Commentary on John Wilkins' 'Of Measure.'

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The first major proposal towards what eventually became the metric system and later the International System of Units (SI) was made in 1668, when John Wilkins published:

An Essay Toward a Real Character and a Philosophical Language.

This contained the idea of a decimal unit system using part of the circumference of the Earth as a standard for measuring lengths. Wilkins not only suggested the use of the Earth as the standard for length, he also suggested that a pendulum of specified time period should be used as a convenient standard for routine use.

Wilkins further suggested that the decimal system of tenths (as suggested by Simon Stevin in 1585) should be used to separate larger and smaller parts.

Wilkins had suggested in his proposal two of the main characteristics of our modern metric system: a standard '*universal measure*' with decimal multiples and sub-multiples.

In this commentary I will use two columns: in the left-hand column I will quote John Wilkins as translated into modern English, and I will put my comments in the right-hand column. Here is a sample:

`To which purpose, it were most desirable to find out some natural Standard, or universal Measure, which hath been esteemed by Learned men as one of the desiderata in Philosophy.`	Wilkins clearly thought that it was desirable to establish a single international standard, or '*universal measure*' of some kind, suggesting that this should be based on the longitude of the Earth. He went on to say that this had long been desired — a desiderata — by learned men.

For you to see how John Wilkins' work fits into an historical context I provide a short chronology of metric system development from 1585 to 1790 as an appendix, but firstly I quote from '*The Adventure of English, The Biography of a Language*', Melvyn Bragg 2003

> *First, though, a digression which I think illustrates how deeply the idea of language as the key to all understanding had bitten in to the scholars and thinkers of the time. In the seventeenth century attempts grew to discover the 'original' language, the language prior to the Tower of Babel as described in the book of Genesis, when all men spoke the same language. It was thought that this 'Adamic' language had been spoken in the Garden of Eden and that its purity had illuminated all things and all thoughts perfectly. Lost by the sinful behaviour of Adam and Eve and become the Babel of tongues that followed the Fall, it was thought that it could be rediscovered, perhaps by the study of ancient Hebrew. It should be noted that this search went alongside the equally serious search of minds as fine as that of Newton to discover the essential secrets of matter through a study of alchemy. In the second half of the seventeenth century, the Royal Society commissioned one of its members, John Wilkins, to create a universal language. This was a highly regarded undertaking. In his book* **An Essay Toward a Real Character and a Philosophical Language** *(1668), Wilkins argued that since the minds of everyone functioned in the same way and had a similar 'apprehension of things', there was no reason to believe there could not be one universal language, This language would not only make international cooperation on every level simpler than ever before, it would also 'prove the shortest and plainest way for the attainment of real knowledge, that have yet been offered to the world'.*

Wilkins' proposal in the chapter, '*Of Measure*', was discussed, amended, criticized, and advocated for 120 years, before the fall of the Bastille and the creation of the National Assembly made his '*universal measure*' a political possibility - in France - in the 1790s.

In this commentary, I am only concerned with the contribution that John Wilkins made to the world of what was required for a universal language of measurement. Of course John Wilkins was not alone in developing this idea; he was well supported by his associates in the academic worlds of Cambridge and Oxford in the 1640s and 1650s before the formation of the '*Royal Society of London for Improving Natural Knowledge*'.

In his essay, Wilkins set out to make words clearer, and along the way listed — in four and a half pages of his 638 page essay — all of the conditions needed for a universal measuring system. You can find the full text at http://www.metricationmatters.com/articles

I suppose that it would be easy to say that John Wilkins' work was simply forgotten, buried as it was within the major wordiness of his full essay. But this is hard to believe when you think of the fluidity of international communication at that time.

Ideas, and even people, flowed freely between countries and even continents. For example, the Scotsman, James Watt, and the Englishman, Joseph Priestly, both influenced the work of the French couple Pierre and Marie Lavoisier. Both Benjamin Franklin and Thomas Jefferson had profound effects through correspondence and personal visits between the USA, the UK, and France; Benjamin Franklin was elected a Fellow of the Royal Society in 1756; he had earlier received the Royal Society's Copley Medal in 1753 for his pioneering work on electricity and Thomas Jefferson was a Fellow of the Royal Society of Edinburgh.

