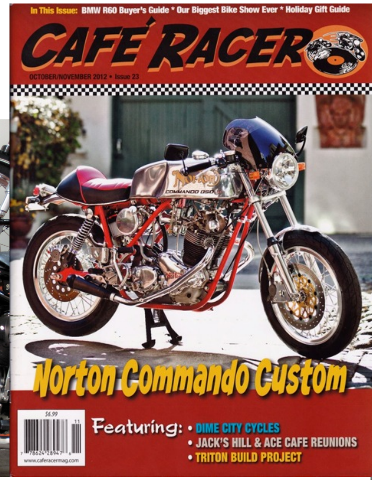
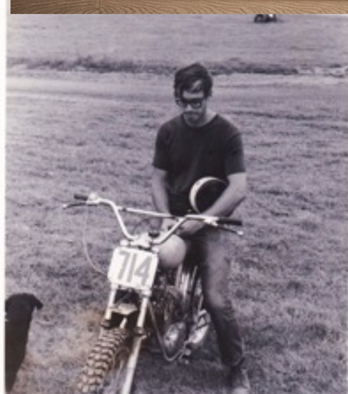
Discovering the MOTORCYCLE WHEEL

by

Bill Becker





Evolution of the Motorcycle Wheel

3201 BC by Gronc

Evolution of the Motorcycle Wheel

1790 by Comte Med de Sivrac, France

Evolution of the Motorcycle Wheel

1885 by Damlier, Germany

Evolution of the Motorcycle Wheel

1895 by Hildebrand & Wolfmuller, Germany

Evolution of the Motorcycle Wheel

1960 Tiger Cub by Triumph, England

Evolution of the Motorcycle Wheel

1960 Munch, Germany

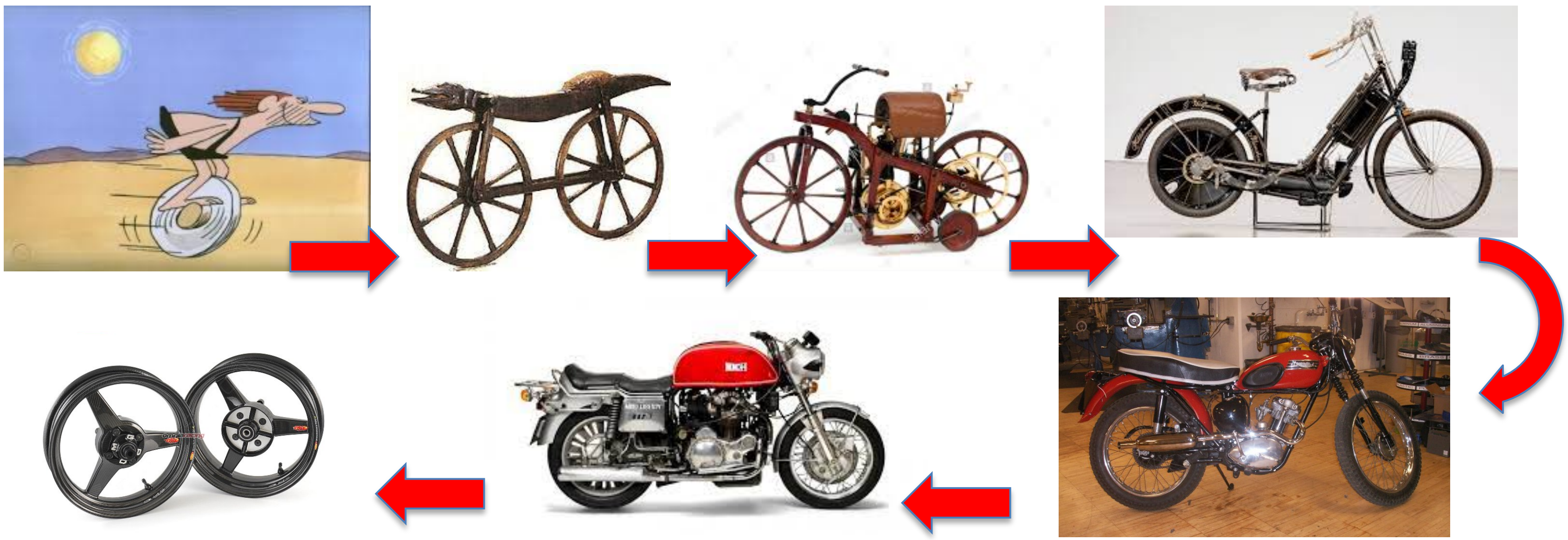
Evolution of the Motorcycle Wheel

TODAY

Consider our Motorcycle Wheel

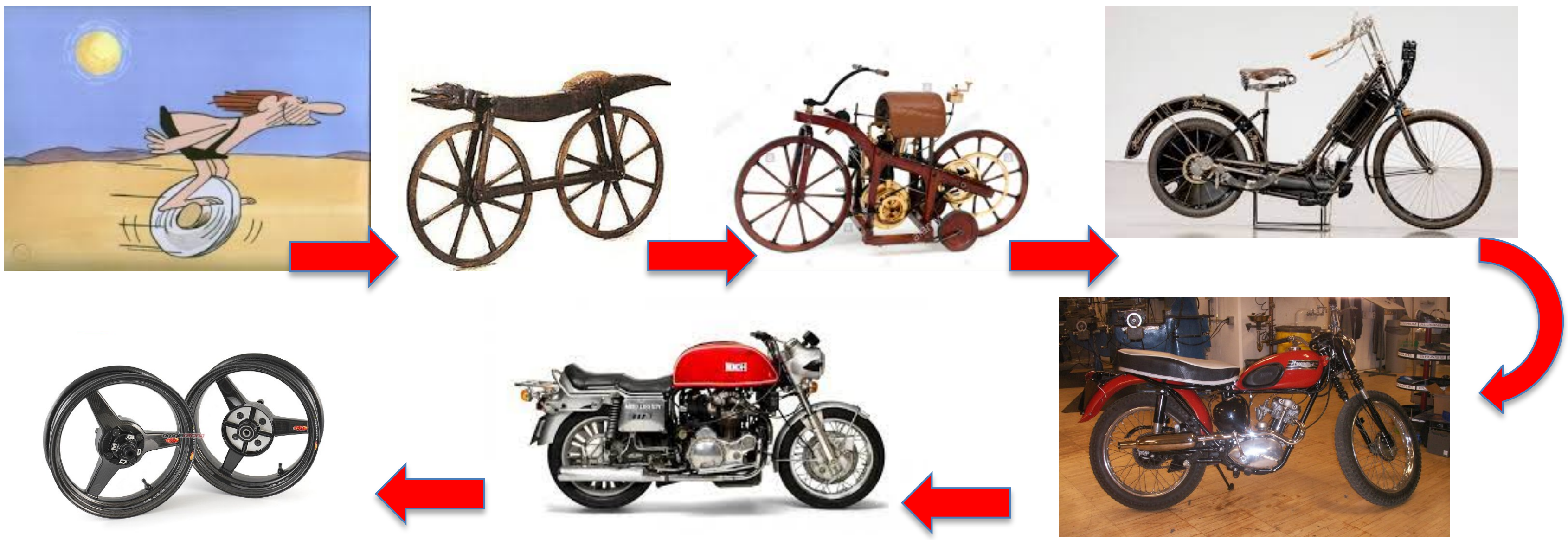
- As a physicist
- As a material scientist
- As a designer
- As an engineer

What are some major forces that played a role in the evolution of the motorcycle wheel?



