

## IV. The Statute Mile, the Foot and the Inch

The origin of the statute mile dates back to Queen Elisabeth and her mathematics tutor John Dee. While the emergence of England as a major world power during the reign of Queen Elisabeth (1558 to 1603) is attributed by most historians to her political ability, her intellect and ability to find and use the leading intellectuals of her time was perhaps at least equally important in the ascendance of England to global power status. Navigation on the sea was critical for any country that wanted to be a global power.

John Dee, born in 1527, was a leading mathematician and all round scholar. He was a contemporary of, and collaborator with Mercator, the geographer instrumental in producing a map on a piece of paper that when laid flat portrayed the geography of the earth in terms of longitude and latitude. Dee was also an occult mystic according to the 16<sup>th</sup> century definition of the phrase. While no record of the thinking concerning the logic of the statute mile exists, a reasonable guess as to the thinking process can be made.

Starting with the numbers 2520 and pi, multiplication produces roughly 7917. Take this number as the diameter of the earth in statute miles and multiply by pi again (pi times the diameter of a circle gives the circumference) to find the circumference of the earth as 24,871 statute miles. This method of calculating the circumference of the earth defines the statute mile. No one is going to wrap a string around the earth at the equator to get the statute mile, but one degree of longitude at the equator is 24,871/360 or 69.1 miles and one tenth of a degree is 6.91 miles.

The sun moves 360 degrees in 24 hours, or 15 degrees per hour. This corresponds to 1/4<sup>th</sup> of a degree per minute. One-fourth of a degree corresponds to 17.3 miles. There is an easier way to see this using a unit conversion equation. Start with 360° of rotation in 24 hours corresponding to 24,871 miles per 24 hours and multiply by 1 hour over 60 minutes and again by 1 minute over 60 seconds to get the rate of 0.29 miles per second.

$$\frac{360^\circ}{24 \text{ hr}} \Rightarrow \frac{24,871 \text{ mi}}{24 \text{ hr}} \left[ \frac{1 \text{ hr}}{60 \text{ min}} \right] \left[ \frac{1 \text{ min}}{60 \text{ sec}} \right] = \frac{0.29 \text{ mi}}{\text{sec}}$$

Experimentally a length standard can be made using this information. Go to the equator and make observations of high noon using the highest point of the sun above the horizon at two points along the equator. If the observations are 5 seconds apart then the distance along the surface of the earth is

$$\frac{0.29 \text{ mi}}{\text{sec}} [5 \text{ sec}] = 1.44 \text{ mi}$$

While the mile is an appropriate size for navigation at sea, everyday interactions require smaller units. It would be convenient to have a length unit comparable to the size of hands or fingers, another one for the size of feet, another for the length of reach (tip of fingers to nose) and shoulder to tip of fingers.

If pi is multiplied by 7 five times the result is 52,800.

$$\pi \times 7 \times 7 \times 7 \times 7 \times 7 = 52,800$$

If the mile were divided by this number, the length would be comparable to hand size. However, the mile was divided by one-tenth of this number, 5280, to obtain a length comparable to the foot of a person. The foot length was further divided by 12 to obtain the inch. The number 12 is convenient because it is easily divisible by 2, 3, 4 and 6. The length from tip of fingers to nose comes out to about 3 feet, a convenient length designated as the yard, and the length from shoulder to tip of fingers is roughly 25 inches.

It is possible to speculate that if the mile were divided by 52,800, a length a little longer than the inch would have resulted, and multiplication by 10 would produce a length comparable to the present day foot. But multiplying by 10 is a problem because 10 is only cleanly divisible by 2 and 5. The advantage of 12 inches per foot is the ease of defining  $\frac{1}{2}$  or  $\frac{1}{3}$  or  $\frac{1}{4}$  of a foot.

The roughly 25 inches for the length from shoulder to tip of fingers is known as the cubit. Cubits have been used for centuries and it is tempting to assign 25.2 inches (one one-hundredth of the 2520 number) to the length of the cubit. The most famous use of the cubit is in the building of the arc of the covenant which is specified as a brick-like structure with square ends of 1.5 cubits and length 2.5 cubits

If we take one one-hundredth of the number 2520 that number is 25.20. The cubit as defined most popularly in the dimensions of the arc of the covenant is by most account in the neighborhood of 25 inches. Newton investigated the use of the cubit as a measure throughout history. With the cubit defined this way (as 25.2 inches), the inch is approximately a thumb width and the foot, 12 inches, the length of a human foot. Why 12 inches? The number 12, besides being roughly the length of a human foot, is convenient because of the easy divisibility. Numbers (in inches) close to the length of a human foot, for example, 11 or 13 or even 10 or 14 do not have this convenience of division into halves, thirds and quarters.

The statute mile was established by Queen Elisabeth in 1592 based along the lines of the arguments presented here. There are no physical records of the discussions between John Dee and Elisabeth concerning the mile, the foot and the inch. The argument presented here is reconstructed from educated guesses based on our understanding of their thinking on the subject.

While the nautical mile is convenient for global navigation, the statute mile and its subdivisions into feet and inches is more useful for everyday measurements.