The Wheels

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FRS 106
The Art and Science of Motorcycle Design

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What is a wheel?

A wheel is “a circular object that revolves on an axle and is fixed below a vehicle or other object to enable it to move easily over the ground.”
Why do we need wheels?

- Two words: Friction and Leverage
- Before wheels — travois or frames
- These generate lots of friction and are difficult to push
- Therefore, the purpose of a wheel is to reduce friction and act as a lever to make it easier for an object to move from place to place
First function of the wheel - Reduce Friction

High friction, box is hard to move

Friction between wheels and axles is much lower so box is far easier to move

Friction gives outside edges of wheels grip on road
Bearings — the Point of friction

- Go on the axle
- Shown below (and what we use on the bike) are **ball bearings**
  with little metal balls between the outer and inner surface
- This design allows the wheels to spin with very little friction
- Need to “pack with grease” (but not too much)
Second function of the wheel - Provide Leverage

The wheel is a lever — apply more force at the center (blue), and you get more speed at the rim (red)

Force and speed are inversely related
Front Wheel

Rear Wheel
Sanding and Priming the hub

1. Puttying the hub to remove blemishes
2. Wet sanding to smooth surface
3. Multiple layers of primer required
Painting the hub

1. Black spray paint
2. Multiple layers of paint required
3. Special technique used
4. Professor Littman helped us finish over Spring Break!
   Thanks, Professor!
Lacing the Wheel

1. Short and long spokes correspond with different sides of the hub (short and long flange)
2. Spoke alignment and placing highly particular and tedious
3. Shorter spokes are threaded through the hub and secured with a nipple
4. Longer spokes are hooked onto the hub and secured with a nipple
Truing the wheel

1. Goals (2):
   a. Wheel must turn evenly (not shift left/right) on the truing stand
   b. Spokes must be secure and not poke out too far at the rim
2. To accomplish this, we spun the wheel and adjusted spokes in problematic spots
3. Eventually, too-long spokes were shaved off at the ends
Tightening the spokes and aligning the hub

**Vertical alignment**
- Tighten these
- Loosen these

**Horizontal alignment**
- Tighten these
- Loosen these
Pressing the bearings and axle in

1. Axle and bearing must be securely in place, which required a machine press
2. Customed a tool to press in evenly without damaging anything
Greasing the Bearings
Putting the tire on the wheel

1. One lip on at a time
2. Inner tube
3. Align nozzle with rim hole
4. Tire irons to finish the job
5. Don’t poke the inner tube!
What We Learned

- How to restore hubs (a lot of sanding, filling, sanding, priming, sanding, and painting)
- To figure out which side of the wheel hub is the long flange side and the short flange side, look to see where the spokes cross (high or low)
- Our spokes have left-handed threads (no longer righty tighty)
- To test if all the spokes are evenly tight, you can listen to see if they produce the same frequency of sound when struck
- To adjust the “trueness” of the wheel, you must tighten and loosen the spokes on the appropriate sides:
Needed Diameter for a One Spoke Wheel

- Weight of motorcycle = 200 lbs; Weight of rider = 200 lbs => Total combined weight = 400 lbs => 200 lbs/whee
- Spokes made of stainless steel with tensile strength of 73,000 psi (lbs/inch^2)
- Cross sectional area of spokes = (pi)(radius)^2
- Weight/tensile strength = minimum cross sectional area needed => 200/73,000 = 0.0027 in^2
- Needed diameter = 2(area/pi)^(½) = 0.06 inch diameter spokel

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F = mg = (200\text{lbs})(32\text{ft/s}^2)
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Thanks for a great semester, Professor Littman!
Sources

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https://bikebrewers.com/true-motorcycle-wheel/

https://www.shutterstock.com/search/motorcycle+cartoon?image_type=illustration