???

What are some major influences in the evolution of motorcycle wheel design?



Weight

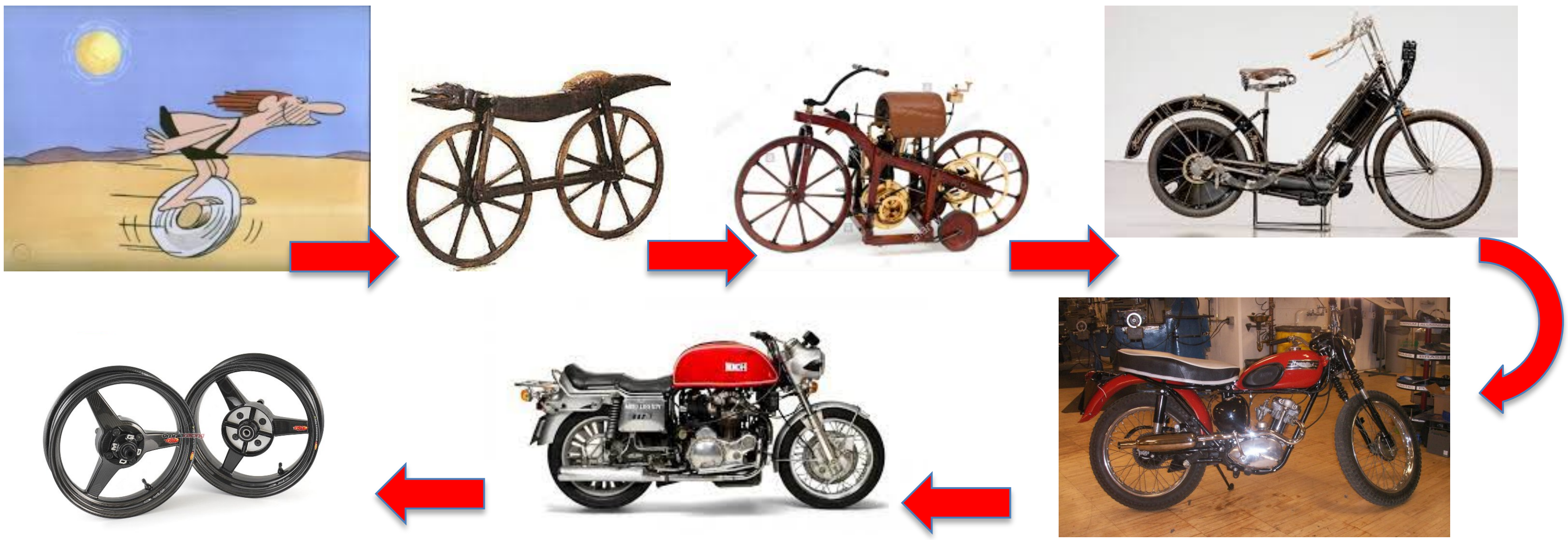
→ make lighter

What are some major influences in the evolution of motorcycle wheel design?

Materials

Make stronger

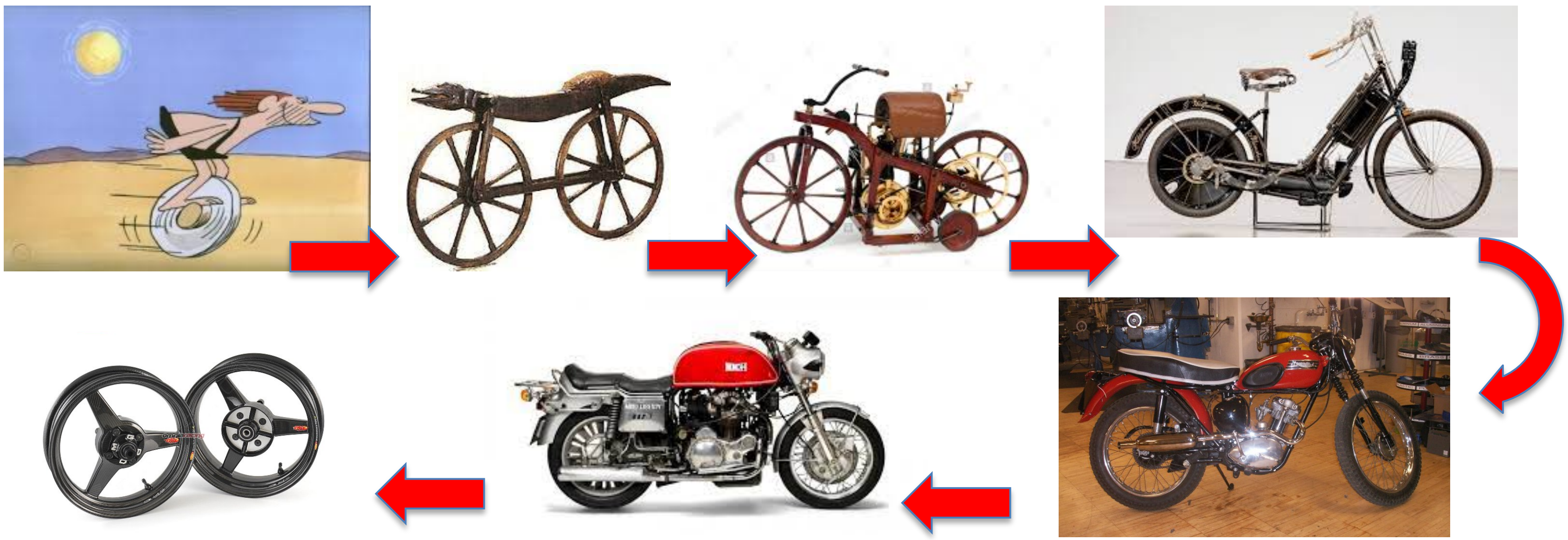
What are some major influences in the evolution of motorcycle wheel design?



Response to Forces

→ Better design

What are some major influences in the evolution of motorcycle wheel design?



Technology

→ Better machinery

Materials—in our motorcycle **WHEEL**
Each material has unique properties

- Strength
- Flexibility or rigidity
- Hardness or softness
- Workability—machinable, malleable (reshape by compression), ductible (reshape by stretching)
- Resistance to corrosion
- Conductivity of heat or electricity
- High or low coefficient of friction
- Cost
- Availability

Materials—in our motorcycle **RIM**:

Mild steel sheet—rolled into correct profile, welded, plated with copper, nickle and chromium

- Strength
- Rigidity
- Hardness
- Workability—machinable, malleable (reshape by compression), ductible (reshape by stretching)
- Resistance to corrosion
- Cost
- Availability

Materials—in our motorcycle **Spokes**:

