From basic tunnel geometry:

$$\begin{pmatrix}\text{In Situ Volume of Material Excavated}\end{pmatrix} = \begin{pmatrix}\text{Tunnel Advance}\end{pmatrix} * \begin{pmatrix}\text{Face Cross-sectional Area}\end{pmatrix} \quad (1)$$

From Rock Mechanics Specific Energy is defined as:

$$\begin{pmatrix}\text{Specific Energy of the rock breaking process}\end{pmatrix} \triangleq \frac{\begin{pmatrix}\text{Energy applied to the rock}\end{pmatrix}}{\begin{pmatrix}\text{Mass of rock Excavated}\end{pmatrix}}$$

This will vary moment to moment and hour to hour as differing strata are encountered. For tunneling it is useful to take averages:

$$\begin{pmatrix}\text{Average Specific Energy of the rock breaking process}\end{pmatrix} \triangleq \frac{\begin{pmatrix}\text{Average Energy applied to the rock}\end{pmatrix}}{\begin{pmatrix}\text{Average mass of rock excavated}\end{pmatrix}} \quad (2)$$

Rearranging (2) we get:

$$\begin{pmatrix}\text{Average mass of rock excavated}\end{pmatrix} = \frac{\begin{pmatrix}\text{Average Energy applied to the rock}\end{pmatrix}}{\begin{pmatrix}\text{Average Specific Energy of the rock breaking process}\end{pmatrix}} \quad (2a)$$

$$\text{Density of rock} \triangleq \frac{\text{Mass}}{\text{Volume}}$$

Rearranging: $\text{Volume} = \frac{\text{Mass}}{\text{Density}}$

or, for our purposes:

$$\begin{pmatrix}\text{Insitu Volume of Rock Excavated}\end{pmatrix} = \frac{\begin{pmatrix}\text{Mass of Rock Excavated}\end{pmatrix}}{\begin{pmatrix}\text{Rock Density}\end{pmatrix}} \quad (3)$$

Rearranging (1) and substituting (3) we get:

$$\left(\text{Tunnel Advance}\right) = \frac{\left(\text{In situ volume of material excavated}\right)}{\left(\text{Face Cross-Sectional Area}\right)} = \frac{\left(\text{Mass of Rock Excavated}\right)}{\left(\text{Density}_{\text{Rock}}\right)\left(\text{Face Cross-Sectional Area}\right)}$$

Substituting from (2a)

$$\left(\text{Tunnel Advance}\right) = \frac{\left(\text{Average Energy Applied to the rock}\right)}{\left(\text{Average Specific Energy of the rock breaking progress}\right)\left(\text{Density}\right)\left(\text{Face Cross-sectional area}\right)} \quad (4)$$

Power is Energy/Time so Energy = Power * Time

or, for our purposes:

$$\left(\text{Average Energy Applied to the rock}\right) = \left(\text{Average power applied to the rock when the machine is operating}\right) * \left(\text{Time that machine is on}\right)$$

Substituting into (4) we have:

$$\left(\text{Tunnel Advance}\right) = \frac{\left(\text{Average power applied to the rock when the machine is operating}\right) * \left(\text{Time that machine is on}\right)}{\left(\text{Average specific energy of the rock breaking process}\right) * \left(\text{Density}\right)\left(\text{Face Cross-Sectional Area}\right)} \quad (5)$$

Now, let us define Two intuitive factors:

$$\text{Effectiveness} \triangleq \frac{\left(\text{Average Power applied to the rock when the machine is operating}\right)}{\left(\text{Total Available Power}\right)}$$

$$\text{Continuity} \triangleq \frac{\left(\text{Time machine is on}\right)}{\left(\text{Total Time}\right)}$$

Inverting these definitions and substituting into (5):

$$\left(\begin{matrix}\text{Tunnel}\\ \text{Advance}\end{matrix}\right) = \frac{\left(\begin{matrix}\text{Total}\\ \text{Available}\\ \text{Power}\end{matrix}\right)\left(\text{Effectiveness}\right)\left(\text{Continuity}\right)\left(\text{Total Time}\right)}{\left(\begin{matrix}\text{Average Specific}\\ \text{Energy of the rock}\\ \text{breaking process}\end{matrix}\right)\left(\text{Density}\right)\left(\begin{matrix}\text{Face Cross-}\\ \text{Sectional Area}\end{matrix}\right)} \qquad (6)$$

Defining two more intuitive factors:

$$\left(\begin{matrix}\text{Power}\\ \text{Intensity}\end{matrix}\right) \triangleq \frac{\left(\begin{matrix}\text{Total}\\ \text{Available}\\ \text{Power}\end{matrix}\right)}{\left(\begin{matrix}\text{Face Cross-}\\ \text{Sectional Area}\end{matrix}\right)}$$

$$\text{Intelligence} \triangleq \frac{1}{\left(\begin{matrix}\text{Average Specific}\\ \text{Energy of the rock}\\ \text{breaking process}\end{matrix}\right)\left(\text{Density}\right)}$$

Note: Units of "Intelligence" are then volume/energy. A process yielding more volume per unit energy is more "intelligent".

Rearranging (6):

$$\frac{\left(\begin{matrix}\text{Tunnel}\\ \text{Advance}\end{matrix}\right)}{\left(\begin{matrix}\text{Total}\\ \text{Time}\end{matrix}\right)} = \frac{\left(\begin{matrix}\text{Total}\\ \text{Available}\\ \text{Power}\end{matrix}\right)}{\left(\begin{matrix}\text{Face Cross-}\\ \text{Sectional Area}\end{matrix}\right)} * \frac{1}{\left(\begin{matrix}\text{Average Specific}\\ \text{Energy of the rock}\\ \text{breaking process}\end{matrix}\right)\left(\text{Density}\right)} * \left(\text{Effectiveness}\right)\left(\text{Continuity}\right)$$

$$\left(\begin{matrix}\text{Tunnel}\\ \text{Advance}\\ \text{Rate}\end{matrix}\right) = \left(\begin{matrix}\text{Power}\\ \text{Intensity}\end{matrix}\right)\left(\text{Intelligence}\right)\left(\text{Effectiveness}\right)\left(\text{Continuity}\right) \qquad (7)$$

This is what we were striving for, an equation that is evocative.