In the article *Energy Dynamics*, the creation of Mysterious Forces was demonstrated using the Law of Conservation of Momentum. However, the key idea of that article was that it was the momentum of energy that was being conserved. Understanding forces in Special Relativity means keeping track of energy in all reference frames and understanding how that energy is moving from reference frame to reference frame. One way to better see the role of energy in Special Relativity is to base transformations in Special Relativity on energy and not on velocity.

In dynamic calculations of force, kinetic energy is the important variable. Kinetic energy KE is:

$$KE = mc^2(\left(\frac{1}{\sqrt{1-\beta^2}}\right) - 1) \tag{87}$$

Equation (87) can be restated:

$$\sqrt{1-\beta^2} = \left(\frac{1}{1+\left(\frac{KE}{mc^2}\right)}\right) \tag{88a}$$

$$\beta = \sqrt{1 - \left(\frac{1}{(1+\left(\frac{KE}{mc^2}\right))^2}\right)} \tag{88b}$$

Transformations in Special Relativity can be based on kinetic energy by making substitutions of (88) into the existing transformation formulas. For example, consider the case of Figure 24.

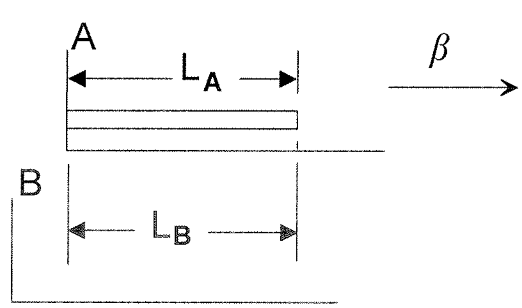

Figure 24

Figure 24 shows reference frame A moving with velocity β relative to reference frame B. A bar with length L_A (as measured by frame A) is stationary in frame A. This bar is measured by frame B to be of length L_B.

$$L_B = L_A\sqrt{1-\beta^2} = \left(\frac{L_A}{1+\left(\frac{KE}{m_A c^2}\right)}\right) \tag{89}$$

Equation (89) assumes the bar has mass m_A, a value determined by experiments run within frame A. Frame B could also run experiments to determine the mass as m_B.

$$m_B = \left(\frac{m_A}{\sqrt{1-\beta^2}}\right) = m_A(1+\left(\frac{KE}{m_A c^2}\right)) \tag{90}$$

If a clock at the origin of frame A reads $t_A = 0$ just as a clock in frame B reads $t_B = 0$, then subsequent clock readings would be:

$$t_B = \left(\frac{t_A}{\sqrt{1-\beta^2}}\right) = t_A(1+\left(\frac{KE}{m_A c^2}\right)) \tag{91}$$

A quantity mc^2 is itself equivalent to an energy. This would be the energy resulting if all of mass m could be converted to energy. It is essentially the total energy of mass m before any kinetic energy was added to it. The ratio KE/mc^2 is the fraction of energy added to the original $E = mc^2$ energy. The quantity $(1 + KE/mc^2)$ is therefore the ratio of final total energy of mass m (after the addition of the kinetic energy) divided by the original total energy.

There is a special case of this energy-ratio description of Special Relativity and that case is where the kinetic energy addition to mass m is done with a constant force F. The force F would act over a distance L resulting in KE = FL. The distance L can be obtained by adapting (52) from the article *Force and Time*.

$$L = (c/A_M)\left[(1+(A_M t)^2)^{1/2} - 1\right] \tag{92}$$

$$A_M = \left(\frac{F}{mc}\right)$$

Equation (92) describes an experiment where mass m is stationary in the reference frame and is then accelerated for time period t with constant force F. Equation (92) can be written:

$$1+\left(\frac{FL}{mc^2}\right) = \left(1+\left(\frac{Ft}{mc}\right)^2\right)^{1/2} \tag{93}$$

The quantity Ft is the momentum gain of mass m during the experiment. This allows an alternate expression for the velocity β of mass m to be developed from (88b).

$$\beta = \left(\frac{\left(\frac{Ft}{mc}\right)}{\left(1 + \left(\frac{Ft}{mc}\right)^2\right)^{1/2}} \right) \qquad (94)$$

Equation (94) is similar to (51) in the article *Force and Time*. Equation (93) can also be rewritten:

$$\left(\frac{1}{2}\right)\left(\frac{F}{m}\right)t^2 = L + \left(\frac{1}{2}\right)\left(\frac{FL^2}{mc^2}\right)$$

$$\left(\frac{1}{2}\right)\left(\frac{F}{m}\right)t^2 = L(1 + \left(\frac{1}{2}\right)\left(\frac{KE}{mc^2}\right)) \qquad (95)$$

Except for the term $\left(\frac{1}{2}\right)\left(\frac{KE}{mc^2}\right)$, (95) is the Newtonian formula for distance as a function of time for the case of a constant applied force. The Newtonian formula for distance as a function of time comes directly from F = ma. Equation (95) could be used to deduce the relativistic version of Newton's Law by differentiating twice. When L is replace by the variable x, the result is:

$$F(1 - \left(\frac{v^2}{c^2}\right)) = (1 + \left(\frac{Fx}{mc^2}\right))ma \qquad (96)$$

$$v = \left(\frac{dx}{dt}\right) \qquad a = \left(\frac{dv}{dt}\right)$$

Equation (96) can be rewritten:

$$F = \left(1 + \left(\frac{KE}{mc^2}\right)\right)^3 ma \qquad (97a)$$

$$F = \left(\frac{ma}{(1 - \beta^2)^{3/2}}\right) \qquad (97b)$$

As before, in (97a) KE = Fx.

This article has presented examples where kinetic energy of an object is used in relativistic transformations instead of the familiar velocity β. The use of kinetic energy in this way is not a significant improvement in the calculations as presented thus far, though it does provide some insight into how energy participates in dynamic experiments.

The participation of energy in dynamic experiments is the same as the participation of material in those experiments. That may be a key idea. Consider a material object moving at constant velocity. Part of the material is converted to heat energy (through nuclear fission) and this energy is contained within the object (the exterior surface of the object is insulation). The Law of Conservation of Momentum and the Law of Conservation of Energy require that the momentum and kinetic energy of the object have not been changed. The momentum and kinetic energy of the object are the same whether the object is composed of only material or has some of its material converted into heat energy (contained within the remaining material of the object).

This could be a fundamental law in the operation of the universe. Think of Special Relativity in the following way. Originally the velocity of light was experimentally observed to be constant and this eventually led to the equation $E = mc^2$. But it should also be possible to start with Newtonian physics and the concept $E = mk$ (k = a constant) and derive the constancy of the speed of light. In other words, the constancy of the speed of light is not the fundamental law that governs the operation of the universe, but is just a consequence of $E = mk$ which is the fundamental law.

The test of this idea will be explored in the articles detailing relativistic transformations in a gravitational field.