This is an extract from ***An Essay Towards a Real Character and a Philosophical Language*** by John Wilkins, published in London in 1668	Comments by Pat Naughtin in 2007 pat.naughtin@metricationmatters.com
	John Wilkins, one of the founders of '*The Royal Society of London for Improving Natural Knowledge*' (Royal Society), uses this 638 page essay to develop a new universal language for the use of philosophers. Wilkins' essay was essentially about words. He defined the 'real character' of this work as a new orthography (a way of spelling) for the English language. Wilkins' characters resembled in some ways a shorthand for the English language such as the one developed in 1837 by Isaac Pitman (1813/1897). The essay included a detailed description of both the written and spoken English language and contained a dictionary of 150 pages that related many other human languages to English. This dictionary was probably only the second dictionary of the English language (after Robert Cawdrey's '*A Table Alphabeticall*' of 1604).
Chap. VII. Measure. Page 190	Title of the section on numbers and measurement.

Those several relations of Quantity, whereby men use to judge of the Multitude or Greatness of things, are styled by the name of MEASURE, Dimension, mete, survey, Rule; to which the relative term of PROPORTION, portion, Rate, Tax, Size, Scantling, Pittance, Share, Dose, Mess, Symetry, Analogy, commensurate, dispense, allot, adapt, is of some Affinity signifying an equality or similitude of the respects that several things or quantities have to one another.	Wilkins developed a 'philosophical language' based on a classification scheme (an ontology) for all the words in the English language. Wilkins' word grouping technique was later used by Peter Mark Roget (1779/1869), when he published his *Thesaurus* as: '*A collection of English words and phrases arranged according to the ideas they express, rather than in alphabetical order to facilitate the expression of ideas and to assist in literary composition*' (1852). Roget acknowledges his debt to John Wilkins in the preface to his first edition.
They are distinguishable into such as respect either MULTITUDE. I. MAGNITUDE. II. GRAVITY. III. VALOR. IV. Duration. More GENERALLY CONSIDERED. V. As RESTRAINED TO LIVING CREATURES. VI.	Firstly, Wilkins divided words into broad classes that he numbered with Roman numerals. Multitude = counting numbers Magnitude = sizes of things Gravity = 'weight' (or mass) of things Valor = value of things in money Duration = measures of time
To the Measure whereby we judge of the MULTITUDE of things may be annexed NUMBER enumerate, reckon, compute, muster, count, re-count, Tale, tell, Arithmetic, Cyphering.	Wilkins then explored each subject in detail. Here he looked at the way the English language handled the words for different amounts.
If the way of Numeration were not to be stated, it would seem more convenient to determine the first Period or Stand at the number Eight, and not at Ten; because the way of Dichotomy or Bipartition being the most natural and easie kind of Division, that Number is capable of this down to an Unite, and according to this should be the several denominations of all other kinds of Measures, whether of Capacity, Gravity, Valor, Duration.	He then suggested the number eight as a convenient way to subdivide into smaller amounts: of all other kinds of Measures, whether of Capacity, Gravity, Valor, Duration Clearly, Wilkins believed that his system would apply to all measurements for all purposes.

So eight Farthings would make a Peny, eight Pence a Shilling, eight Shillings an Angel, eight Angels a Pound. So eight Grains should make a Scruple, eight Scruples a Dram, either Drams an Ounce, eight Ounces a Pound, & c.	This is Wilkins' method of eighths applied to English money.
But because general custom hath already agreed upon the decimal way, therefore I shall not insist upon the change of it.	Decimal numbers had become popular in Europe following Simon Stevin's '*De Thiende*' (Of Tenths) in 1585. They became particularly popular in England when Simon Stevin's book was translated into English by Robert Norton in 1608 as: '*Disme: The art of tenths — or Decimall Arithmetike*'. So Wilkins conceded that decimal numbers were successful.
The different degrees of Number generally received, are these:	Back to the Thesaurus-like properties of the John Wilkins' essay.
ONE, Ace, Unit, Once, First, Imprimis, Single. TWO, a Couple, a Brace, a Pair, a Yoke, second-ly, Twice, Double, Twofold, Bipartite. THREE, A leash, Ternary, Trey, Third-ly, Tertian, Thrice, Treble, Threefold, Tripartite, Trine-ity. FOUR, Fourth-ly, quartan, Quarternion, Fourfold, Quadruple, Quadrupartite, Quartile. FIVE, Fifth-ly, Quintuple, Fivefold. SIX, Sixth-ly, Sixfold, Sextuple, Sextile, Senary. SEVEN, Seventh-ly, Septuple, Sevenfold. EIGHT, Eighth-ly, Octuple, Eightfold. NINE, ninth-ly, Ninefold.	Here Wilkins listed all the English number words with similar meanings.
How other numbers besides these here enumerated may be expressed both in writing and speech, see hereafter, Chap.	He then pointed toward a later chapter where he will describe larger and smaller numbers.

