_{Hitch} = (Hitch Weight * (HitchSB – Wheelbase)) / Wheelbase

FAW_{Toter} = UFAW + f_{Drom} + f_{Bed} – f_{Hitch}

Load Balance – Example 1



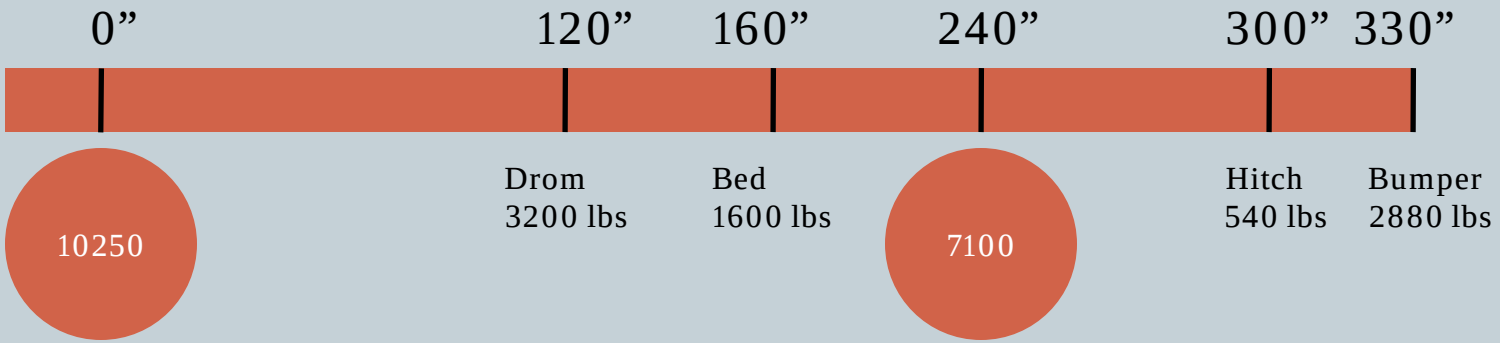
$f_{Bed} = (2500 * 70) / 200 = 875$
$f_{Bike} = (1200 * 100)/ 200 = 600$
$f_{Hitch} = (600 * 50)/ 200 = 150$

$f_{Bed} = (2500 * 130) / 200 = 1625$
$f_{Bike} = (1200 * 100)/ 200 = 600$
$f_{Hitch} = (600 * 250)/ 200 = 750$

RAW = 7100 + 1625 +600 + 750 = 10075

FAW = 9750 + 875 + 600 – 150 = 11075

Load Balance – Example 2



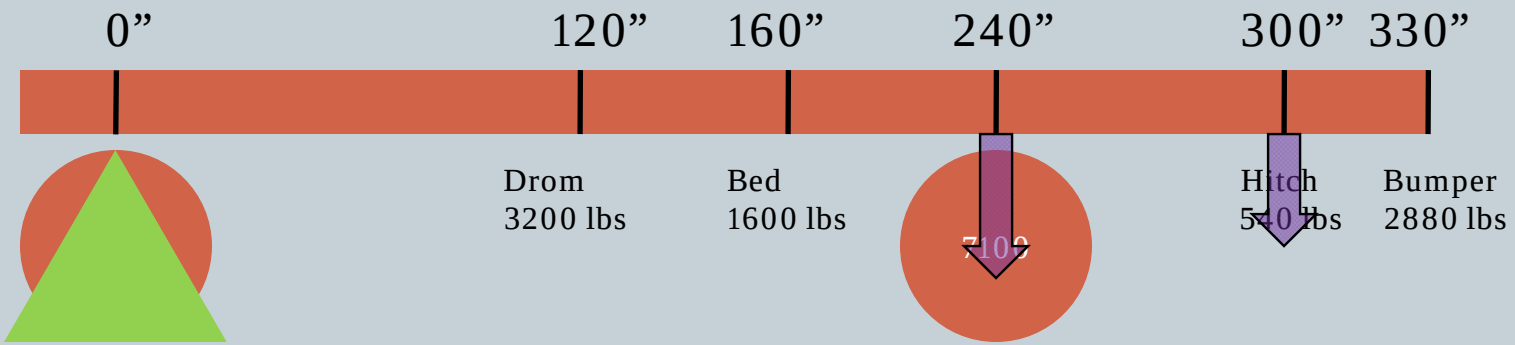
$f_{Bed} = (1800 * 80) / 240 = 600$
$f_{Drom} = (3200 * 120)/ 240 = 1600$
$f_{Hitch} = (540 * 60/ 240 = 135$
$f_{Bumper} = (2880 * 90)/240 = 1080$