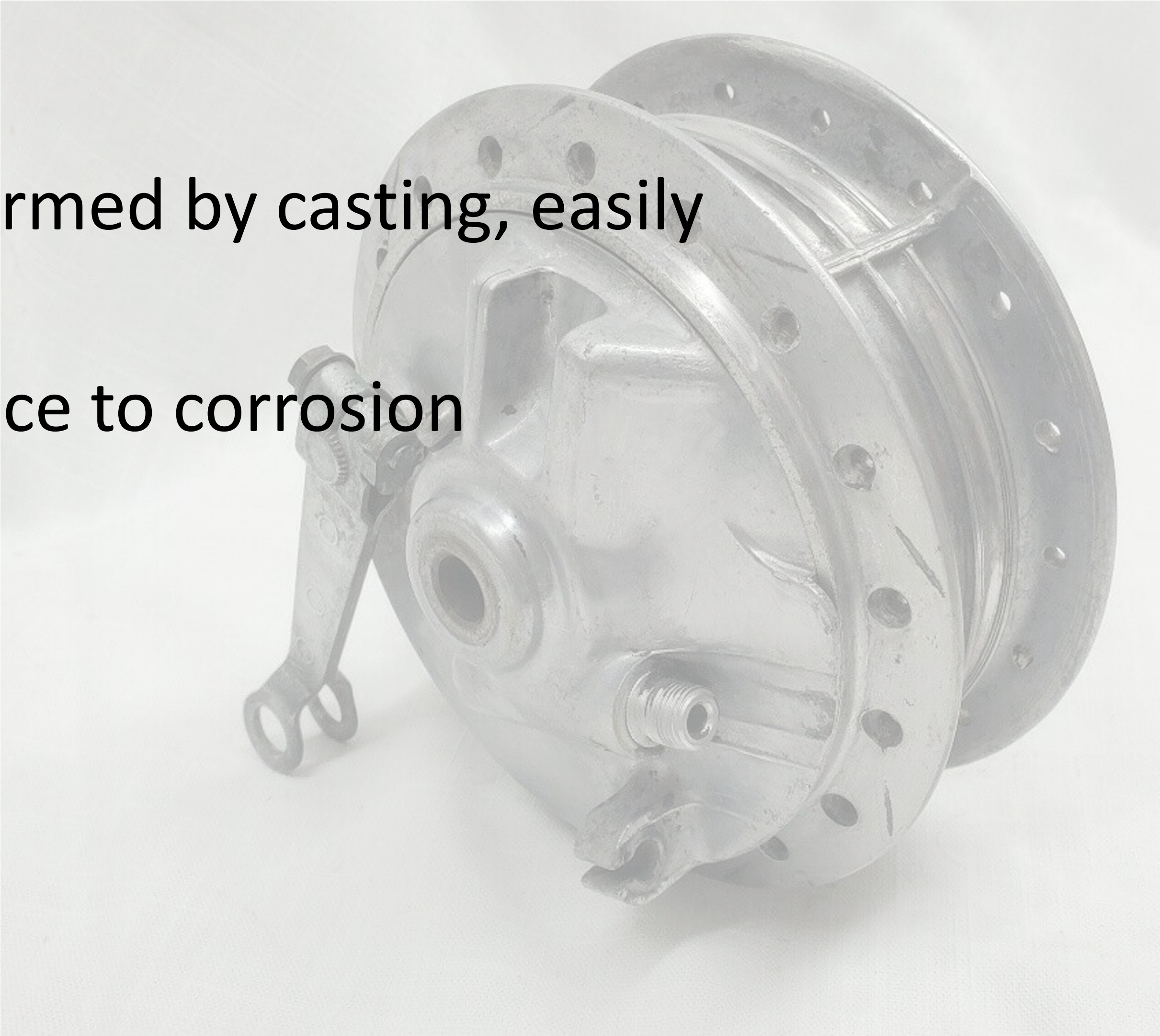
Mild steel wire—drawn into correct profile, bent, threaded, plated with copper, nickle and chromium

- Strength
- Hardness
- Workability—machinable, malleable (reshape by compression), ductible (reshape by stretching)
- Resistance to corrosion
- Cost
- Availability

Materials—in our motorcycle **Hub**:

Aluminum, cast, machined, polished

- Light weight
- Workability—formed by casting, easily machinable
- Natural resistance to corrosion
- Conducts heat
- Cost
- Availability



Materials—in our motorcycle **Bearings**

- Extremely hard
- Withstands wear
- Reduces friction
- Cost
- Availability

Materials—in our motorcycle **Tires**:

- Flexible
- Soft yet durable
- Moldable
- Resilient
- High coefficient of friction
- Cost
- Availability

