The Metric System

A Highly Instructive and Interesting Lecture by Dr. James E. Talmage.

The large lecture hall of the physical laboratory of the University of Utah was packed to its full capacity last (Friday) night with students and citizens assembled to hear President Talmage's exposition of the metric system. The lecture was originally designed for the students of the University and grew out of the following resolution adopted by the faculty last week:

"Resolved that it be the sense of this faculty that the Constitution of the State of Utah should require that the metric system of weights and measures be taught in all the public schools of the State, and that the said system be made the legal system in all public business."

The interest manifested in the subject outside the University caused the time to be changed from the afternoon to the evening in order to give all those who desired to do so an opportunity to attend. The character of the audience was a surprise to those most sanguine in behalf of the new system. A considerable number of leading merchants and citizens were among the spectators and showed all the symptoms of full converts to the reform.

The subject in the hands of a less able speaker might have been a dry one, but it proved to be anything but that in the present case. The lecturer was introduced by Dr. J. T. Kingsbury, who in a brief way introduced the subject of the evening by calling attention to a few of its most important features. One highly important point made by Dr. Kingsbury was the statement that no fully equipped college in America could be counted for study without a knowledge of the metric system. He explained that that system was the basis of all their physical and chemical apparatus—no other kind was now manufactured.

The lecturer was surrounded by apparatus and various other appliances illustrative of his subject, and behind him on black boards and charts were exhibited tables showing the contrast between the new system and the one now in use. The speaker was followed with the closest attention throughout, and showed the superiority and advantages of the metric system sufficiently clear for the comprehension of the dullest mind in the audience.

Dr. Talmage said: We have all much to do with the weights and measures of material things. Magnitude is one of the [illegible] universal properties of matter; every piece of matter possesses extension in the three directions, length, breadth and thickness; and the existence of this property, which in the simplest of [illegible] may be named as that of size constitutes the means of defining "matter"—the term that proved so difficult to the early philosophers. To determine and describe this property of matter, some standard of measurement is absolutely indispensable. In very early times, certain portions of the human body were accepted as convenient standards; and hence we derive our terms "foot," "cubit" (from elbow to middle finger tip), "finger's length," "finger's breadth," "hand's breadth," "span," etc. It is plain that if a unit be adopted, multiple and fractional units may be determined from it. It is said that a certain philosopher once undertook on a wager to determine the number of grains of sand, which, placed end to end, would extend a mile. He found that a certain number of sand grains covered the space of one millet seed; so many millet seeds one bean, so many beans in a span; so many spans in a stride, and so many strides in a mile. Arbitrary standards have been very generally used, in spite of the very great uncertainty and unsatisfaction accompanying their use.

The importance of establishing efficient standards for the determination of size and weight is very clearly set forth in the House of Representatives' committee on coinage, weights and measures of the Forty-sixth Congress—"There is no subject in which the general business interests of all countries as well as progress in science in all its departments are more deeply involved than in this, hence it is a subject which has occupied the attention of the most [illegible] thinkers and the best law-givers in all ages and in all lands and climes. The establishment of the system of weights and measures belongs not merely to the domain of mechanical science, but enters as well into the higher science of metaphysics, and the generalization of history." Even semi-civilized peoples recognize the need of some standard of measurement, and the higher the civilization the more general is the use of the accepted standard. The world calls today for an international standard, a unit of measurement common to all nations having mutual relations of commerce and other dealings. Prof. Barnard writes, "No cause since the earliest organization of civilized society has contributed more largely to embarrass business transactions among men, especially by interfering with the facility of commercial exchanges between different countries or between different provinces, cities, or even individual citizens of the same country, than the endless diversity of instrumentalities employed for the purpose of determining the quantities of exchangeable commodities."

Let us consider some of the sources of our present units. In the year 1120 King Henry decreed that the British ell or yard should be the length of his own royal arm. A standard rod, purporting to be of the exact length of the king's arm, was deposited in the exchequer. It was broken, however, and was so clumsily repaired that its accuracy could not be trusted. In 1266, during the reign of Henry III of England, grains of wheat became the basis of measurement, and in 1324 there issued from Edward II the solemn decree that barley corns should constitute wheat grains, and the royal word went forth that "three barley corns, round and dry, shall make an inch, and twelve inches a foot." In 1760 a copy of the ancient yard was prepared for the English government, and was known as "Bird's yard standard;" this was destroyed in the great London fire of 1834. At last the British authorities accepted a standard from the most reliable copies of Bird's standard; and of this copy of a copy another copy was made for the use of the United States coast survey. This yard is, however now known to be .001 inch longer than the British imperial yard, a type of which is now kept in London tower. It is copies of this scale which are furnished with sets of weights to the state governors by our common government.