Measures of Magnitude do comprehend both those of Length, and of Superficies or Area, together with those of Solidity; both comprehended in that which is adjoined, viz. the word CAPACITY, hold, contain. The several Nationals of the World do not more differ in their Languages, then in the various kinds and proportions of these Measures. And it is not without great difficulty, that the Measures observed by all those different Nations who traffick together, are reduced to that which is commonly known and received by any one of them; which labour would be much abbreviated, if they were all of them fixed to any one certain Standard.	This single paragraph contained for the first time Wilkins' ideas for an international standard to help all those different Nations who traffick together. Wilkins seemed to be aware of the problems faced by international traders when they confront different measuring methods as their goods cross borders. He suggested that labour would be much abbreviated, if they were all of them fixed to any one certain Standard. Wilkins also seemed to be aware of the time and cost savings available from simple rational measurement methods. Wilkins is suggesting a universal measuring language to make labor and trade much easier and less stressful between all the nations of the world.
To which purpose, it were most desirable to find out some natural Standard, or universal Measure, which hath been esteemed by Learned men as one of the desiderata in Philosophy.	Clearly, Wilkins thought it desirable to establish a single international standard of some kind and suggested that this should be based on the longitude of the Earth. He went on to say that this has long been desired — a desiderata — by learned men.
If this could be done in Longitude, the other Measures might be easily fixed from thence.	Wilkins specifically suggested that a line of longitude on the Earth's surface would be suitable as the basis of a world 'Standard'.
This was heretofore aimed at and endeavoured after in all those various Measures, derived from natural things, though none of them do sufficiently answer this end. As for that of a Barly corn, which is made the common ground and original of the rest, the magnitude and weight of it may be to various in several times and places, as will render it incapable of serving for this purpose; which is true likewise of those other Measures, an Inch, Palm, Span, Cubit, Fathom, a Foot, Pace; & c. none of this can be determined to any sufficient certainty.	Wilkins then went through the measuring words that were currently available in the English language. In 1668, the main legal definition for both length and weight was the barleycorn — *chosen from the middle of the ear, full and round* — that was used to define such lengths as different shoe sizes, an inch, a foot, a yard, and the weight of gold coins and potatoes. However, Wilkins dismissed this as being unsuitable to be the 'Standard' because it could not be defined with sufficient accuracy or precision.

Some have conceived that this might be better done by subdividing a Degree upon the Earth: But there would be so much difficulty and uncertainty in this way as would render it unpracticable.	The 'some' that Wilkins referred to were the people with whom he regularly met to discuss scientific and technical questions. These were largely, by 1668, the other members of the Royal Society. They included: Robert Boyle, a natural philosopher and chemist; Lord Brouncker, the president of the Royal Society; King Charles II, king of England; John Evelyn, a diarist, traveller and gardener; John Flamsteed, an astronomer; Robert Hooke, an experimental physicist; Sir Isaac Newton and his assistant, J. T. Desaguliers; and Samuel Pepys, a diarist. The Royal Society was, and is, committed to establishing scientific truth through experiment rather than through reference to authorities. Its motto, '*Nullius in Verba*', literally means '*On the words of no one*'. The method suggested here by Wilkins in 1668 was essentially the same as that used by Giovanni Cassini for his meridian experimental measurements in 1683, and by Delambre and Méchain for their meridian measurements from Dunquerque in France to Barcelona in Spain between 1792 and 1798.
Others have thought, it might be derived from the Quick-silver experiment: But the unequal gravity and thickness of the Atmosphere, together with the various tempers of Air in several places and seasons, would expose that also to much uncertainty.	The 'others' mentioned here are other members of the Royal Society. The Quick-silver experiment referred to the idea of using a mercury-based barometer to measure heights accurately based on the thought that pressure varies with height. Wilkins rejected this idea as too variable.
The most probable way for the effecting of this, is that which was first suggested by Doctor Christopher Wren, namely, by Vibration of a Pendulum: Time it self being a natural Measure, depending upon a revolution of the Heaven or the Earth, which is supposed to be everywhere equal and uniform. If any way could be found out to make Longitude commensurable to Time, this might be the foundation of a natural Standard.	Wilkins then decided that the most likely way to develop a 'Standard' was to use a 'seconds' pendulum, which was thought at that time to vary only by very small amounts around the world.