Designers select materials based on their suitability for the task

Best performance

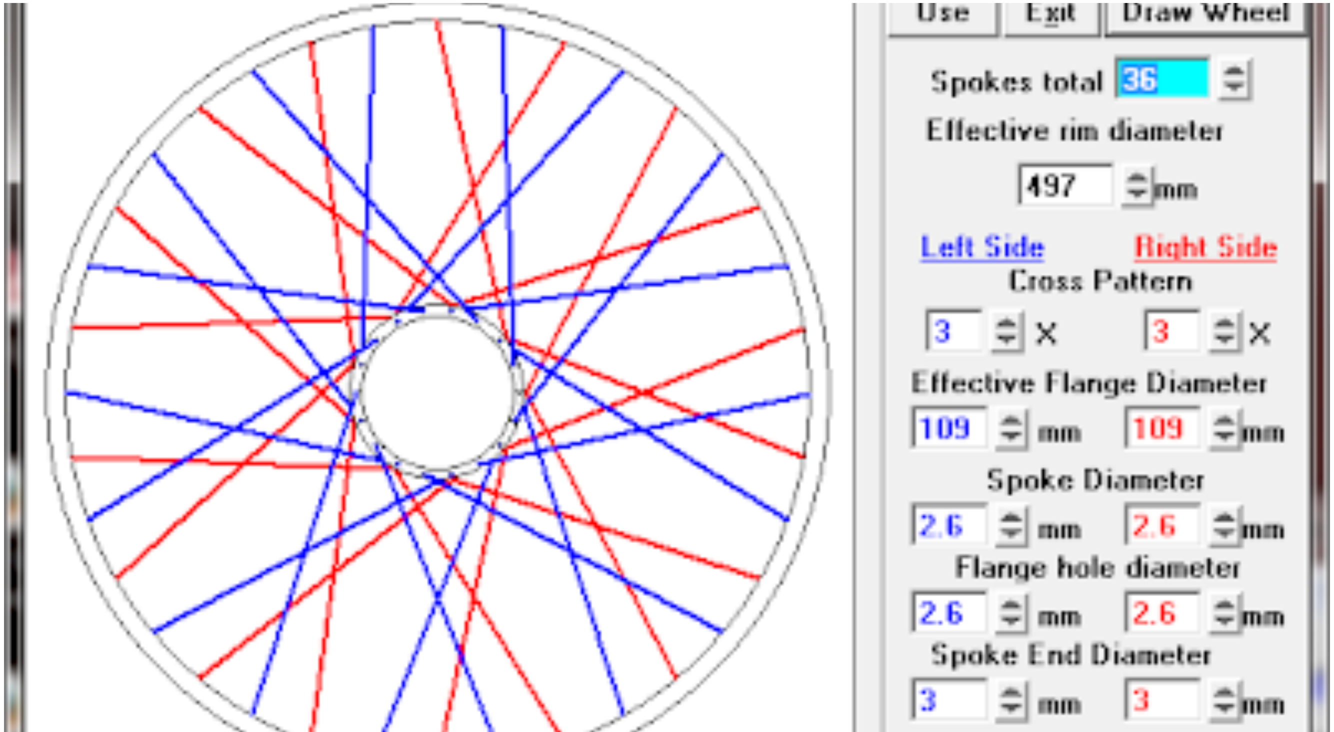
at

the lowest cost

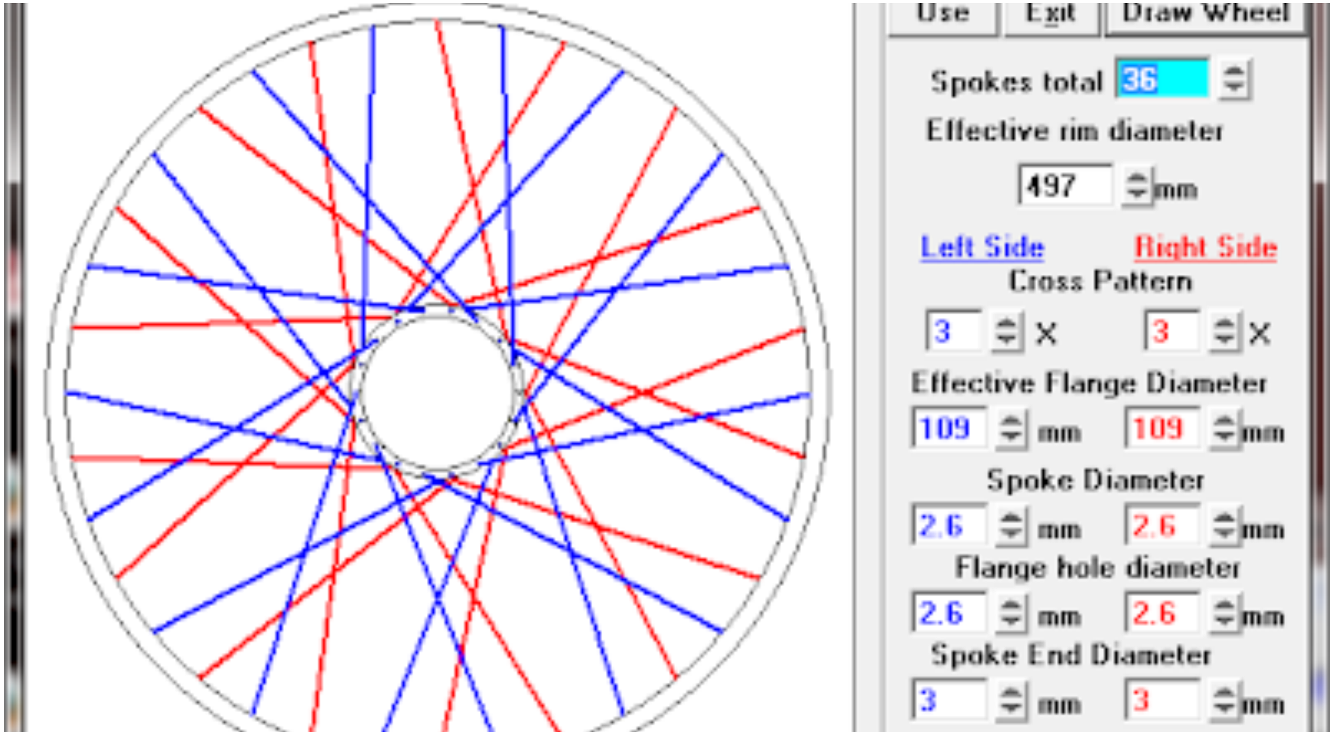
=

EFFICIENCY

Examine the motorcycle wheel from the perspective of an engineer.



Engineers look at the <u>forces</u> acting on a structure and <u>analyze</u> the effect.



