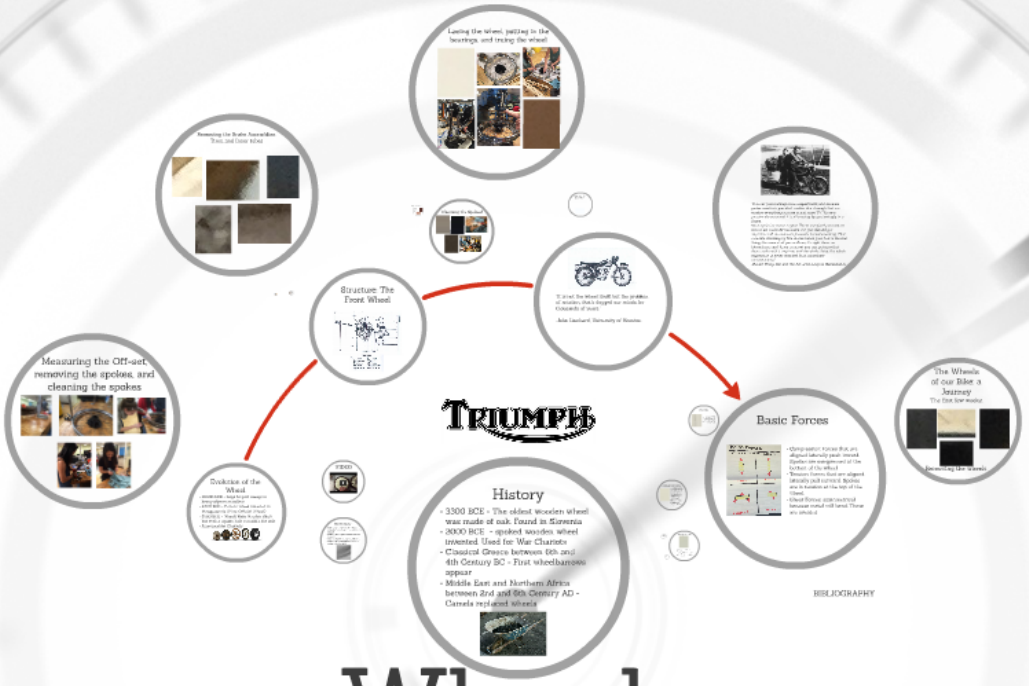
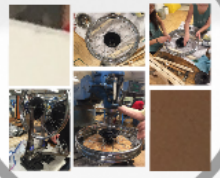


Wheels

Grace Cordsen, Aly Kersley, Qiyan (Jenny) Zhao

Wheels

Lacing the wheel, putting in the bearings, and truing the wheel

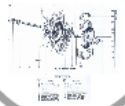


Removing the Brake Assemblies, Tires, and Inner tubes

Cleaning the Spokes!

"It is one piece always in a compartment, and because you're used to it you don't realize that through that one window everything you see is just more TV. You're a passive observer and it's all moving by you harmonically in a frame.
On a cycle the frame is gone. You're completely in contact with it all. You're IN the scene, not just watching it. Judgment, and the sense of pressure is overwhelming. That underside including all the bodies behind your head is the real thing. But some stuff you touch on. It's right there, so blurred you can't focus on it, but you can see your hand down and touch it anytime, and the whole thing, the whole conjunction is never lostsomed from introducing consciousness."
Robert Pirsig, Zen and the Art of Motorcycle Maintenance

Structure: The Front Wheel



"It is not the wheel itself, but the problem of rotation, that's dogged our minds for thousands of years."

-John Lienhard, University of Houston

Measuring the Off-set, removing the spokes, and cleaning the spokes

Evolution of the Wheel

- 10000 BCE - Logs helped transport heavy objects on sledges
- 4000 BCE - Potter's wheel invented in Mesopotamia (First Official Wheel)
- 3500 BCE - wheels were wooden discs but with a square hole in middle for axle
- Also used for Chariots

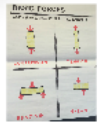
VIDEO

TRIUMPH

History

- 3300 BCE - The oldest wooden wheel was made of oak. Found in Slovenia
- 2000 BCE - spoked wooden wheel invented. Used for War Chariots
- Classical Greece between 6th and 4th Century BC - First wheelbarrows appear
- Middle East and Northern Africa between 2nd and 6th Century AD - Camels replaced wheels

