

Vehicle 1

Getting Around

Vehicle 1 is equipped with one sensor and one motor (figure 1). The connection is a very simple one. The more there is of the quality to which the sensor is tuned, the faster the motor goes. Let the quality be temperature and let the force exerted by the motor be exactly proportionate to the absolute temperature (the temperature above zero degrees Kelvin) measured by the sensor. The vehicle will move, wherever it is (the absolute temperature is nowhere equal to zero), in the direction in which it happens to be pointing. It will slow down in cold regions and speed up where it is warm.

Here we have introduced a bit of Aristotelian physics. Aristotle, like everybody else between this ancient Greek philosopher and the less ancient Italian physicist Galileo, thought that the speed of a moving body is proportionate to the force that drives it. This is true in most instances, namely when there is friction to slow down the vehicle. Normally friction will see to it that the velocity becomes zero in the absence of any force, that it will stay at a certain small value for a certain small force, at a higher value for a higher force, and so forth.

Of course, as you all know, this is not true for heavenly bodies

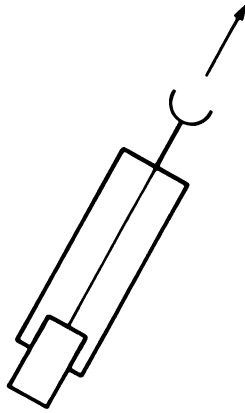


Figure 1

Vehicle 1, the simplest vehicle. The speed of the motor (rectangular box at the tail end) is controlled by a sensor (half circle on a stalk, at the front end). Motion is always forward, in the direction of the arrow, except for perturbations.

(especially if you don't invest astronomical time in observing them). Their velocity is a complicated result of all the forces that ever hit them. This is another reason for letting our vehicles move in water or on the surface of the earth rather than in outer space.

In this Aristotelian world our vehicle number 1 may even come to rest. This will happen when it enters a cold region where the force exerted by its motor, being proportionate to the temperature, becomes smaller than the frictional force.

Once you let friction come into the picture, other amazing things may happen. In outer space Vehicle 1 would move on a straight course with varying speed (the gravitational pull of neighboring galaxies averages out to nothing). Not so on earth. The friction, which is nothing but the sum of all the microscopic forces that arise in a situation too messy to be analyzed in detail, may not be quite symmetrical. As the vehicle pushes forward against frictional forces, it will deviate from its course. In the long run it will be seen to move in a complicated trajectory, curving one way or the other without apparent good reason. If it is very small, its motion will be quite erratic, similar to "Brownian motion," only with a certain drive added.

Imagine, now, what you would think if you saw such a vehicle swimming around in a pond. It is restless, you would say, and does not like warm water. But it is quite stupid, since it is not able to turn back to the nice cold spot it overshot in its restlessness. Anyway, you would say, it is *ALIVE*, since you have never seen a particle of dead matter move around quite like that.

Vehicle 2

Fear and Aggression

Vehicle 2 is generally similar to Vehicle 1 except that it has two sensors, one on each side, and two motors, right and left (figure 2). You may think of it as being a descendant of Vehicle 1 through some incomplete process of biological reduplication: two of the earlier brand stuck together side by side. Again, the more the sensors are excited, the faster the motors run.

Of course you notice right away that we can make three kinds of such vehicles, depending on whether we connect (a) each sensor to the motor on the same side, (b) each sensor to the motor on the opposite side, or (c) both sensors to both motors. We can immediately dismiss case (c), for this is nothing but a somewhat more luxurious version of Vehicle 1. The difference between (a) and (b), however, is very interesting.

