Reaction for March 24 Journal

March 20, 2008

Let's imagine the following situation: a 300 lb offensive tackle leads a running back from the backfield, hitting the opposition's big middle linebacker at full speed. This particular tackle's fast: he can do a 40 yd sprint in 5 seconds and he has managed to get to this speed just before this collision. Let's say he's going to the right, which we'll call the positive x direction.

The linebacker is a big boy also and stops the tackle in 200 ms, or 0.2 seconds. What I want to know is the average force that the tackle feels as a result of this collision.

Remember Newton's second law in the form that Newton considered it:

$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t}. \tag{1}$$

We'll presume that the tackle loses no body parts or heavy pieces of his equipment in the collision, so his mass stays constant throughout. Then, the Second Law can be written as:

$$\vec{F} = \frac{m\Delta \vec{v}}{\Delta t}. \tag{2}$$

He comes to a stop, so that the final velocity is zero. Can you convince yourself that his 40 yard dash speed is equal to 24 ft/second?

Think about signs...The initial velocity is to the right, which we'll call the positive x direction. I suspect if you think about it, you'll realize that the force applied to the tackle in the collision is going to be to the *left*. So, if we get rid of the vector symbols, we should have a negative force when we're all done, and that's just telling us that the force pushes back on him.
So, we have:

$$\begin{aligned} v_{initial} &= +24 ft/s \\ v_{final} &= 0. \end{aligned}$$

Question to respond to: show that $\Delta v = -24$ ft/s.

With that information in hand, the Second Law situation becomes:

$$F = m\frac{-24}{0.2}. \tag{3}$$

Okay. Mass vs. weight. I labeled the tackle at 300 lbs, which is the his weight. Remember, the unit of mass in the English system is "slugs,"...honest. From the relationship between mass and weight,

$$W = mg \tag{4}$$

and with the information that the acceleration due to gravity on the surface of the earth (where the game is played) is 32 ft/s^2, convince yourself that the mass of the tackle is 9.4 slugs.
Now, with all of this together:

$$\begin{aligned} \Delta v &= -24 \text{ ft/s}, \\ \Delta t &= 0.2 \text{ s, and} \\ m &= 9.4 \text{ slugs}, \end{aligned}$$

Respond to this question: show that the force that the tackle experiences is a little more than half a ton.

(You might want to Google your way to figuring out how many pounds are in a "short ton.")

Football is a contact sport.