Basic Forces



- Compression: forces that are aligned laterally push inward. Spokes are compressed at the bottom of the wheel
- Tension: forces that are aligned laterally pull outward. Spokes are in tension at the top of the wheel
- Shear Forces: asymmetrical because metal will bend. These are avoided

The Wheels of our Bike: a Journey

The first few weeks:

Removing the wheels

BIBLIOGRAPHY

Evolution of the Wheel

- 10000 BCE - Logs helped transport heavy objects as rollers
- 4000 BCE - Potter's wheel invented is Mesopotamia (First Official Wheel)
- 3500 BCE - wheels were wooden discs but with a square hole in middle for axle
- Also used for Chariots

History

- 3300 BCE - The oldest wooden wheel was made of oak. Found in Slovenia
- 2000 BCE - spoked wooden wheel invented. Used for War Chariots
- Classical Greece between 6th and 4th Century BC - First wheelbarrows appear
- Middle East and Northern Africa between 2nd and 6th Century AD - Camels replaced wheels

More History

- 1800s - Steam Locomotive Wheel (introduction of metal rims, with metal tracks)
- 1800s - Wire Spokes Introduced (our favorite!)
- 1920s - Steel Rims and Disc Wheels
- 1960s - Alloy Wheels introduced to reduce wheel weight

VIDEO

Structure: The Front Wheel

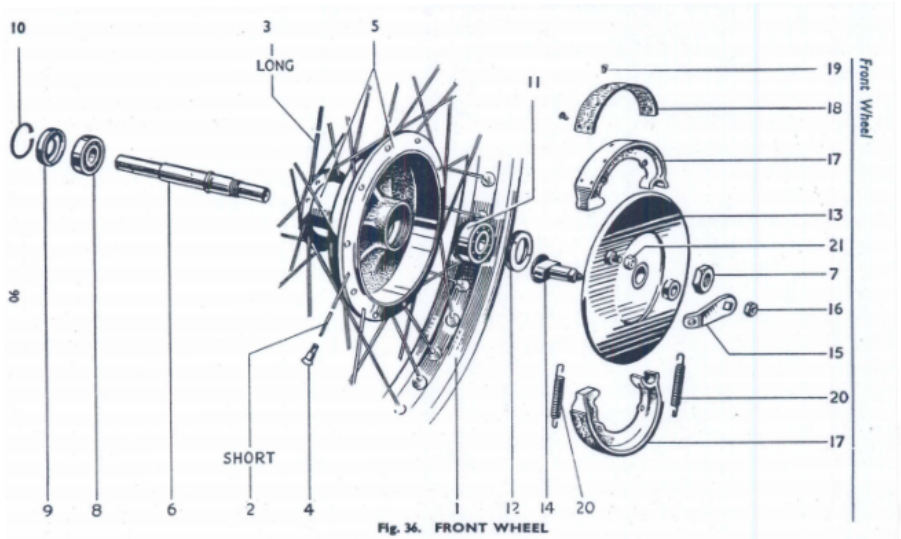


Fig. 36. FRONT WHEEL

INDEX TO FIG. 36

Index No.	Description.	Index No.	Description.
1	Rim, front wheel.	12	Ring, front wheel R.H. locking.
2	Spoke, right hand (short).	13	Plate, front brake anchor.
3	Spoke, left hand (long).	14	Cam, front brake.
4	Nipple, spoke.	15	Lever, front brake.
5	Hub and brake drum assembly.	16	Nut, front brake lever.
6	Spindle, front wheel.	17	Shoe, front brake c/w lining.
7	Nut, front wheel spindle.	18	Lining, front brake.
8	Bearing, front wheel L.H.	19	Rivets, front brake lining.
9	Dustcap, front wheel L.H.	20	Spring, front brake shoe.
10	Circlip, front wheel L.H.	21	Nut, front brake anchor.
11	Bearing, front wheel R.H.		