What are the <u>forces</u> on our wheel?
<u>Loads</u> in engineering terms

- **DEAD LOAD** =
  wheel itself
  and the motorcycle

- **LIVE LOAD** =
  rider,
  passenger,
  gas and oil,
  luggage

What are the forces on our wheel?
Loads in engineering terms

- STATIC LOAD =

  wheel at rest

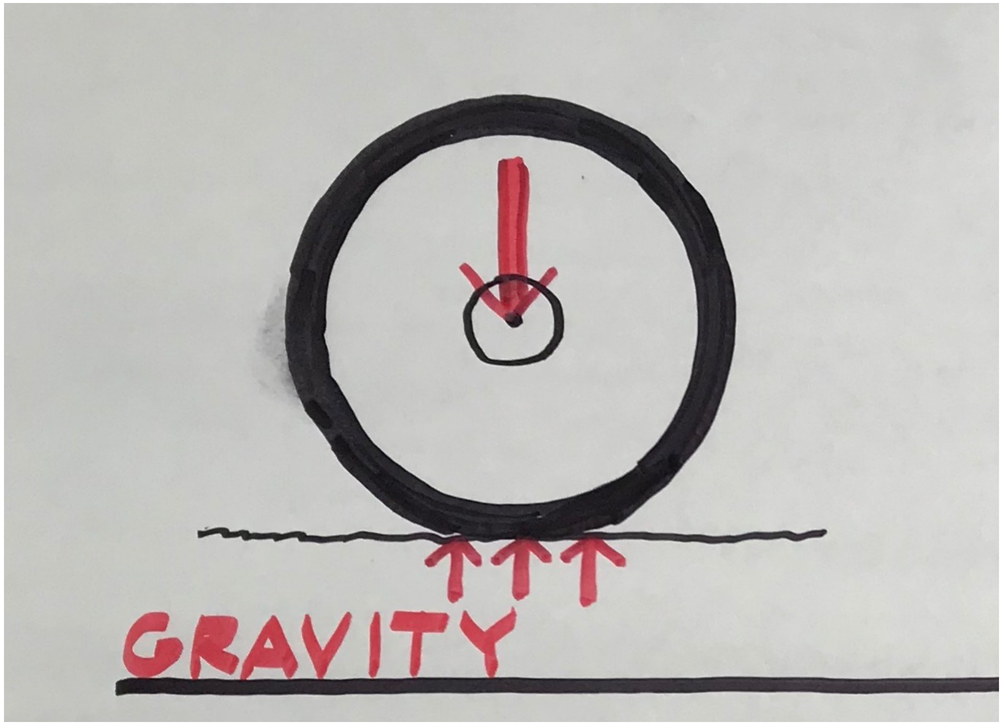
- DYNAMIC LOAD =

  wheel in motion,

  4 types

What are the forces on our wheel?
Loads in engineering terms

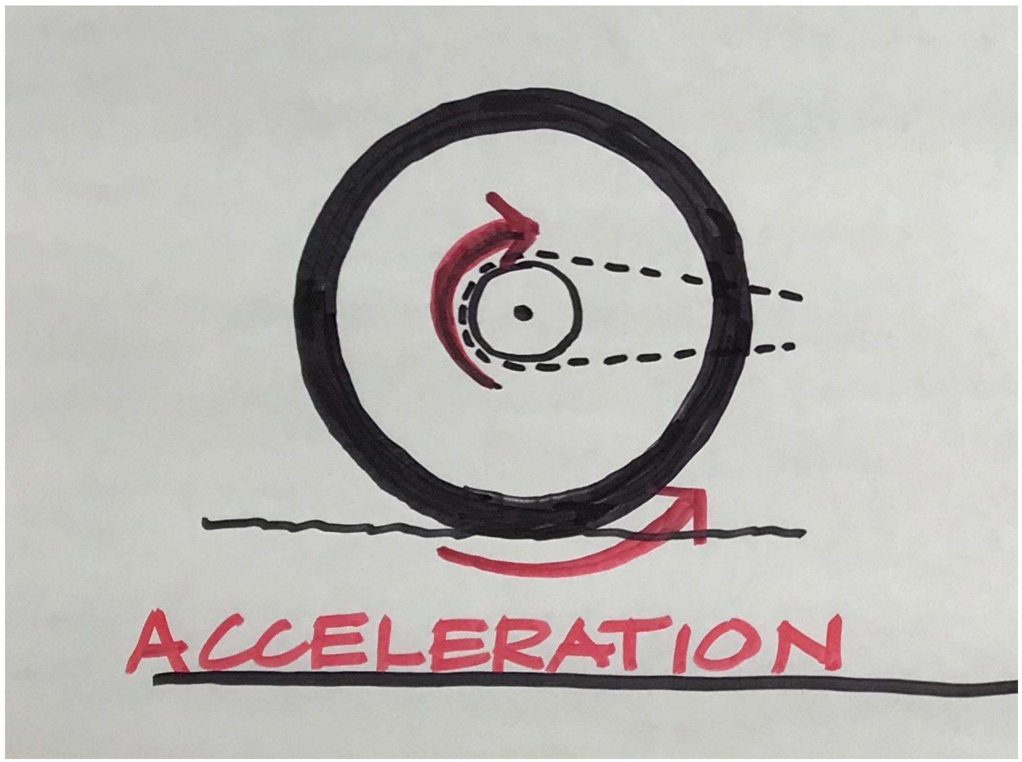
- STATIC LOAD = wheel at rest:



1. Effect of gravity

What are the forces on our wheel?
Loads in engineering terms

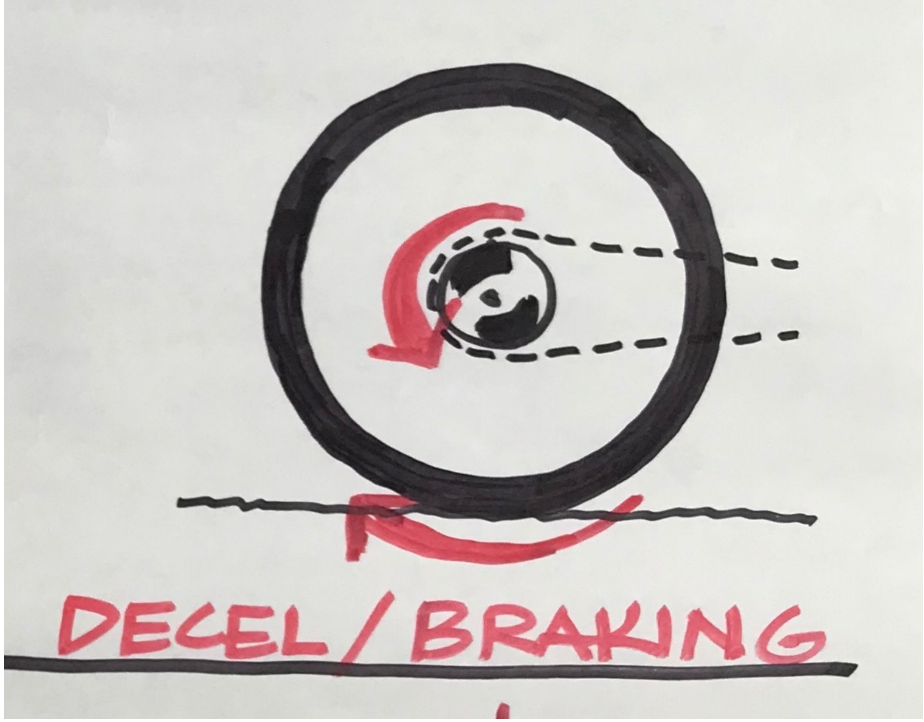
- DYNAMIC LOAD = wheel in motion:



1. Effect of applying motor power

What are the forces on our wheel?
Loads in engineering terms

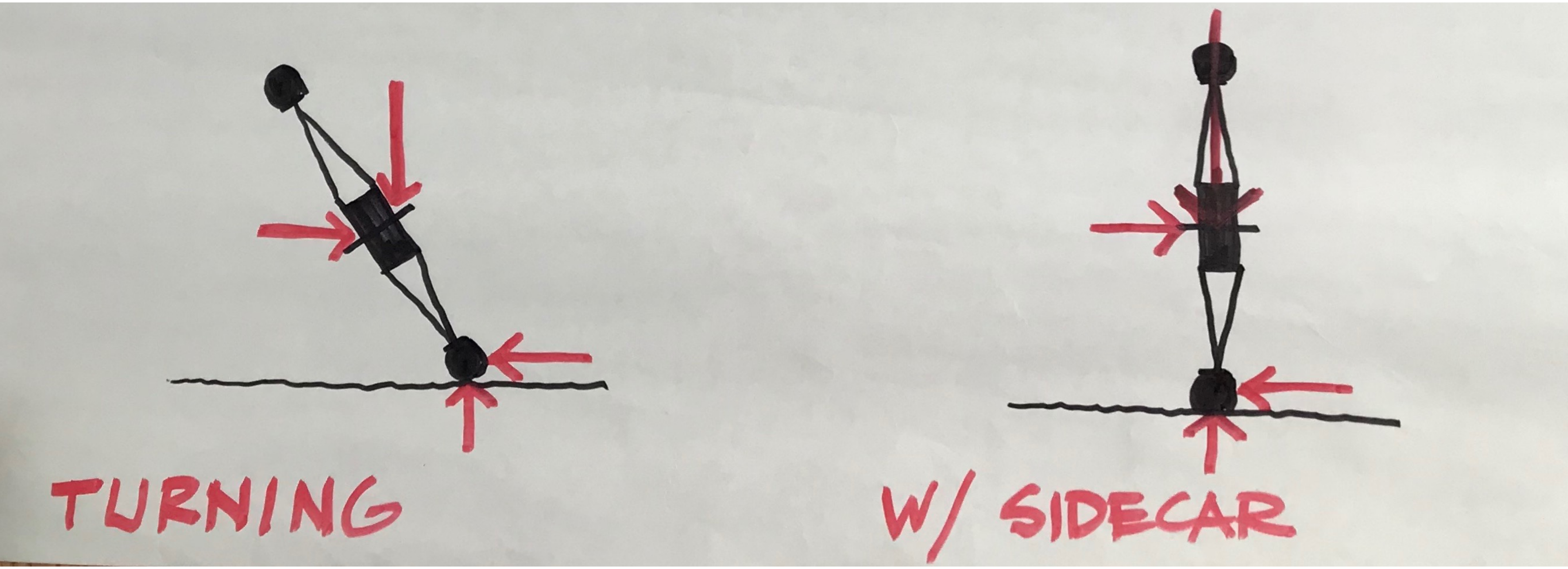
- DYNAMIC LOAD = wheel in motion:



2. Effect of applying brakes

What are the forces on our wheel?
Loads in engineering terms

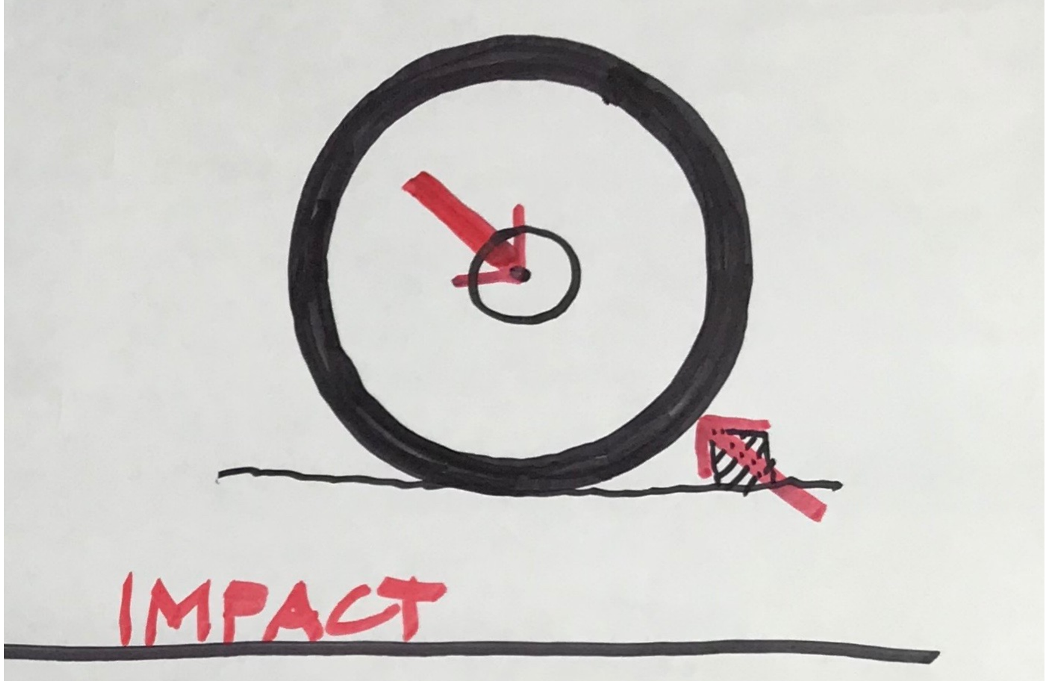
- DYNAMIC LOAD = wheel in motion:



3. Effect of turning the motorcycle

What are the forces on our wheel?
Loads in engineering terms

- DYNAMIC LOAD = wheel in motion:



4. Effect of striking an object

Forces act in a directional manner.
The GEOMETRY of the wheel reacts to forces.

Typical 40 spoke British wheel design like the Triumph Tiger Cub

Forces act in a directional manner.
The GEOMETRY of the wheel reacts to forces.

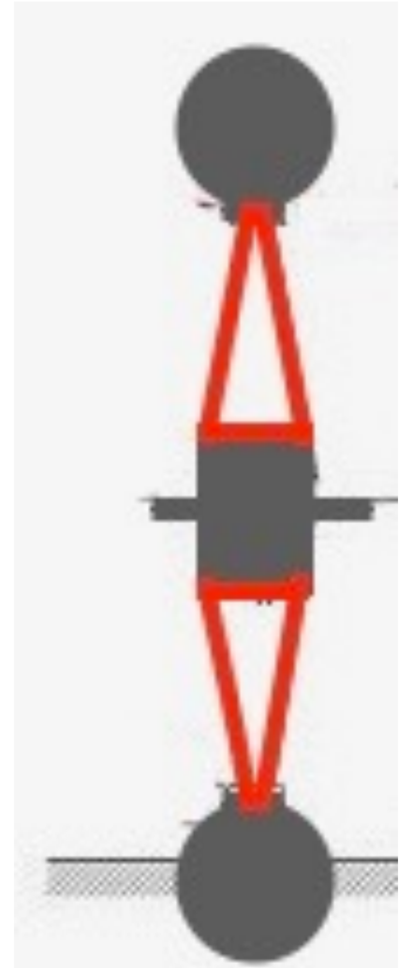
10 sets of groups of four spokes

Forces act in a directional manner.
The GEOMETRY of the wheel reacts to forces.

Observe the red spokes are forward leaning; left side and right side.

Observe the green spokes are backward leaning; left side and right side.

Forces act in a directional manner.
The GEOMETRY of the wheel reacts to forces.

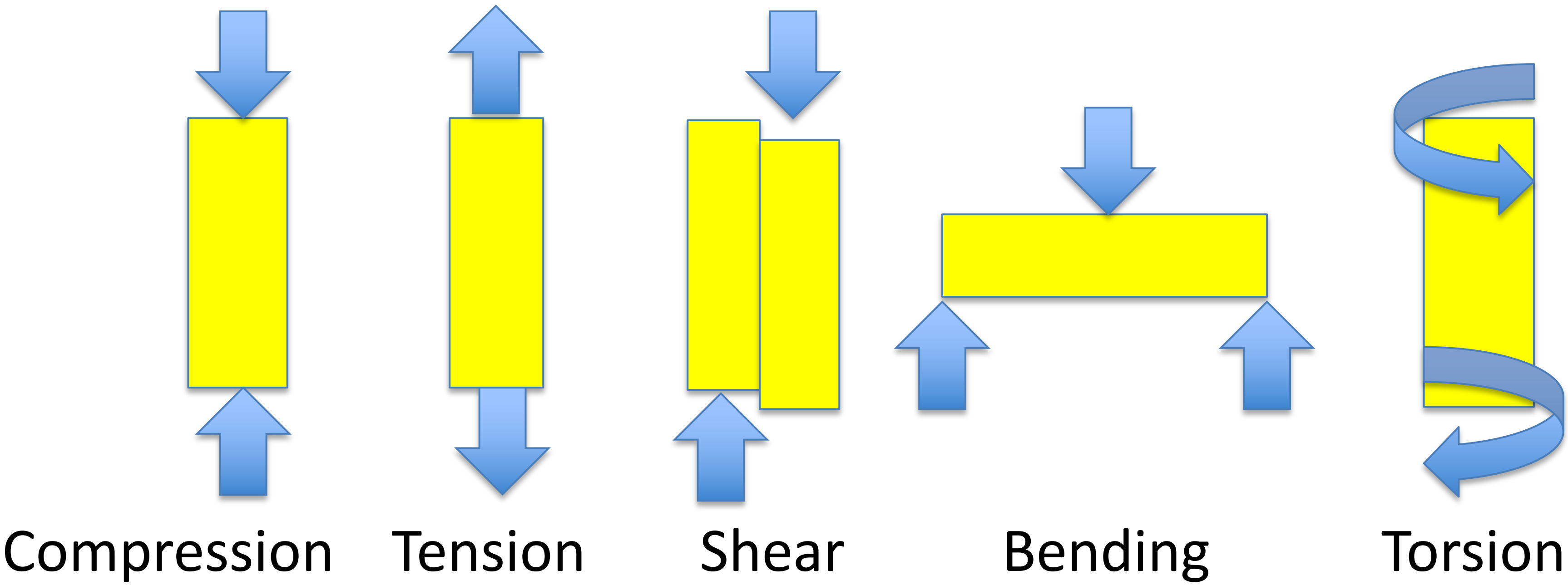


Observe the effectives of TRIANGULATION the circle.

Observe the effectives of TRIANGULATION within the cross section.

How do forces effect the elements within a structure?

5 basic forces acting on elements:



How do the elements within a structure support the system?

TIRE—Cushions the other elements from impact

How do the elements within a structure support the system?

RIM—Compression ring that supports the tire

How do the elements within a structure support the system?