In order to which, let there be a solid Ball exactly round, of some of the heaviest metals Let there be a String to hang it upon the smallest, Limberest, and least subject to retch: Let this Ball be suspended by this String, being extended to such a length, that the space of every Vibration may be equal to a second Minute of time, the String being, by frequent trials, either lengthened or shortened, till it attain to this equality These Vibrations should be the smallest, that can last a sufficient space of time, to afford a considerable number of them, either 6, or 500 at least; for which end, its passing an arch of five or six degrees at the first may be sufficient. The Pendulum being so ordered as to have every one of its Vibrations equal to a second minute of time, which is to be adjusted with much care and exactness; then measure the length of this String, from its place of suspension to the Centre of the Ball; which Measure must be taken as it hangs free in its perpendicular posture, and not otherwise, because of stretching: which being done, there are given these two Lengths, viz. of the String, and of the Radius of the Ball, to which a third Proportional must be found out; which must be as the length of the String from the point of Suspension to the Centre of the Ball is to the Radius of the Ball, so must the said Radius be to this third which being so found, let two fifths of this third Proportional be set off from the Centre downwards, and that will give the Measure desired.	Wilkins described in detail how to go about establishing a '*Natural Standard*' for yourself wherever you are on the surface of the Earth. Clearly, Wilkins wanted to share this uniform 'Standard' so that everyone could benefit from a common, standardised, international, measurement language. As a founding member of the Royal Society, Wilkins was dedicated to the free flow of information to encourage clear communication between all the people of the world. One of the early goals of the Royal Society was to develop an '*Empire of Learning*' by removing language barriers, including language barriers that included the names of old measuring methods. These days, we refer to the 'second minute of time' simply as a 'second'.

And this (according to the discovery and observation of those two excellent persons, the Lord Viscount Brouncker, President of the Royal Society, and Mon. Huygens, a worthy Member of it) will prove to be 38 Rhinland Inches, or which is all one 39 Inches and a quarter, according to our London Standard.	Wilkins here described the length that later became known to the rest of us as the '**metre**'. Given the precision of the methods at that time his definition was extraordinarily accurate. His result would define a metre as: **996.95 millimetres** compared to the modern value of: **1000 millimetres exactly**. This is a truly remarkable achievement in 1668, more than 120 years before the French Revolution and the subsequent definition of the metre in France.
Let this Length therefore be called the Standard; let one Tenth of it be called a Foot; one Tenth of a Foot, an Inch; one Tenth of an Inch, a Line. And so upward, Ten Standards should be a Pearch; Ten Pearches, a Furlong; Ten Furlongs, a Mile; Ten Miles, a League, & c. And so for Measures of Capacity: The cubical content of this Standard may be called the Bushel: the Tenth part of the Bushel, the Peck; the Tenth part of a Peck, a Quart; and the Tenth of that, a Pint, & c. And so for as many other Measures upwards as shall be thought expedient for use.	It seems likely that Secretary of State Thomas Jefferson had consulted a copy of John Wilkins' Essay before he submitted his report, called a '*Plan for Establishing Uniformity in the Coinage, Weights, and Measures of the United States*', to the U.S. House of Representatives in 1790 (July 13). Thomas Jefferson also promoted his decimal ideas in France when he was Ambassador to France from 1784 to 1789.
As for Measures of Weight; Let this cubical content of distilled Rain-water be the Hundred; the Tenth part of that, a Stone; the Tenth part of a Stone, a Pound; the Tenth of a Pound, an Ounce; the Tenth of an Ounce, a Dram; the Tenth of a Dram, a Scruple; the Tenth of a Scruple, a Grain, & c. And so upwards; Ten of these cubical Measures may be called a Thousand, and Ten of these Thousand may be called a Tun, & c.	The adoption of the idea that an exact amount of pure water should become the 'Standard' of mass was taken up by the French Academicians when they decided, about 120 years later, that a litre of water would have a mass of 1 kilogram. It seems most likely that the French designers of the metric system had access to John Wilkins' Essay and that they directly used his thoughts as the basis of the metric system.