Structure: The Rear Wheel

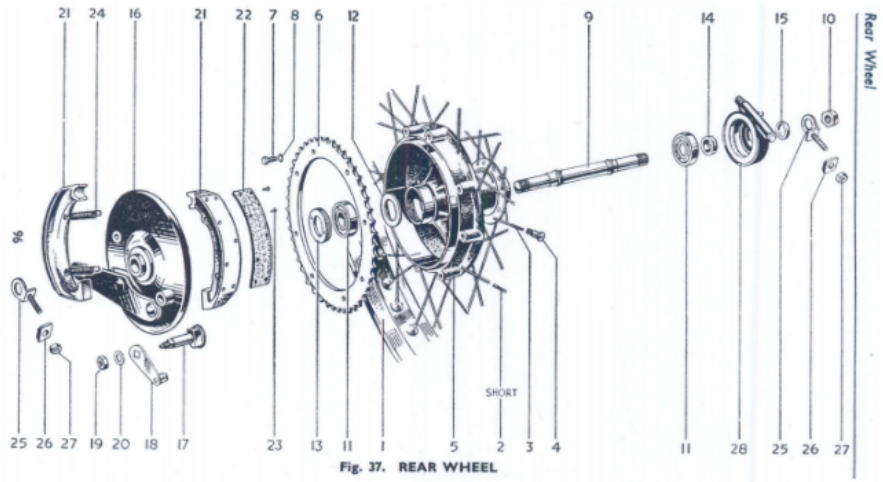


Fig. 37. REAR WHEEL

INDEX TO FIG. 37

Index No.	Description.	Index No.	Description.
1	Rim.	15	Distance piece, R.H. outer.
2	Spoke, L.H. (short).	16	Plate, brake anchor.
3	Spoke, R.H. (long).	17	Cam, brake operating.
4	Nipple, spoke.	18	Lever, brake operating.
5	Hub and brake drum.	19	Nut.
6	Sprocket (54 teeth).	20	Washer.
7	Bolt, sprocket fixing.	21	Shoe, rear brake c/w lining.
8	Washer, spring.	22	Lining, brake.
9	Spindle.	23	Rivet, brake lining.
10	Nut, spindle.	24	Spring, shoe return.
11	Bearing.	25	Adjuster, chain.
12	Ring, bearing backing.	26	Cap, chain adjuster.
13	Ring nut, L.H. bearing.	27	Nut.
14	Distance piece, R.H. inner.	28	Gearbox, speedometer drive.

"In a car you're always in a compartment, and because you're used to it you don't realize that through that car window everything you see is just more TV. You're a passive observer and it is all moving by you boringly in a frame.
On a cycle the frame is gone. You're completely in contact with it all. You're IN the scene, not just watching it anymore, and the sense of presence is overwhelming. That concrete whizzing by five inches below your foot is the real thing, the same stuff you walk on, it's right there, so blurred you can't focus on it, yet you can put your foot down and touch it anytime, and the whole thing, the whole experience, is never removed from immediate consciousness."
-Robert Pirsig, Zen and the Art of Motorcycle Maintenance

The Wheels of our Bike: a Journey

The first few weeks:



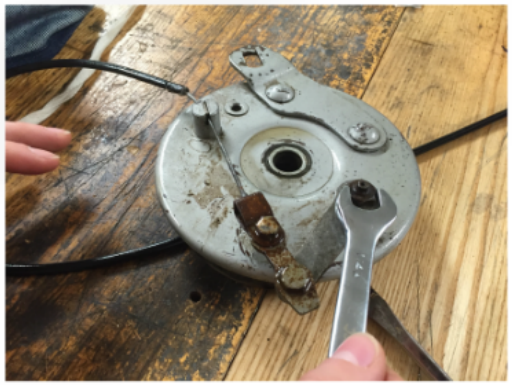

Removing the wheels

Once the wheels are removed from the bike it's time to start taking them apart!