$f_{Bed} = (1800 * 160) / 240 = 1200$
$f_{Drom} = (3200 * 120)/ 240 = 1600$
$f_{Hitch} = (540 * 300)/ 240 = 675$
$f_{Bumper} = (2880 * 330)/240 = 3960$

RAW = 7100 + 1200 + 1600 + 675 = 10575
FAW = 10250 + 600 + 1600 – 135 = 12315

RAW = 7100 + 1200 + 1600 + 675 + 3960 = 14535
FAW = 10250 + 600 + 1600 – 135 – 1080 = 11235

Calculate Max Pin Weight

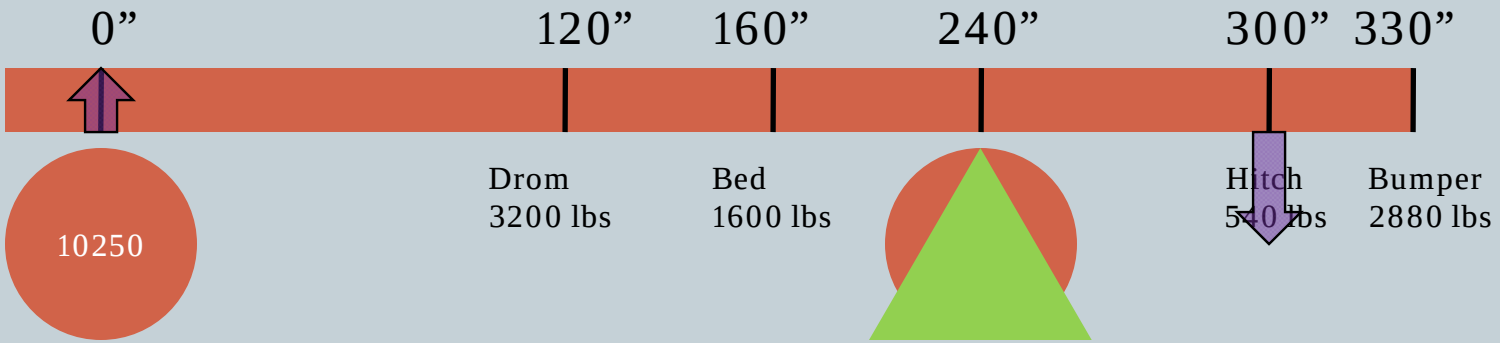


RAW = 14535, GAWR = 19900
FAW = 11235, GAWR = 12350

Available axle weight is 19900 – 14535 = 5365

$f_1 * d_1 = f_2 * d_2$
$f_1 * 300 = 5365 * 240$
$f_1 = (5365 * 240)/300$
$f_1 = 4292$
Assuming 20%-25%, Trailer Max is 17168-21460