As for the Measures of Mony, 'tis requisite that they should be determined by the different Quantities of those two natural Metals which are the most usual materials of it, viz. Gold and Silver, considered in their Purity without any allay. A Cube of this Standard of either of these Metals may be styled a Thousand or a Talent of each; the Tenth part of this weight, a Hundred; the Tenth of a Hundred, a Pound; the Tenth of a Pound, an Angel; the Tenth of an Angel, a Shilling; the Tenth of a Shilling, a Peny; the Tenth of a Peny, a Farthing.	Wilkins then went on to describe the decimal money that we now all use, all around the world, every day. The only difference is that he seemed unaware that it is very difficult to have the same word — but with a different definition — accepted by the public. As a person who studied words he seems to be unaware of how closely some people will clutch to words beyond all reason. One has only to look at how some people in the UK cling to the four remaining legal measuring words still in use there (carats, miles, pints, and therms) even though these are now all defined in terms of metric units (milligrams, kilometres, millilitres, and megajoules).
I mention these particulars, not out of any hope or expectation that the World will ever make use of them, but only to shew the possibility of reducing all Measures to one determined certainty.	It seems that John Wilkins was not an optimist, but he would surely whoop with glee if he returned and saw the success that his ideas have achieved in the relatively (historically) short time of 340 years between 1668 and now.

A metric chronology from 1585 to 1790

In 2007, during a round the world speaking tour, I had the good fortune to visit Monticello in Virginia, the home of Thomas Jefferson. There I discovered that Jefferson was a keen surveyor (as were George Washington and Abraham Lincoln).

Here is an extract from the historical Reference at http://celebrating200years.noaa.gov/theodolites/theodolitehead_zm.html

> *Several of our nation's early presidents spent time as surveyors.*
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> *Lawrence and Austin Washington inherited the most valuable of the Washington lands when their father died in 1743, leaving younger brother George (future first president of the United States) in need of a profession. George did inherit Augustine Washington's surveying equipment, and, at age sixteen, George embarked on his first career. George headed across the Blue Ridge Mountains, then considered the western frontier, to survey land for Thomas, Lord Fairfax.*
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> *Abraham Lincoln wrote of the time he spent as assistant to the Sangamon County (Illinois) Surveyor as something that "procured bread and kept soul and body together". Unfortunately, it apparently didn't always pay the bills, as in 1834, Lincoln sold his surveying equipment at auction to pay a debt.*
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> *While it may not be common knowledge that Presidents Washington and Lincoln were practitioners of the science of surveying, it should come as no surprise that Thomas Jefferson, the same President who referred to freedom as "the first born daughter of science," sent the Lewis and Clark Expedition west and established the Survey of the Coast, was also fascinated by the mathematics and techniques of surveying. Although he filled the post of Albemarle County (Virginia) Surveyor for a*

short time, Jefferson primarily used his skills on his own lands. However, in 1815, at the age of 72, Jefferson used the theodolite to determine the elevation of the Peaks of Otter in the Blue Ridge Mountains.

This fascinating piece of information provided me with the missing link as to how the system of '*universal measure*' travelled from England in 1668 to France in the 1790s. It seemed to me that the idea for a decimally based '*universal measure*' travelled from England to France in large part through the USA via two people, George Washington and Thomas Jefferson, as both of these men had had direct experience with the simplicity of decimal numbers in their surveying calculations using Gunter's Chain.

This sounds odd so let me put this into context with a short chronology:

1585

Simon Stevin published his decimal arithmetic book in two languages as:

Thiende (Tenths in Flemish) and as *Disme* (Tenths in French).

1608

When Simon Stevin's book was translated into English, Robert Norton gave it the title **'Disme: The Art of Tenths** or **Decimall Arithmeticke**'. From this title, the USA eventually used the word 'Disme' (without the silent internal 's') as the name of the coin that is the tenth of a dollar. The dime in the USA is quite likely the world's only coin that was named after a book!