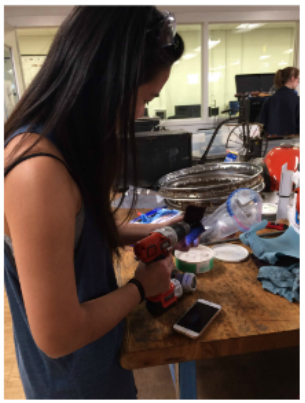


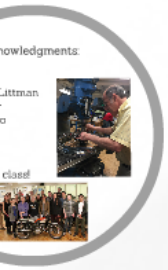



Removing the Brake Assemblies, Tires, and Inner tubes

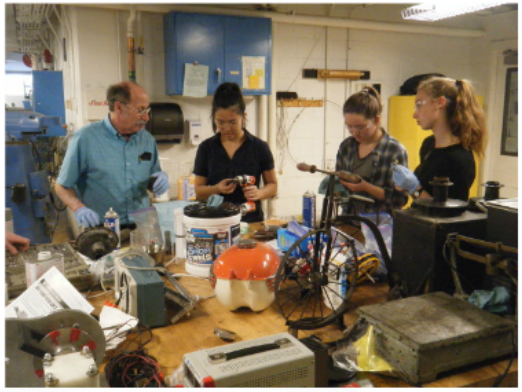


Measuring the Off-set, removing the spokes, and cleaning the spokes

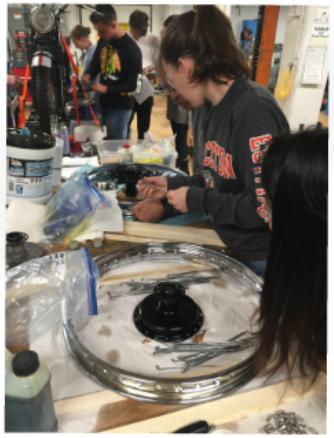




Cleaning the Spokes!!



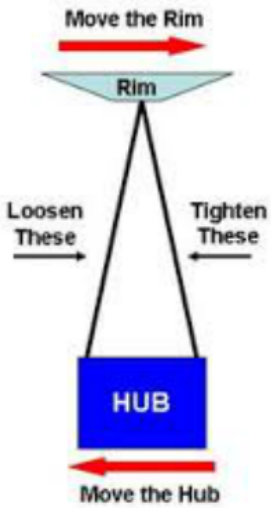
Lacing the wheel, putting in the bearings, and truing the wheel

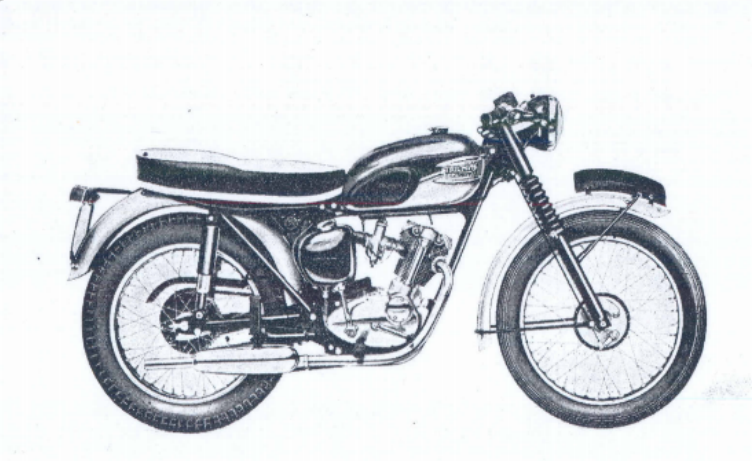





Truing the Wheel

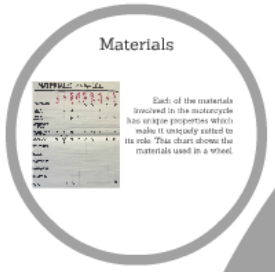
Truing a wheel involves loosening and tightening the spokes so that the rim moves laterally or concentrically until it spins smoothly.



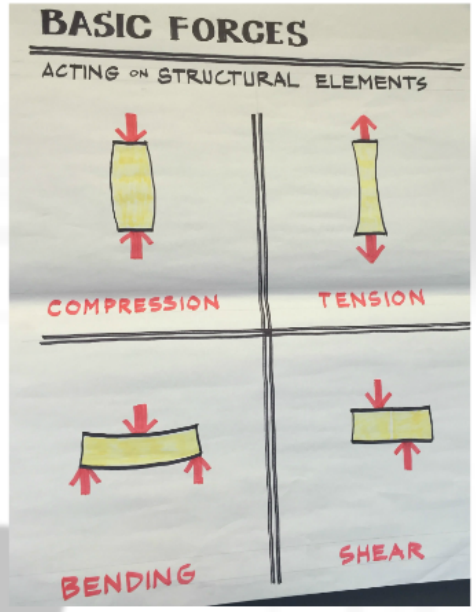


"It is not the wheel itself, but the problem of rotation, that's dogged our minds for thousands of years."