Calculate Result on Front Axle



RAW = 14535, GAWR = 19900
FAW = 11235, GAWR = 12350
Pin = 4292

$f_1 * d_1 = f_2 * d_2$

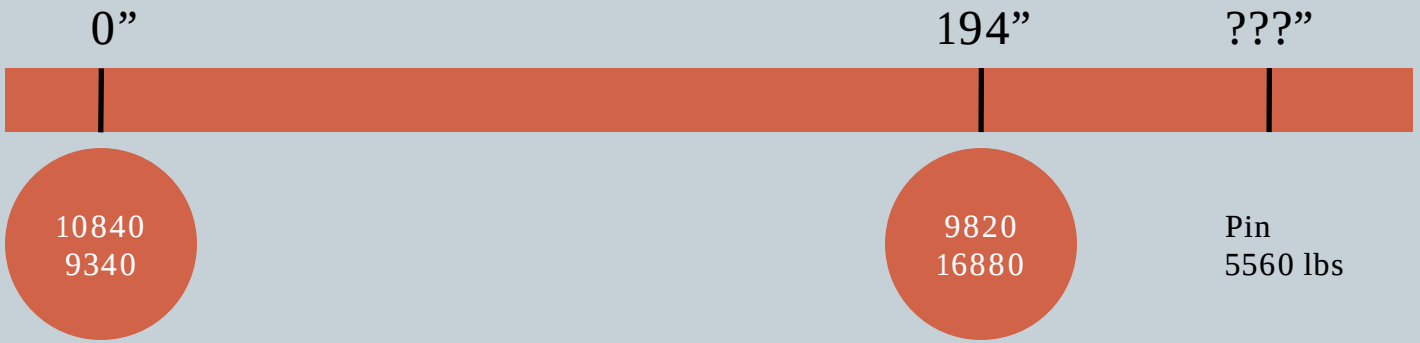
$f_1 * 240 = 4292 * 60$

$f_1 = (4292 * 60) / 240$

$f_1 = 1073$

$FAW_{LoadedToter} = 11235 - 1073 = 10162$

Prove using scale tickets



$f_1 * d_1 = f_2 * d_2$
$f_1 = 5560$, $d_1 = ???$
$f_2 = 7060$ (16880-9820), $d_2 = 194$

$d_1 = (f_2 * d_2) / f_1$
$d_1 = (7060 * 194) / 5560$
$d_1 = 246$, 52” behind the axle

Design Considerations

What Features Do You Want?

- Bed
  - Carry Stuff?
  - Add Weight?
- Drom Box
  - Tool Storage?
  - Satellite Dish Storage?
  - RC Helicopters?
- Support for 5th Wheel
- Standalone Motorhome
- Storage Boxes
  - Special Items – Cookery
  - Concert Organ with Footboard
  - MIG Welder w/ Tank
- Smart Car Loader
- Extended Boondocking
- Hitch
  - ET, ET TSR
  - TrailerSaver
  - BRP Head?

Major Design Considerations

- What wheelbase do you need?
  - Single or Dual?
  - If single, front, rear, some other?
- Where do you place the hitch
- What total length can you live with?

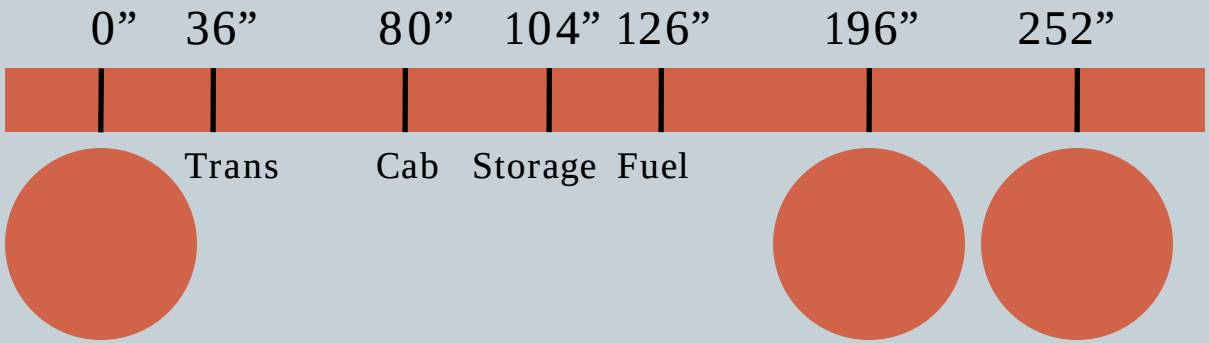
Secondary Design Considerations

- Mounting Techniques
  - Direct Bolt On
  - Brackets
  - Isolation Bushings
- Miscellaneous
  - Access to Fuel Fillers
  - Departure Angle Clearance
  - Rear Flat Tire
  - Cab Shocks and Air Bags
  - DOT Lights and Reflectors