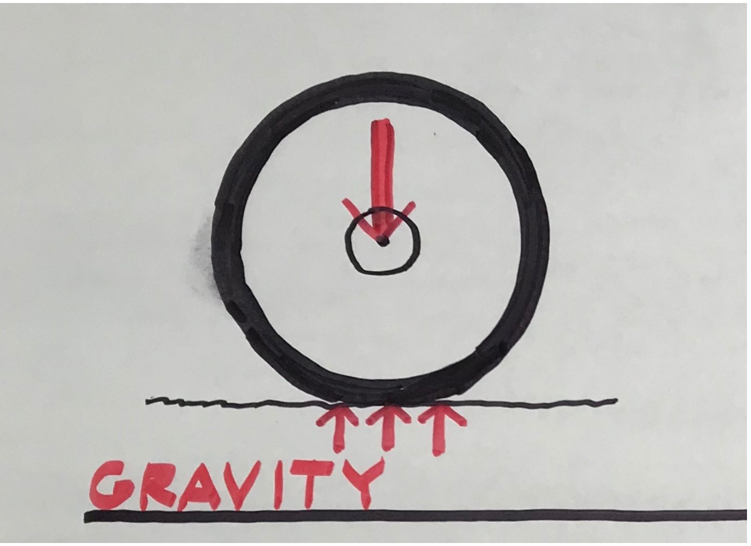
SPOKES—Tension member that supports the rim

How do the elements within a structure support the system?

HUB—Tension member that supports the spokes.

Also connects the wheel assembly to the motorcycle

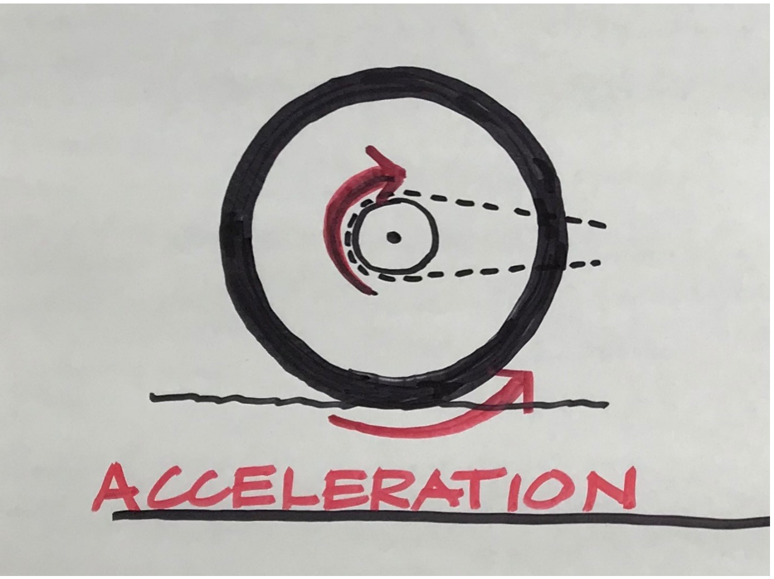
How do the SPOKES within the wheel react to applied forces?



Top 20 spokes provide tensile reaction.

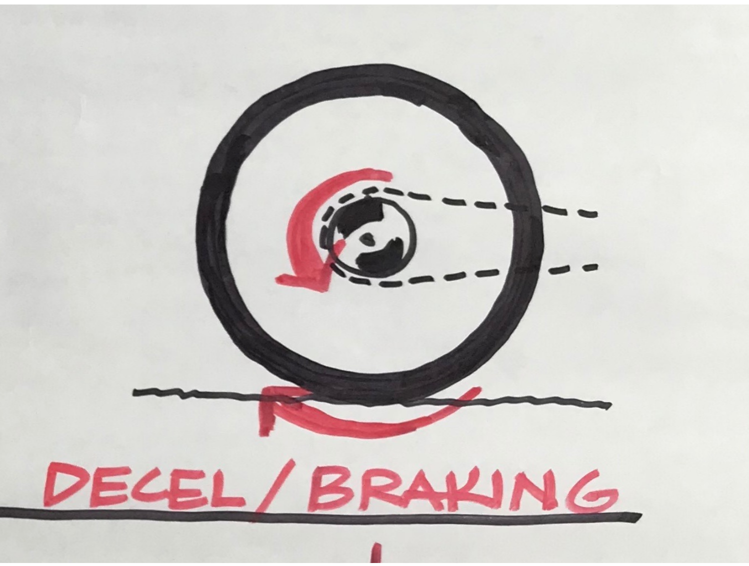
Why don't the bottom spokes provide support?

How do the SPOKES within the wheel react to applied forces?



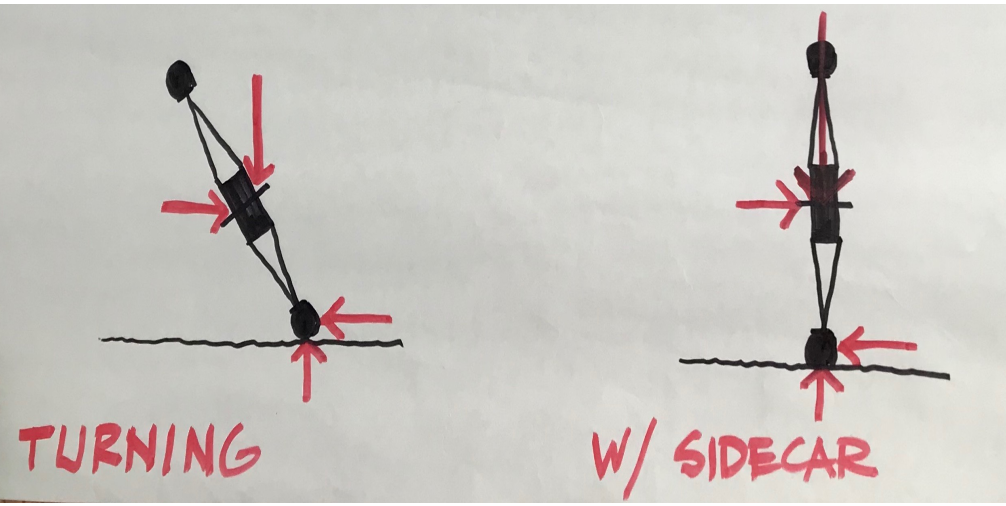
Backward leaning 20 spokes provide tensile reaction

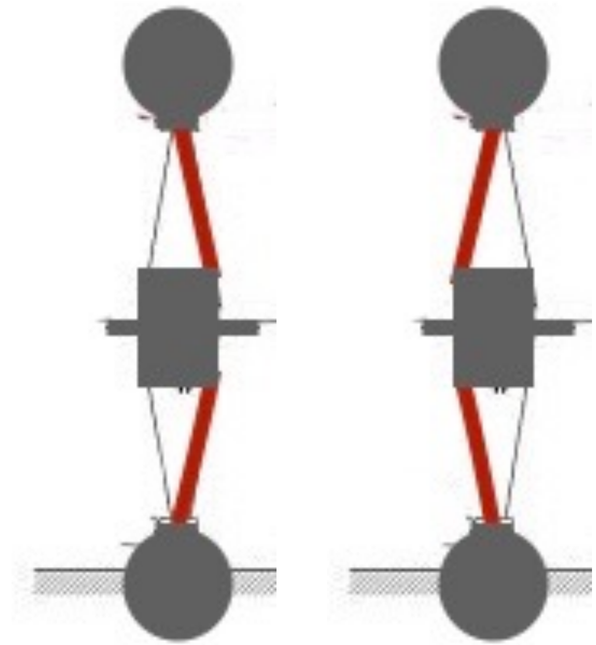
How do the SPOKES within the wheel react to applied forces?