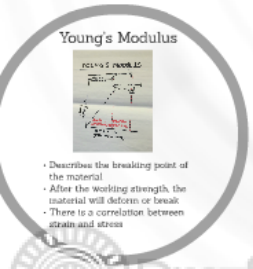
-John Lienhard, University of Houston



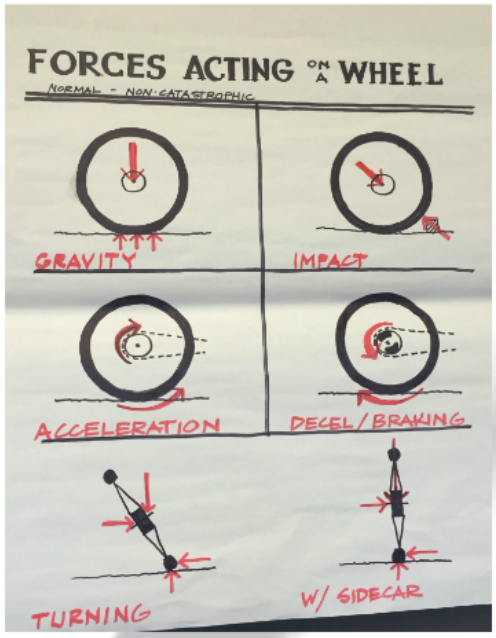
Basic Forces



- Compression: forces that are aligned laterally push inward. Spokes are compressed at the bottom of the wheel
- Tension: forces that are aligned laterally pull outward. Spokes are in tension at the top of the wheel.
- Shear Forces: asymmetrical because metal will bend. These are avoided

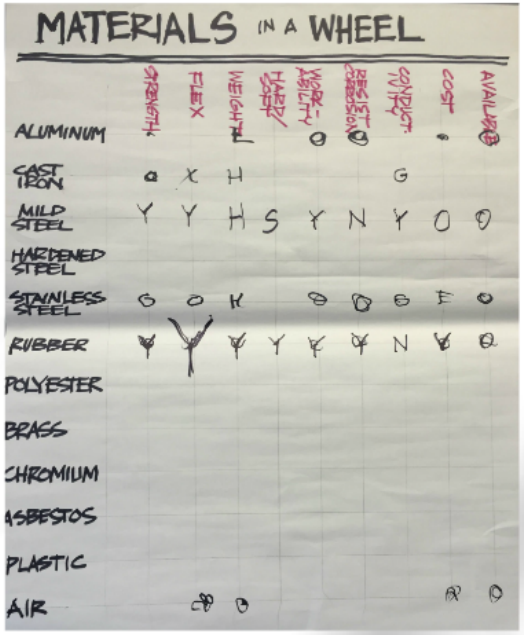


Forces on the Wheel



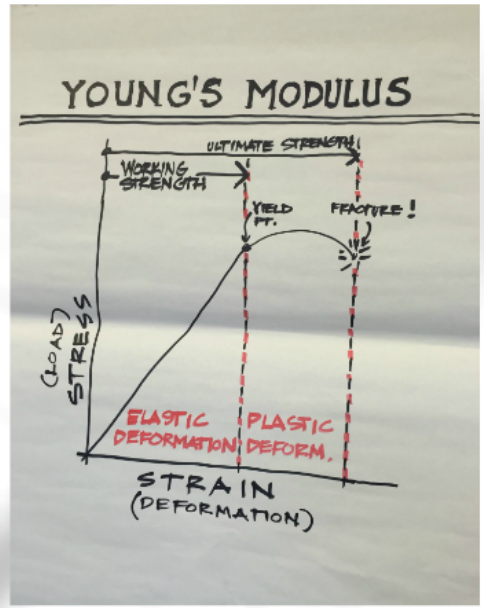
- Gravity: Top spokes carry the force of gravity. It compresses the bottom spokes because it pulls on the hub
- Impact: tire hits impact pieces and a force moves up and away from the piece. A normal force is then generated that acts opposite to it
- During acceleration and deceleration, only half the spokes are working
- Acceleration: acts clockise around hub. Reaction forces: act counterclockwise
- Deceleration: friction between road and tire