Secondary Design Considerations

- One Piece
  - Installation and Removal requires heavy equipment
  - Minimizes storage box panels
  - Access to mounting points is difficult
  - Access to repair items is more difficult, adds $$$ to repair
- Modular
  - Allows for manual installation of parts.
  - More labor during fabrication.
  - Flexible structure
  - Removal of parts for repairs possible
  - More difficult final assembly

Design Consideration – Singling



f_{Trans} = (2500*(196-36))/196 = 2041
f_{Cab} = (3000*(196-80))/196 = 1776
$f_{Storage}$ = (400*(196-104))/196 = 188
f_{Fuel} = (1800*(196-126))/196 = 643

f_{Trans} = (2500*(252-36))/252 = 2143
f_{Cab} = (3000*(252-80))/252 = 2048
$f_{Storage}$ = (400*(252-104))/252 = 235
f_{Fuel} = (1800*(252-126))/252 = 900

Singling to the rear position transfers weight from the rear axle to the front axle.

In our example above: 678 lbs.

Design Considerations - Hitch

- Hitch (Applies to All Mfg)
  - Must be directly mounted to the truck frame.
  - Hitch Height needs to match trailer.
  - Usually needs to be mounted below the top flange of the frame.

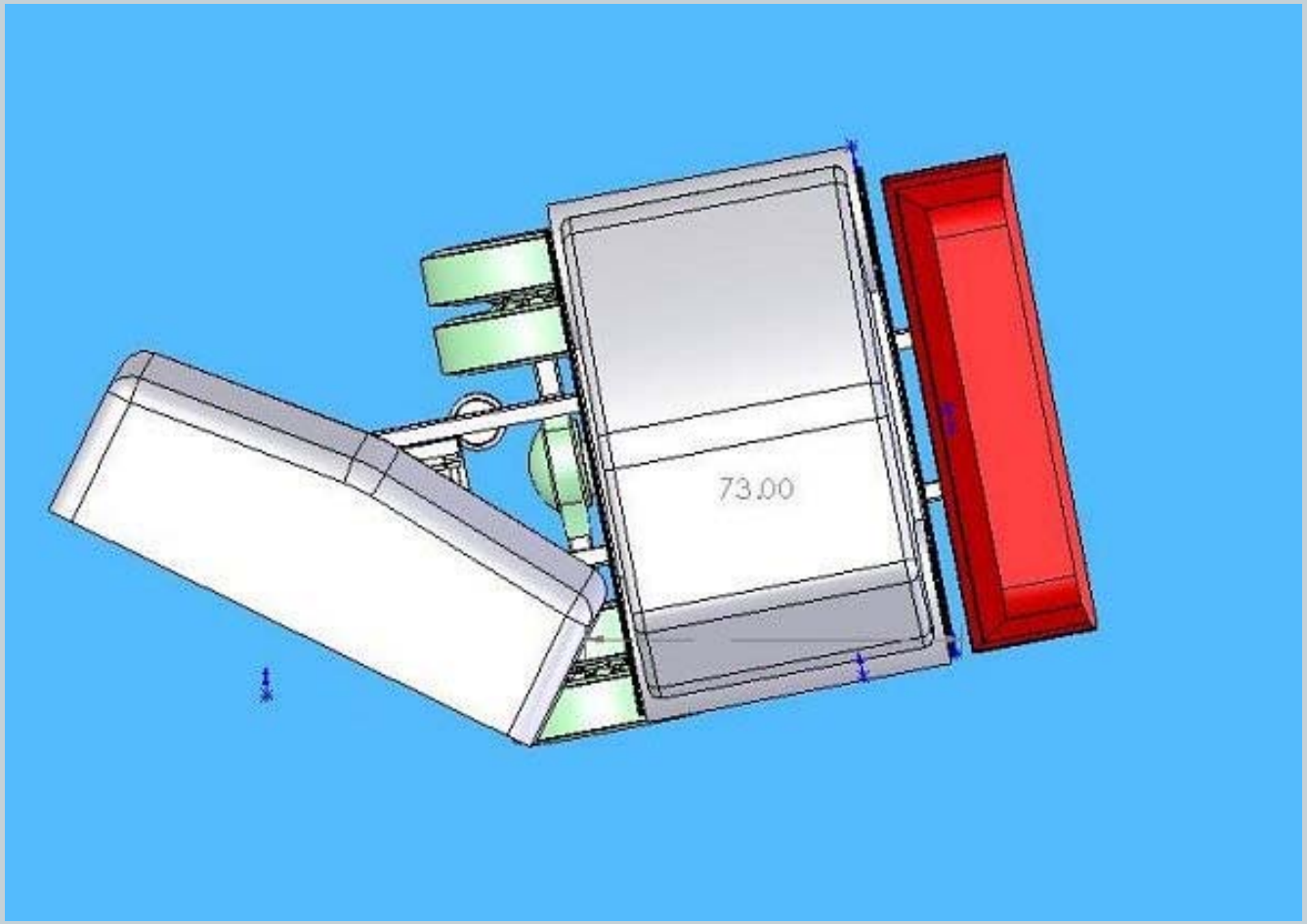
- Mounting Plate
  - Must be ½" full plate OR two pieces of 6" wide, ¾" plate.
    - Source - TrailerSaver mounting instructions
  - No drilling in frame flanges, only in the frame web.
  - No welding on frame in front of rearmost suspension mount point.