1617

Willebrord Snellius, from Leiden in the Netherlands, made the first calculations of the length of the Earth's meridian.

1620

Edmund Gunter (1581/1626) published his 'Canon Triangulorum' describing several measuring instruments that he had invented including what has become known as 'Gunter's Chain'. Gunter's Chain was based on Simon Stevin's decimal arithmetic in that it had 100 links to facilitate the use of decimal arithmetic in making relatively complex trigonometric calculations. It is interesting that Edmund Gunter's base in London, Gresham College, was the same college where John Wilkins worked in the 1660s. Presumably, Gunter was familiar with Simon Stevin's work on decimal arithmetic that had been translated into English as 'Decimall Arthmetike' in 1608. At Gresham College in the 1660s, John Wilkins would have been familiar with Gunter's decimal work as he formulated his ideas for a '*universal measure*' based on decimal numbers.

1657

Christian Huygens, a Dutch horologist, made the first clock that used a pendulum to measure time.

1660 November 28

Following a lecture by Sir Christopher Wren, the *Society of London for the Improvement of Natural Knowledge* was founded at Gresham College in London. The main proponent in the formation of this society was John Wilkins.

This society became known as the '*Royal*' *Society of London for the Improvement of Natural Knowledge* or simply as the *Royal Society* when King Charles II becomes its patron. The Royal Society claims to be the oldest learned society for science still in existence. As a voluntary organisation it serves as the academy of sciences of the UK. One of the first actions of the *Royal Society* was to suggest that a universal measuring system should be based on the length of a pendulum that swung uniformly back and forth in one second.

1665

Gabriel Mouton, a country vicar and choirmaster, repeatedly counted and recorded the swings of a pendulum to establish the right length to beat a second of time. This kind of device is a 'second's pendulum'. However, it was soon realised that a second's pendulum would have to be shorter near the equator than at the North or South Pole because the force of gravity is greater near the poles and centrifugal forces are greater near the equator.

1668

The Royal Society published '**An Essay Towards a Real Character and a Philosophical Language by John Wilkins**'. This 638 page essay included a four and a half page description of a system that included an idea for a '*universal measure*' that could be used for length, 'weight', capacity, and money.

Following the publication of John Wilkins' essay many other people in several countries seemed to take up and promote themes that appeared in John Wilkins' essay.

1670

Gabriel Mouton promoted a system of measurement the definition of which, like that of Wilkins, was to be based on the Earth's measurements. Mouton used the idea of a decimal unit system using part of the circumference of the Earth as a standard for measuring lengths rather than a measurement based on the length of a pendulum or one or other measurements of a human body.

1671

Jean Picard promoted the idea that the length of a pendulum beating in seconds should be a standard unit of length. He suggested that a pendulum of specified time period could be used as a convenient sub-multiple for people to use routinely as a standard for length.

1675

Tito Livio Burattini first used the expression '*metro catholico*' to describe the length of a pendulum beating one second. This looks like a direct translation of Wilkins' '*universal measure*' into Italian. The Italian word '*metro*' derives from '*metron*', a Greek word for measure and it is probable that the French word, '*metre*' is also from these sources.

1743

George Washington (1732/1799) inherited his father's surveying equipment so he was familiar with the simplicity of the decimal measures made using Gunter's decimal chain.

1757

Thomas Jefferson inherited his father's (Peter Jefferson) surveying equipment, again with a decimal Gunter's Chain.

1785

Federal legislation in the USA required that official surveys had to be done using Gunter's chains made up of 100 links each 7.92 inches long. This was in recognition that Gunter's Chain had been already widely used for many years throughout the USA.

1785 to 1789

Thomas Jefferson served as Ambassador to France where he was in regular contact with English and French intellectual leaders of the Enlightenment as they formed their ideas about universal measurement.

Charles Maurice de Talleyrand-Périgord (1754/1838), Bishop of Autun (but usually known simply as Talleyrand), in France; Sir John Riggs-Miller, in England; and Thomas Jefferson, USA Minister to France; corresponded on a proposal for universal measures. It is most likely that Jefferson promoted his strong support for decimal measurement and for decimal currency at this time.

Essentially, Talleyrand, Riggs-Miller, and Jefferson were proposing that their three nations should cooperate to equalise their weights and measures, by the joint introduction of a 'decimal système metrique' (decimal metric system).