Materials

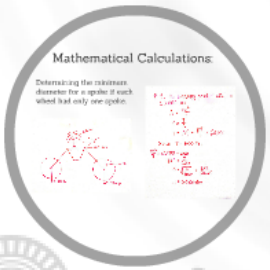


Each of the materials involved in the motorcycle has unique properties which make it uniquely suited to its role. This chart shows the materials used in a wheel.

Young's Modulus

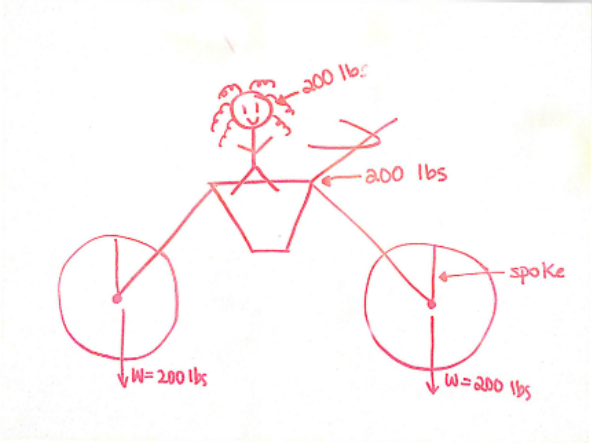


- Describes the breaking point of the material
- After the working strength, the material will deform or break
- There is a correlation between strain and stress



Mathematical Calculations:

Determining the minimum diameter for a spoke if each wheel had only one spoke.



if f, the breaking point of steel, is 60,000 psi

$$A = \frac{\pi d^2}{4}$$

$$f = \frac{T}{A}$$

$$T = Af = \frac{\pi d^2}{4} \times 60{,}000$$

Since $T = 200$ lbs

$$\frac{\pi d^2}{4} \times 60{,}000 = 200$$

$$\pi d^2 = \frac{8}{600}$$

$$d = \sqrt{\frac{8}{600\pi}} = \frac{2\sqrt{2}}{(10\sqrt{6}\pi)}$$

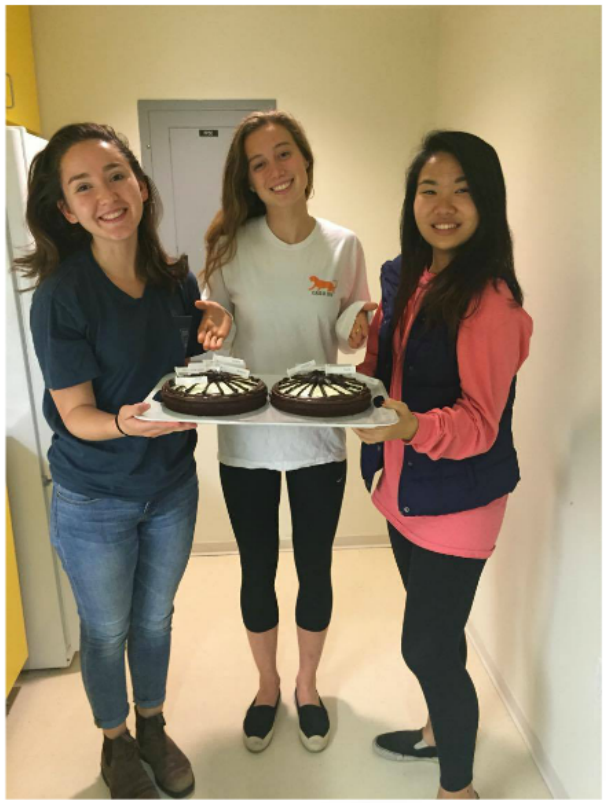
$$d \cong 0.065 \text{ inches}$$

Thanks for a great semester!

