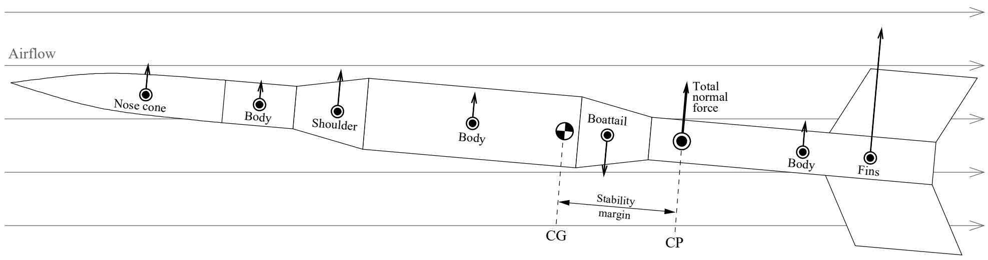

Figure 2.4: Normal forces produced by the rocket components.

of the rocket can be seen as producing a separate normal force component originating from the component's CP, as depicted in Figure 2.4.

The effect of the separate normal forces can be combined into a single force, the magnitude of which is the sum of the separate forces and which effects the same moment as the separate forces. The point on which the total force acts is defined as the center of pressure or the rocket. As can be seen from Figure 2.4, the moment produced attempts to correct the rocket's flight only if the CP is located aft of the CG. If this condition holds, the rocket is said to be *statically stable*. A statically stable rocket always produces a corrective moment when flying at a small angle of attack.

The argument for static stability above may fail in two conditions: First, the normal forces might cancel each other out exactly, in which case a moment would be produced but with zero total force. Second, the normal force at the CP might be in the wrong direction (downward in the figure), yielding an uncorrective moment. However, we shall see that the only component to produce a downward force is a boattail, and the force is equivalent to the corresponding broadening of the body. Therefore the total force acting on the rocket cannot be zero nor in a direction to produce an uncorrective moment when aft of the CG.

The *stability margin* of a rocket is defined as the distance between the CP and CG, measured in *calibers*, where one caliber is the maximum body diameter of the rocket. A rule of thumb among model rocketeers is that the CP should be approximately 1–2 calibers aft of the CG. However, the CP of a rocket typically moves upwards as the angle of attack increases. In some cases, a 1–2 caliber stability margin may totally disappear at an angle of attack of only a few degrees. As side wind is the primary cause of angles of attack, this effect is called *wind caused instability* [13].