Hitch Placement

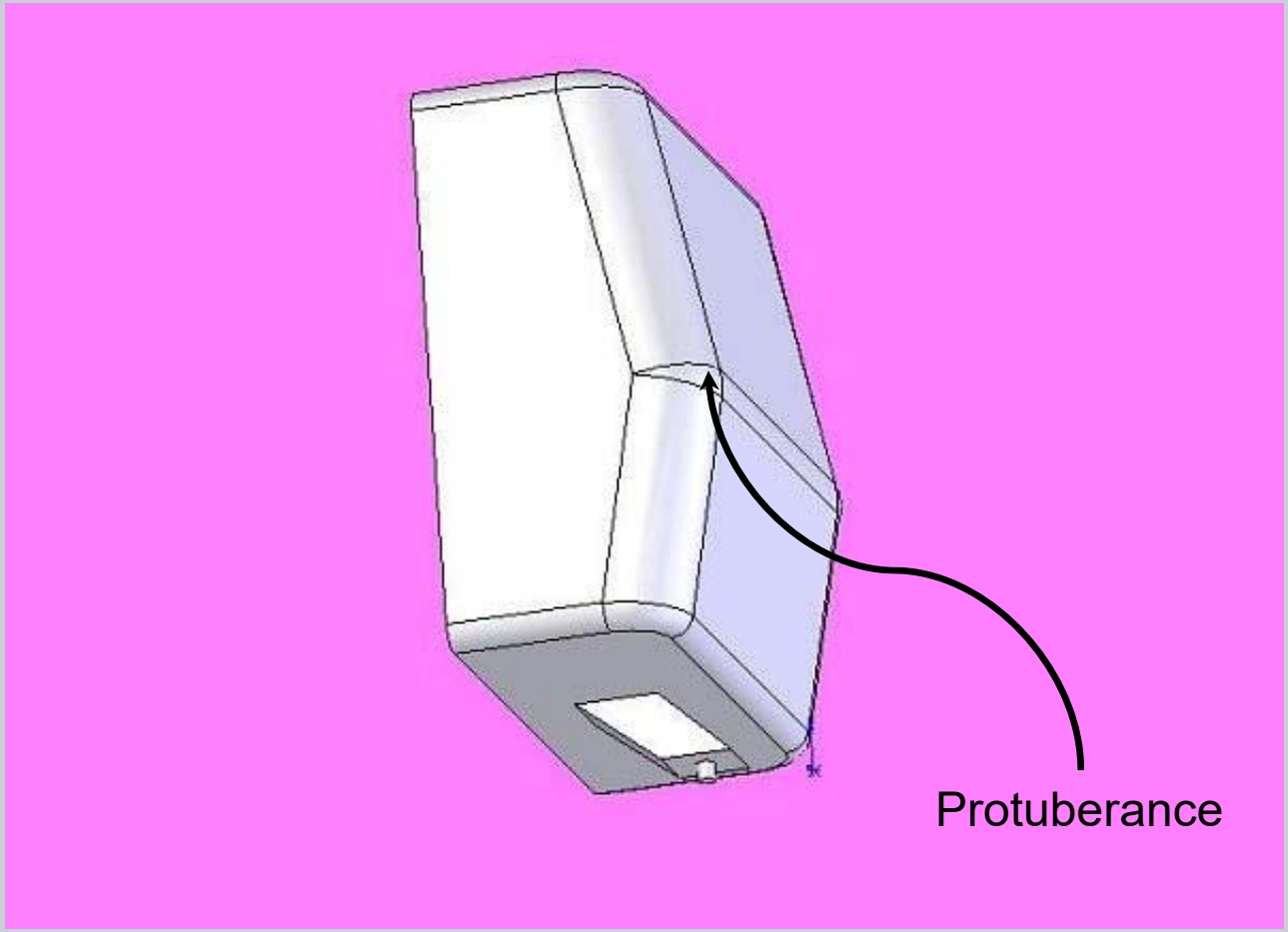
- Hitch placement affects:
  - Loaded axle weight
  - Turning Capability
    - Jack Knife
    - Campground backing
    - Urban maneuverability
  - Deck Utilization