Acknowledgments:

- Professor Littman
- Bill Becker
- Noel Valero
- Glenn
- Chris
- Jon
- The entire class!

Thanks for a great semester!

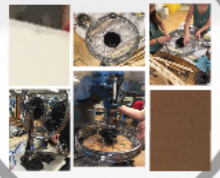


Bibliography

- Becker, Bill. FRS 106. Princeton University, Princeton, NJ. 31 March 2016. Guest Lecture.
- jamie.englert. "Evolution of the Wheel." Photograph. *Visually.* n.p., 9 August 2013. Web. 1 May 2016. *http://thumbnails-visually.netdna-ssl.com/evolution-of-the-wheel_520501cebf0c6_w1500.jpg*
- James Steidl, "Illustration showing the evolution of the wheel starting from a stone wheel and ending with a steel belted radial tire. Shot on a white background." Photograph. *123RF*, n.p., n.d. Web. 1 May 2016. *http://www.123rf.com/photo_7060199_illustration-showing-the-evolution-of-the-wheel-starting-from-a-stone-wheel-and-ending-with-a-steel-.html*
- Ildar Sagdajev, "A common wheelbarrow." Photograph. *Wikipedia*, Wikipedia, 15 July 2008. Web. 1 May 2016. *https://en.wikipedia.org/wiki/Wheelbarrow#/media/File:2008-07-15_Construction_wheelbarrow_at_Duke.jpg*
- "A Salute to the Wheel." *Smithsonian.com*. Smithsonian, 17 June 2009. Web. 1 May 2016. *http://www.smithsonianmag.com/science-nature/a-salute-to-the-wheel-31805121/?wheel=round%3Fno-ist&no-ist=&page=1*
- Texas Joe. "Diagram of hub and spokes." Photograph. *webBikeWorld.com*, webBikeWorld, n.d. Web. 1 May 2016. *http://www.webbikeworld.com/motorcycle-wheels/spoke-wheels/*

Wheels

Lacing the wheel, putting in the bearings, and truing the wheel



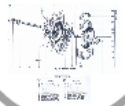
Removing the Brake Assemblies, Tires, and Inner tubes

Cleaning the Spokes!

"It is one piece always in a compartment, and because you're used to it you don't realize that through that one window everything you see is just more TV. You're a passive observer and it's all moving by you lazingly in a frame.
On a cycle the frame is gone. You're completely in contact with it all. You're IN the scene not just watching it. Immediate and the sense of pressure is overwhelming. That underside whizzing by. It's broken behind your back. In the end thing the scene stuff you walk on. It's right there, so blurred you can't focus on it, but you can see your foot down and touch it anytime, and the whole thing, the whole conjunction is never interrupted from introduction consciousness."

Robert Pirsig, Zen and the Art of Motorcycle Maintenance

Structure: The Front Wheel



"It is not the wheel itself, but the problem of rotation, that's dogged our minds for thousands of years."

-John Lienhard, University of Houston

Measuring the Off-set, removing the spokes, and cleaning the spokes

Evolution of the Wheel

- 10000 BCE - Logs helped transport heavy objects on rollers
- 4000 BCE - Potter's wheel invented in Mesopotamia (First Official Wheel)
- 3500 BCE - wheels were wooden discs but with a square hole in middle for axle
- Also used for Chariots

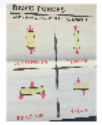
VIDEO

TRIUMPH

History

- 3300 BCE - The oldest wooden wheel was made of oak. Found in Slovenia
- 2000 BCE - spoked wooden wheel invented. Used for War Chariots
- Classical Greece between 6th and 4th Century BC - First wheelbarrows appear
- Middle East and Northern Africa between 2nd and 6th Century AD - Camels replaced wheels

Basic Forces



- Compression: forces that are aligned laterally push inward. Spokes are compressed at the bottom of the wheel
- Tension: forces that are aligned laterally pull outward. Spokes are in tension at the top of the wheel
- Shear Forces: asymmetrical because metal will bend. These are avoided

The Wheels of our Bike: a Journey

The first few weeks:

Removing the wheels

BIBLIOGRAPHY