

*A Discourse proving from Experiments, That the larger the Wheels of a Coach, &c. are (cæteris paribus,) the more easily they may be drawn over a Stone or such like obstacle that lies in the way: by a Member of the Philosophical Society of Oxford.*

**H**AVING read in the *Mechanicks of Merfennus*<sup>a</sup>, *Herigon*<sup>b</sup>, and *Dr. Wallis*<sup>c</sup>, *That the larger the Wheels of a Coach, &c. are, (cæteris paribus,) the more easily they may be drawn over a stone or such like obstacle that lies in their way*; I was willing to try some Experiments which I thought might convince some men better of the truth of it, than a Mathematicall demonstration.

I therefore ordered a Modell of a part of a *Wagon* to be made, consisting of 4 wheels, 2 axes and a board nailed upon the axes. The lesser wheels were  $4\frac{1}{2}$  inches high, and the bigger wheels  $5\frac{2}{3}$  inches high, *viz*:  $\frac{1}{12}$  of the ordinary height of the wheels of a *Wagon*: The weight of the Modell was almost a pound and half. I had also 2 other wheels made  $5\frac{2}{3}$  inches high to be put on instead of the lesser. The middle of the 2 axes were  $6\frac{1}{4}$  inches a-funder. All the wheels turned very easily upon the axes.

A piece of Lead  $50\frac{1}{2}$  avoirdupois was laid upon the modell, so forward that the lesser wheels seemed to bear above parts of the weight. Then the modell was drawn with a string laid over a Pulley, the top whereof was  $\frac{1}{4}$  of an inch higher then the top of the hinder axis;

<sup>a</sup> Geom. pa. 459    <sup>b</sup> Mec. pr. 16. Schol.    <sup>c</sup> Mec. c 7. pr. 3    Schol. § 15,  
and

and the middle of this Pulley was  $7\frac{1}{2}$  inches from the middle of the fore-axis.

The lesser wheels being put on, and the string being tied to the top of their axis,

1. Three pound drew the modell on the smooth level Table.

2. Twenty pound drew the lesser wheels over a squared rod  $\frac{1}{4}$  of an inch thick.

3. Thirty pound drew them over a round rod a little more then half an inch thick.

4. Thirty one pound drew them over a square rod half an inch thick.

5. Twelve pound drew the hinder wheels over the bigger square rod.

The string being laid under the axis, *viz*:  $\frac{1}{8}$  of an inch lower then before.

6. Twenty nine pound drew the lesser wheels over the bigger square rod.

Then the 2 bigger wheels being put on instead of the lesser, and the string lying over the axis.

7. Three pound drew the modell on the Table.

8. Twenty five pound drew the Fore-wheels over the round rod.

9. Twenty five pound drew them over the bigger square rod.

10. The string lying under the axis, sixteen pound drew them over the least rod.

11. Twenty three pound drew them over the round rod.

12. Twenty three pound drew them over the bigger square rod.

13. Thirteen pound drew the hinder wheels over the bigger square rod.

All these Experiments were tried twice at least, and most of them 3 or 4 times over

In all of them the Lead was laid exactly upon the

same part of the board, but yet when the lesser wheels were taken off, the Lead did not lean so much forward, so that the hinder wheels were somewhat more pressed than they were before.

By comparing the 2d, 3d and 4th Experiments with the 10th, 11th, and 12th, it appears how much more easily a *Wagon*, &c. might be drawn in rough wayes, if the fore-wheels were as high as the hinder wheels, and if the thills were fixt under the axis. Such a *Wagon* as this would likewise be drawn more easily where the wheels cut in Clay, or Sand, or any soft Ground. And moreover high wheels would not cut so deep as low wheels, as *Dr. Wallis* does plainly demonstrate<sup>d</sup>; besides some other advantages which he mentions.

Low wheels are better for turning in a narrow Compass than high ones: But it seems probable that *Wagons* with 4 high wheels might be so contrived that there should be no great inconvenience in that respect; at least such *Wagons* as seldom have occasion to turn short, as *Carrier Wagons* and such like.

The difference which you may observe in the 8th and 11th Experiments, is agreeable to what is said by *S. Stevinus*<sup>e</sup>, and *Dr. Wallis*<sup>f</sup>; viz. that if a *Coach*, &c. must be drawn over rough, uneven places, it is best to fix the *Traces* to the *Coach* lower than the height of the *Horses* shoulders. And therefore that is not the best way which some *Wagoners* use, who sometimes putting their horses in pairs, hook the chains of some of the *Horses* to the chest of the *Wagon* higher than they need to do.

14. A Table  $2\frac{1}{2}$  foot long was set with one end  $8\frac{1}{2}$  inches higher than the other end, and the Modell being loaded as before, less weight by 6 ounces drew it up the Table when the 4 bigger wheels were on, then when 2 bigger and 2 less were on.

<sup>d</sup> *Mec.* c. 7. pr. 3. *Schol.* §. 21. <sup>e</sup> *Stat.* l. 3. pr. 2. <sup>f</sup> *Mec.* c. 7. pr. 3. §. 36.

The reason of this is given by Dr. *Wallis* and other Writers of *Mechanicks*: *viz.* because in the first case there was almost the same direction of the motion of the Modell and of the string that drew it; but not in the 2d case when the fore axis was so much lower then the top of the Pulley.

g *Mech. c. 7. pr. 3. §. 36.*