Consider (a) first. This vehicle will spend more time in the places where there is less of the stuff that excites its sensors and will speed up when it is exposed to higher concentrations. If the source of the stuff (say, light in the case of light sensors) is directly ahead, the vehicle may hit the source unless it is deflected from its course. If the source is to one side (figure 3), one of the sensors, the one nearer to the source, is excited more than the other. The corresponding

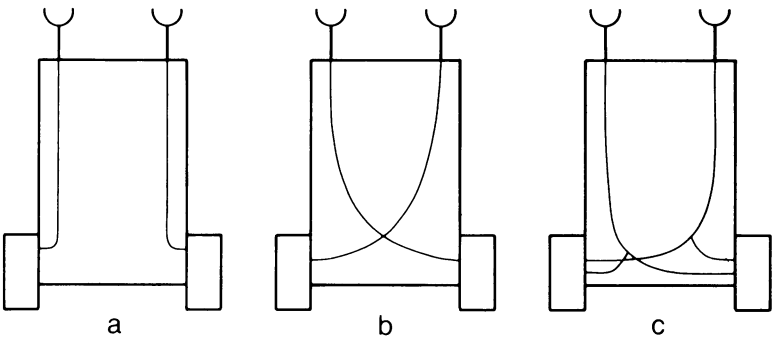


Figure 2

Vehicle 2, with two motors and two sensors; otherwise like Vehicle 1. The connections differ in a, b, and c.

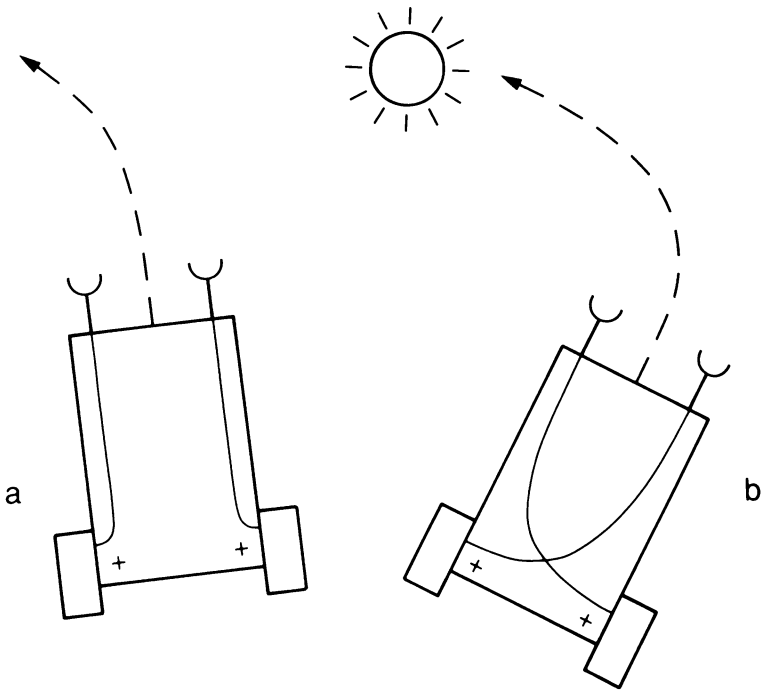


Figure 3

Vehicles 2a and 2b in the vicinity of a source (circle with rays emanating from it). Vehicle 2b orients toward the source, 2a away from it.

motor will work harder. And as a consequence the vehicle will turn away from the source.

Now let us try the other scheme of sensory-motor connections, (b) in figure 3. No change if the source is straight ahead. If it is to one side, however, we notice a difference with respect to Vehicle 2a. Vehicle 2b will turn toward the source and eventually hit it. There is no escaping: as long as 2b stays in the vicinity of the source, no matter how it stumbles and hesitates, it will hit the source frontally in the end. Only in the unlikely case that a strong perturbation in its course makes it turn exactly away from the source, and no further perturbation occurs, can it escape its fate.

Let Vehicles 2a and 2b move around in their world for a while and watch them. Their characters are quite opposite. Both DISLIKE sources. But 2a becomes restless in their vicinity and tends to avoid them, escaping until it safely reaches a place where the influence of the source is scarcely felt. Vehicle 2a is a COWARD, you would say. Not so Vehicle 2b. It, too, is excited by the presence of sources, but resolutely turns toward them and hits them with high velocity, as if it wanted to destroy them. Vehicle 2b is AGGRESSIVE, obviously.