Tiger Cub Transmission

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The first motorcycle only had one gear and could only reach 25 mph. It also needed pedal assistance from the rider when going up hills.

In the 1920’s and 30’s motorcycle engines were adjusted and now had 3 speeds or gears which created more of a need for a transmission.

As motorcycle racing developed motorcycles came out with as many as 12 speeds.

Motorcycles continued to increase in speed and making more gears necessary.

There are two types of transmissions.
Two Types of Transmission

Automatic

Pros
- Good for beginners
- Better acceleration
- Convenient in traffic

Cons
- More expensive
- Less control
- More fuel
- More maintenance

Manual

Pros
- More engaging
- Safer
- More reliable

Cons
- Pulls focus from the road
- Higher chance of stalling
How It Works

- Most vintage motorcycle transmissions have constant-mesh, sequential gearboxes
- Different torque and power needs
- Output shaft have gears that revolve freely around while those on the layshaft are fixed
  - Input shaft is connected to clutch and crankshaft
  - Output shaft connected to the backend
- The shifting forks are connected to sprockets and shift sideways to engage specific gears to produce a particular gear ratio
An Overview of Gears

A smaller wheel can rotate a bigger wheel easier but with less power.

A larger wheel can rotate a bigger wheel with more power but it takes more work.
THINK OF... BIKING UP A HILL OR IN A CITY
VS BIKING IN A BIKE RACE
## Trade Off Between Speed and Torque

<table>
<thead>
<tr>
<th>GEAR NUMBER</th>
<th>TRANSMISSION RATIO</th>
<th>ENGINE RPM AT CONSTANT SPEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>4th - “High Gear”</td>
<td>1x</td>
<td>4,000</td>
</tr>
<tr>
<td>3rd</td>
<td>1.3x</td>
<td>5,200</td>
</tr>
<tr>
<td>2nd</td>
<td>2x</td>
<td>8,000</td>
</tr>
<tr>
<td>1st - “Low gear”</td>
<td>3x</td>
<td>12,000</td>
</tr>
</tbody>
</table>

A 1:3 ratio requires three times as many RPMs to get to the same speed as a 1:1.
Ger Ratios

Certain vehicles lend themselves to a preference towards a closer or smaller gear ratio depending on whether it needs more speed or torque.

<table>
<thead>
<tr>
<th>Transmission type:</th>
<th>LOW (FIRST)</th>
<th>THIRD</th>
<th>SECOND</th>
<th>TOP (FOURTH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide</td>
<td>Mainshaft</td>
<td>16</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Layshaft</td>
<td>29</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Standard</td>
<td>Mainshaft</td>
<td>16</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Layshaft</td>
<td>29</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Close</td>
<td>Mainshaft</td>
<td>16</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Layshaft</td>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extra Close</td>
<td>Mainshaft</td>
<td>16</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Layshaft</td>
<td>29</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>Ultra Close</td>
<td>Mainshaft</td>
<td>17</td>
<td>23</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Layshaft</td>
<td>28</td>
<td>22</td>
<td>25</td>
</tr>
</tbody>
</table>

Good for our needs because easy to stop/start and fast high speed not required.
Gears

- Mainshaft and layshaft each have four gears
- M1, M3 are coupled to the mainshaft
- L2, L4 are coupled to the layshaft
- M2, M4, L1, L3 all rotate independently
  - Unless engaged by M3, L2 respectively
- Input power comes in through M1, M3
- Output power is sent out through M4
  - Connected to output sprocket (not shown)
CALCULATION OF GEAR RATIOS

First Gear: M1 - L1 (L2) - L4 - M4
\[ \frac{29}{16} \div \frac{17}{17} \times 28 = \frac{203}{68} = 2.985 \]

Second Gear: M3 - L3 (L2) - L4 - M4
\[ \frac{25}{20} \div \frac{17}{17} \times 28 = \frac{35}{17} = 2.059 \]

Third Gear: M2 (M3) - L3 - L4 - M4
\[ \frac{20}{25} \div \frac{17}{17} \times 28 = \frac{112}{85} = 1.318 \]

Fourth Gear: M4 (M3)
M4 is directly driven: 1

<table>
<thead>
<tr>
<th>Mainshaft</th>
<th>16</th>
<th>25</th>
<th>20</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layshaft</td>
<td>29</td>
<td>20</td>
<td>25</td>
<td>17</td>
</tr>
</tbody>
</table>
CALCULATION OF TOP GEAR (4th GEAR) MAX SPEED

Motorcycle Velocity = rear wheel speed \times \text{wheel circumference} \times \frac{60 \text{min}}{63360 \text{in}} \times \frac{\text{inches per mile}}{\text{minutes in hour}}

Rear wheel speed = \frac{\text{engine speed}}{\text{engine sprocket}} \times (\frac{\text{output sprocket}}{\text{clutch basket}}) \times (\frac{1}{\text{Gear Ratio}})

\text{Rear wheel speed (RWS)} = 6500 \text{RPM} \times \left(\frac{19}{48}\right) \div 1 \times \left(\frac{17}{46}\right) \approx 950.86 \text{ RPM}

Now calculated Motorcycle Velocity:

\text{Motorcycle Velocity (MV)} = \frac{950.86 \text{RPM} \times 73.83 \text{in} \times 60 \text{min}}{63360 \text{in}} \approx 66.48 \text{ mph}
Power Curve

- As engine rpm climbs, the power does as well for a given torque
- Can inform about the characteristics of the motorcycle
  - Tradeoff: more power at a high RPM would make stopping and starting difficult
- Gear ratios come into play
**Tiger Cub**

**Clutch Lever.** On the left side of the handlebar. The clutch lever should not be operated when the machine is in motion except to change gear and when bringing the machine to a halt.

**Gearchange.** A small foot lever in front of the right footrest. The lever is moved DOWN to select a low gear and UP to select a higher gear. The gear selected is shown by the indicator on the nacelle.
An Overview of the Physical Transmission
Shifter Plate

- The shifter plate on the Tiger Cub is controlled by the shifting pedal that allows the rider to shift between gears by moving the plate.
- The shifter plate is what allows for the movement of the shift forks.
- This is in turn what controls the movement of the sprockets along the shafts.
Shifter Forks

Created in Fusion 360
Model (made in fusion)

- Each color is representative of a different gear
- As the shifter plate is moved up and down the ends of the shift forks will move accordingly
Shifter Plate neutral position
Neutral

- Neutral is in between 1st and 2nd gear mostly for the safety of the rider.
- Unlike a car, motorcycles have a shifter pedal which can cause for double shifting at times.
- In order to avoid this, when stopping at a light, neutral is placed between the two gears to make sure this is impossible,
  - This is because in order to get to first gear you must shift down to it instead of shifting up and accidentally skipping first gear.
NEUTRAL

neutral sprocket position

Torque

neutral sprocket position
FIRST GEAR

neutral sprocket position

Torque

First gear engaged
SECOND GEAR

neutral sprocket position

TORQUE

↑ second gear engaged
FOURTH GEAR

Fourth gear engaged

Neutral sprocket position

Torque
Our Models

7 – Mainshaft Cluster (Katherine)
9 – High Gear (Sarah)
11 – Mainshaft Second Gear (Katherine)
13 – Layshaft Cluster (Alan)
14 – Layshaft Third Gear (Alan)
15 – Layshaft Low Gear (Tejas)
18 – Gearbox sprocket (Sarah)
20 – Selector Forks (Tejas)
22 – Camplate (Max)
42-46 – Kickstarter Spindle (Tejas)
Fusion 360 Demonstration
Bibliography

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