- Hitch placement may require structural truck work
  - Air bag valve actuator arm
  - Frame cross members

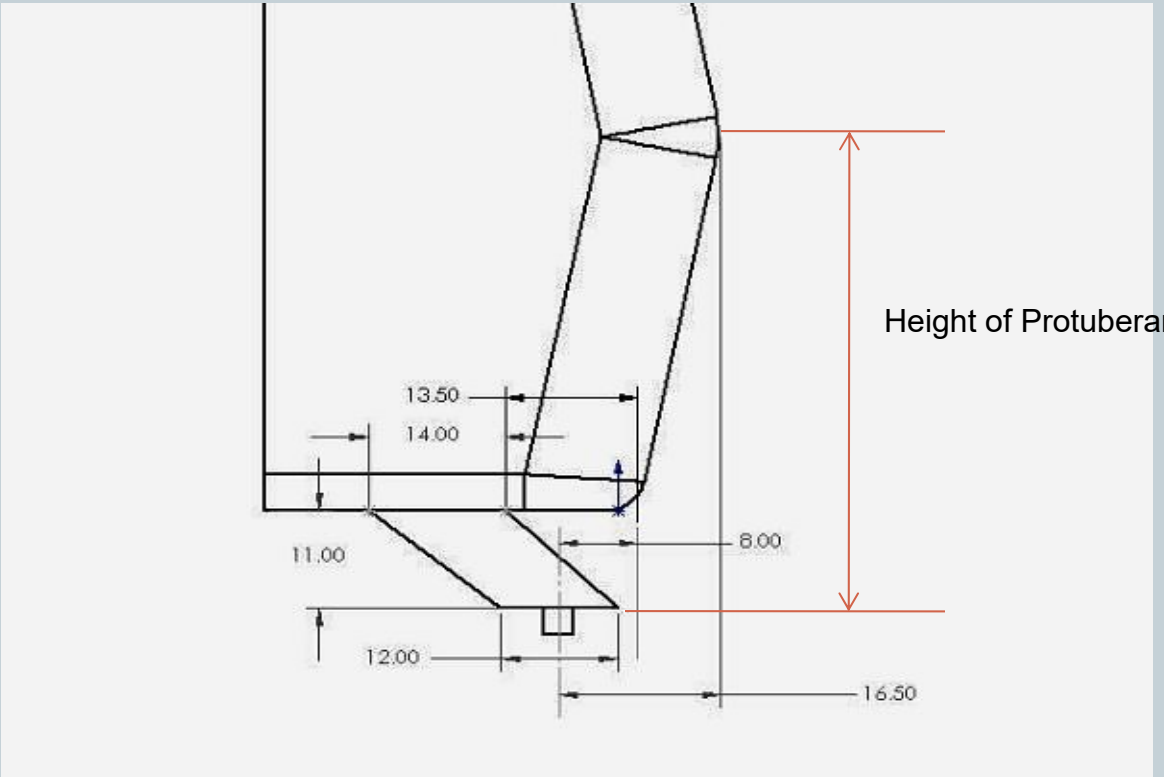
Hitch Placement – Avoid Jack Knife