1790 January

George Washington (1732/1739), in his first message to Congress, reminded the legislators of their responsibility on weights and measures when he said:

> *A uniformity of weights and measures is among the important objects submitted to you by the Constitution, and, if it can be derived from a standard at once invariable and universal, it must be no less honorable to the public council than conducive to the public convenience.*

George Washington was clearly referring to an idea similar to Wilkins' '*universal measure*' when he said, '*derived from a standard at once invariable and universal*'.

The House of Representatives responded by asking Secretary of State Thomas Jefferson (1743/1826) to make a special report on the subject of measurement in the USA.

Jefferson's report used some of the scientific investigations aimed at reform of the French weights and measures but it varied in the detail. Jefferson's proposals had a remarkable similarity to the design for a '*universal measure*' outlined by John Wilkins in 1668. This led me to believe that Jefferson had access to: '*An Essay Towards a Real Character and a Philosophical Language* (1668) by John Wilkins'. This conjecture seems more likely when we set Wilkins' plan for length alongside that of Jefferson.

Wilkins' plan	Jefferson's plan
Let this Length therefore be called the Standard; let one Tenth of it be called a Foot; one Tenth of a Foot, an Inch; one Tenth of an Inch, a Line. And so upward, Ten Standards should be a Pearch; Ten Pearches, a Furlong; Ten Furlongs, a Mile; Ten Miles, a League, & c.	*Let the foot be divided into 10 inches; the inch into 10 lines; and the line into 10 points. Let 10 feet make a decad; 10 decads one rood; 10 roods a furlong; and 10 furlongs a mile.*

And there are many other parallels. Jefferson suggested a pendulum that had a rod instead of a string, but his report at: http://en.wikipedia.org/wiki/Plan_for_Establishing_Uniformity_in_the_Coinage,_Weights,_and_Measures_of_the_United_States) might have been taken straight from John Wilkins' essay with only slight changes to the names of the various components of the plan.

I have been unable to confirm that Jefferson had access to Wilkins' book although I have searched several catalogs of Jefferson's extensive book collections. Jefferson was a very keen book collector and although I suspect that he either owned or had access to Wilkins' 'Essay', I suppose that Jefferson's copy of Wilkins' book could have been lost in the Library of Congress fire of 1851, (http://www.loc.gov/exhibits/jefferson/jefflib.html)

Jefferson recommended a two-part decimal plan to Congress.

The first part of Jefferson's plan proposed the adoption of a universal length based on the seconds-pendulum, measured at 45 degrees north latitude at sea level and the conversion of existing old English units to this new universal measure.

The second part of Jefferson's plan proposed the use of a decimal system as a basis for dividing and multiplying the seconds-pendulum unit; to reduce:

> *Every branch to the same decimal ratio, thus bringing the calculations of the principal affairs of life within the arithmetic of every man who can multiply and divide plain numbers.*

George Washington and Thomas Jefferson combined forces politically, to propose the use of decimal currency for the USA. Decimal currency became reality in the USA in 1792.

1790 March 29

Knowing that Sir John Riggs Miller had raised the question of weights and measures in the British House of Commons during 1789, Talleyrand wrote this private letter to him (This is Sir John Riggs Miller's translation of Talleyrand's letter).

> *Sir,*
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> *I understand that you have submitted for the consideration of the British Parliament, a valuable plan for the equalization of measures: I have felt it my duty to make a like proposition to our National Assembly. It appears to me worthy of the present epoch that the two Nations should unite in their endeavour to establish an invariable measure and that they should address themselves to Nature for this important discovery.*
>
> *If you and I think alike on this subject, and that you are of opinion that much general benefit may be derived from it, it is through you only that we can hope for its accomplishment; and I beg to recommend it to your consideration. Too long have Great Britain and France been at variance with each other, for empty honour or for guilty interests. It is time that two free Nations should unite their exertions for the promotion of a discovery that must be useful to mankind.*
>
> *I have the honour to be, Sir, with due respect, your most humble and obedient servant,*
>
> *The Bishop of Autun*

Talleyrand's concept was for the adoption of a brand new basic standard, 'derived from nature' (*pris dans le nature*) and therefore acceptable to all nations. Talleyrand further suggested that the French National Assembly, the English Parliament, and the Royal Society of London should undertake preliminary work towards this objective jointly. He wrote:

> *Perhaps this scientific collaboration for an important purpose will pave the way for political collaboration between the two nations.*

1790 April 13

Sir John Riggs Miller reported to Parliament on the receipt of the letter from Talleyrand, and expressed himself in favour of the scheme. He then made a speech to the British House of Commons proposing measurement reform. He had been in contact with both

Talleyrand and with Thomas Jefferson, who was then the first Secretary of State of the United States of America.