Forward leaning 20 spokes provide tensile reaction

How do the SPOKES within the wheel react to applied forces?





Right Left

Right or Left 20 spokes provide tensile reaction

How do forces effect the elements within a structure?

Applying forces to an element creates

STRESS.

And the reaction to the stress is

STRAIN.

Relationship of

STRESS to STRAIN

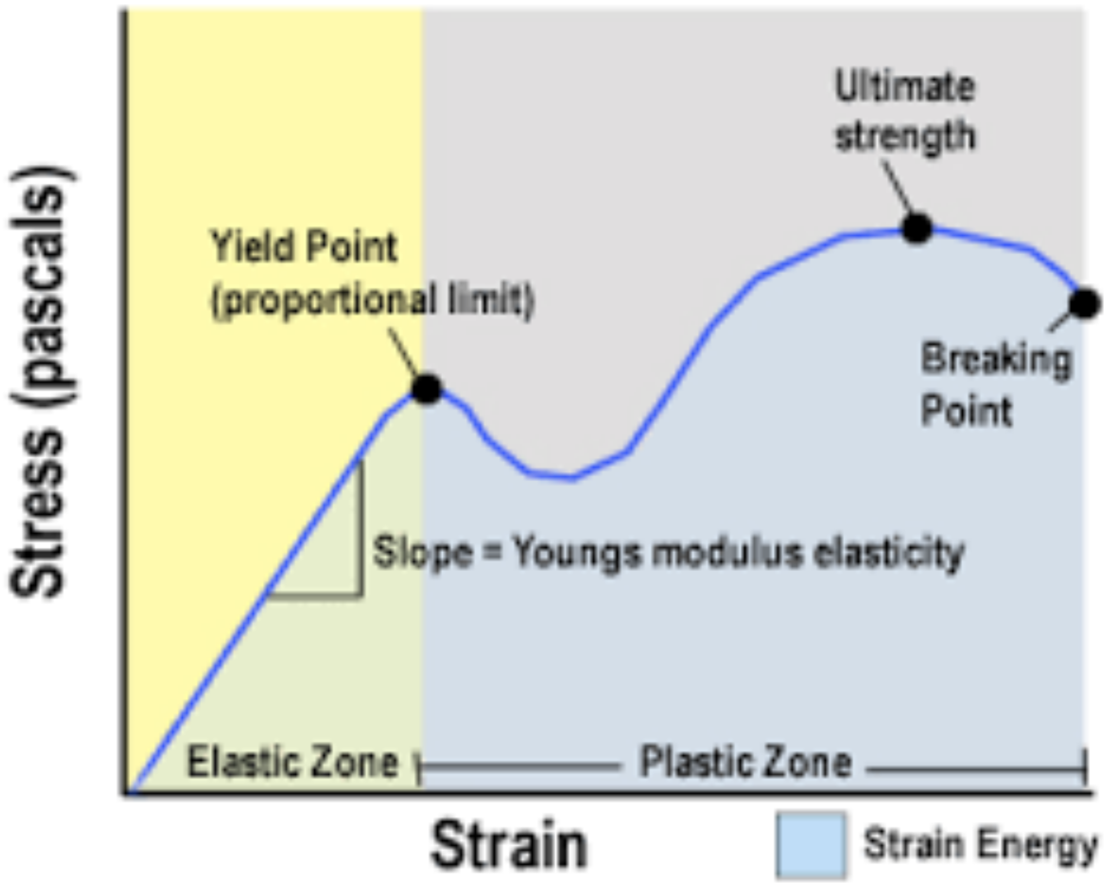
Thomas Young (1773 to 1829)
made contributions to:

- Vision
- Light
- Solid mechanics
- Energy
- Physiology
- Language
- Musical harmony
- Egyptology

Relationship of

STRESS to STRAIN

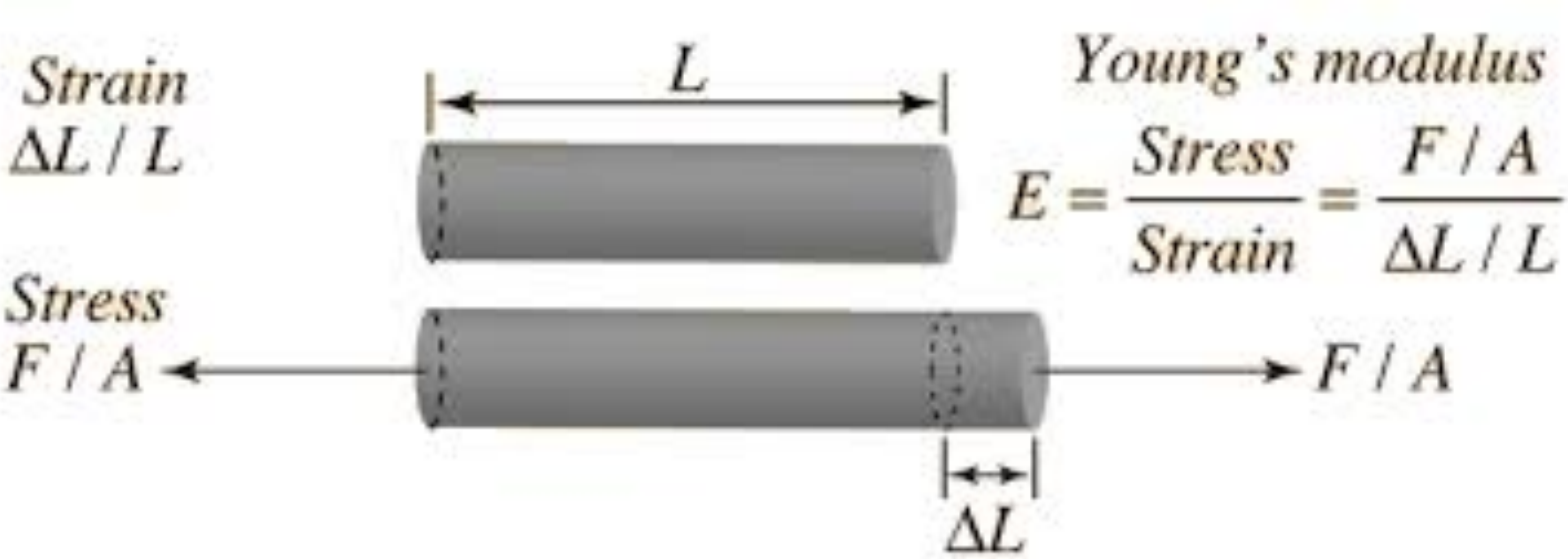
measured in FORCE/AREA　　　measured in change LENGTH/LENGTH



Relationship of

STRESS to STRAIN

measured in FORCE/AREA   measured in change of LENGTH/LENGTH



Relationship of

STRESS to STRAIN

What is the working load that our motorcycle spoke is capable of carrying?

What is the deformation experienced at this stress?

Relationship of

STRESS to STRAIN

What is the working load that our motorcycle spoke is capable of carrying?

Strength = Ultimate strength of steel X Area

= 62,000 psi X .0121 sq. in.

= **750 pounds**

Relationship of

STRESS to STRAIN

What is the deformation experienced at this stress?

Elongation = Force / Area X Modulus of Elasticity

= 750 pounds /.0121 sq. in. X 30,000,000

= **.002 inches**

Thanks for listening!