Design Considerations - Hitch



Hitch Placement – Calculate Arc

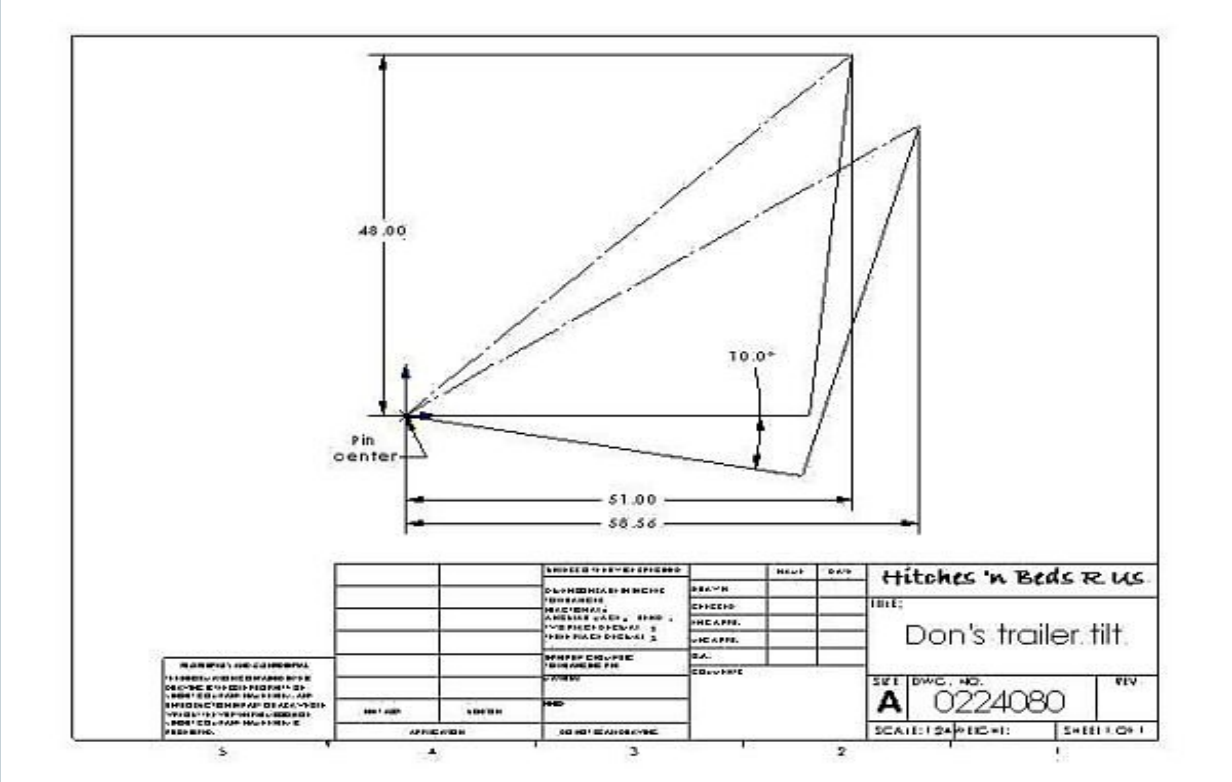


The distance from the furthest point is given by the Pythagorean equation.