At about the same time Talleyrand, one of the foremost members of the French National Assembly, introduced the subject and launched a debate that resulted in a directive to the French Academy of Sciences to prepare a report on a new system of measurement for France and for the world. The French National Assembly sent delegates to Britain, Spain and the United States to propose cooperation in units of measurement.

1790 May 8

Talleyrand submitted a proposal to the National Assembly for a decimal system of stable, unvarying and simple measurement units. These were to be based on the length of the seconds pendulum at 45° latitude beating a second. At Talleyrand's suggestion, the French National Assembly adopted this new measuring system. Louis XVI authorised scientific investigations aimed at a reform of all French weights and measures and these investigations led to the development of the 'decimal metric system'.

1790 August 22

Talleyrand's proposal, having been referred to the Committee on Agriculture and Commerce, was recommended to the king, who sanctioned action on August 22. This was the French decree that led to the further development of the metric system. The French Academy of Sciences was made responsible, and appointed a committee that included Lagrange and Laplace among its members; their first report, in October, recommended the decimal division of money, weights, and measures.

The National Assembly decreed that all measures in use throughout the provinces of France should be sent to the Academy of Sciences who would then issue new standard measures to all the parishes of France. The idea was that by doing this the old measures could be dispensed with altogether. However, it seems that the National Assembly had little idea of the complexity and magnitude of this task as they considered that the new standards could be adopted and copies of it could be distributed, replacing all of the old measures with the new, within six months.

1790 October 27

Later in the year the French Academy of Science issued a report that recommended:

> *... that the length of a meridian from the North Pole to the Equator be determined, that 1/10 000 000th of this distance be termed the metre and form the basis of a new decimal linear system, and, further, that a new unit of weight should be derived from the weight of a cubic metre of water.*

This report also recommended that the new system of weights and measures should be decimal and it included a list of prefixes for decimal multiples and sub-multiples. This system became the decimal metric system that later became the International System of Units (SI) that we now use in every nation in the world.

1790 November 11

Talleyrand urged that the preparation of a new system of weights and measures should be a collaborative venture, with the French inviting the participation of the English Parliament and the Royal Society of London. Talleyrand also made efforts to establish contacts with other countries. These included negotiations with Thomas Jefferson concerning the definition of the metre.

Jefferson initially favored using a pendulum at the latitude of 38°N as this was close to the centre of the territory of the United States of America, but eventually he accepted the 45°N, proposed by the French National Assembly as he felt that this was better suited to an international destiny for the metric system.

The metric system as it was first proposed by John Wilkins in England, and developed in France (with help from the USA) in the 1790s, was designed as a standard universal system that would be easy for everyone in the world to understand and to use.

In fact, when Talleyrand presented the plan for a system of decimal metric units to the French National Assembly he described it as:

… an enterprise whose result should belong some day to the whole world.

On 1791 March 26 the (gloriously named) French mathematician and philosopher, Marie Jean Antoine Nicolas de Caritat, Le Marquis de Condorcet (1743/1794) put this thought succinctly in a report called '*Le Mètre: du monde*' (The metre: of the world) where he described the metric system simply as:

'For all time, for all people

The international metric system conference of 1799 decided that a medal should be struck to honor the metric system and bearing the words of Condorcet:

A TOUS LES TEMPS, A TOUS LES PEUPLES

My thanks to Mark Dominus who alerted me to the work of John Wilkins when I read his web page at http://blog.plover.com/physics/meter.html Subsequently, I was able to visit the libraries of Wadham College, Oxford; Trinity College, Cambridge, The Royal Society, London; and the Library of Congress, Washington DC, where I was able to confirm Mark Dominus' observations and to research related materials. I have also had the opportunity to discuss John Wilkins and the metric system with members of the United Kingdom Metric Association, the Canadian Metric Association, and the United States Metric Association.

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