$A^2+B^2=C^2$, A=16.5, B=51, therefore C=56.1

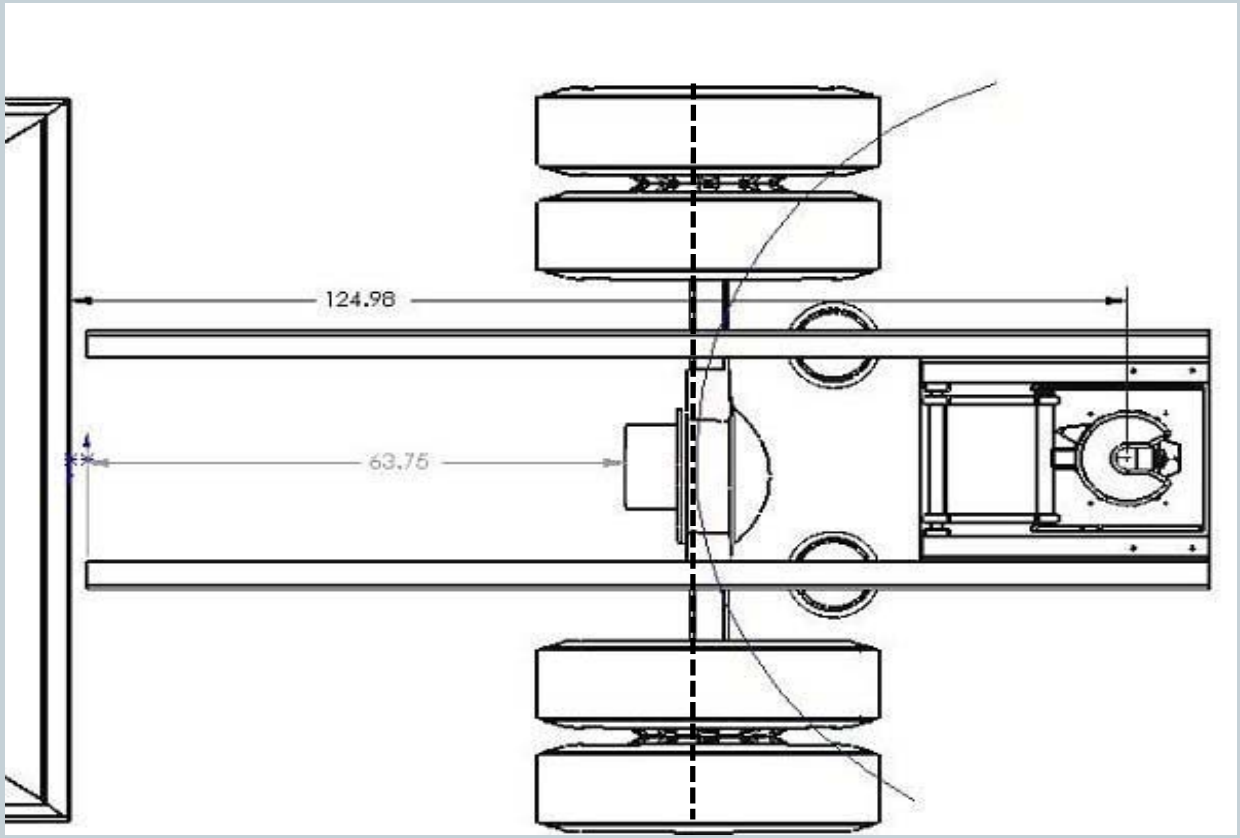
Always use 51 for “B”

Hitch Placement – Account For Dip



As the trailer and truck move off-angle, the cap of the trailer moves towards the truck as specified by Sin 10° * Height of Protuberance.
5° is trucking standard minimum. 10° covers just about every campground.

Hitch Placement – Useable Deck Space



Usable deck space is the area tangent to the Arc at it's midpoint.

Hitch Placement – Typical Installation

DOT and Your Bed

Do you need a DOT sticker ?

NO, But …

What do they actually care about ?

Safety Equipment

What's Wrong?