Long ago the French adopted the length of the foot of Louis XIV as the standard length, but this proving as perishable as the arm of the English king, the people of France set about devising a more satisfactory standard as will be afterwards described. Their first proposition was to make the length of a pendulum vibrating seconds at sea level in latitude 45° N, a standard of measurement, and in the determination of this unit the French asked their British neighbors to co-operate, but the latter refused.

The perplexities incident to the lack of a simple and rational system of weights and measures were experienced and deplored by the early fathers of our nation. The Articles of Confederation provided, and the Constitution of our country afterward confirmed the provision, that Congress should hold supreme power in prescribing systems of weights, measures, and the units of coinage.

Washington in his first message to Congress recommended early attention to the subject of providing a uniform system of weights and measures; and in a later communication he repeated the recommendation, using these words: "A uniformity in the weights and measures of the country 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, must be no less honorable to the public councils than conducive to the public convenience." Successors to the presidential chair earnestly urged that an attempt be made to establish a desirable standard, and in July, 1790, Jefferson, secretary of state, proposes in Congress a simplified system founded on a decimal relation. The basis was to be the second's pendulum at sea level, 45° north, and of this [illegible] was to be the legal rod; each foot contains 10 inches, each inch 10 lines, each line 10 points; 10 feet were to make a decad; 10 decads a rood, 10 roods a furlong; 10 furlongs a mile. The cubic foot was to constitute a bushel, which with multiples and fractions decimally determined was to furnish the secondary units for liquid and dry measure, and the weight of a definite volume of water was to constitute the unit of weight. This report was never favorably acted upon, as the proposition of France to establish an intermediate system then was growing in favor.

In any efficient system, precision of terms must be secured; that is, each term should possess a definite significance. This desirable condition is not reached in our present nomenclature. Thus the term "quart" conveys no explicit meaning, for a beer measure quart consists of 70.5 cubic inches; while a quart in dry measure is 67.2 cubic inches, and a United States liquid quart holds but 57.75 cubic inches. So in regard to the gallon; a wine measure gallon consists of 231 cubic inches, dry measure gallon 268.8 cubic inches; and a beer gallon 282 cubic inches.

The complicated nature of our usual tables of measurements may be seen in the great number of different factors to be used in reducing measurements of one denomination to those of another.

Thus we see from our long measure:

An inch contains 12 lines.
A [illegible] inches.
A foot [illegible] or 12 inches, or 1 21/25 links.
A yard—432 lines, 36 inches, 4 6/11 links, or 3 feet.
A fathom—864 lines, 72 inches, 6 feet, or 2 yards.
A rod, pole or perch—[illegible] inches, or 16 1/2 feet, or 5 1/2 yards or 2 3/4 fathoms.
A chain—792 inches, 100 links, 66 feet, 22 yards, 11 fathoms, or 4 rods.
A furlong 7,920 inches, 1,000 links, 660 feet, 220 yards, 110 fathoms, or 40 rods.
A mile 63,360 inches, 8,000 links, 5,280 feet, 1,760 yards, 880 fathoms, 320 rods, or 8 furlongs.

[The multiplicity of factors necessary in ordinary computations is compounded were shown in the case of measures of weight, (avoirdupois, troy and apothecary's) capacity, etc., by elaborate tables exhibited before the audience.]

In the common units of weight we have to deal with three separate tables, each [illegible] and bearing no simple relation to the other systems; I refer to the avoirdupois, the troy, and the apothecaries weights. These have but one unit in common—the grain. Thus an avoirdupois ounce contains 437 1/2 grains, and an apothecaries' ounce 480 grains. The troy pound contains 5,760 grains, while an avoirdupois pound consists of 7,000 grains.

Such complications are rendered the more annoying by the [illegible] given to [illegible] measurements in trade. Thus in Great Britain, [illegible] if hooked, are sold by the score; trawled fish, so much apiece, and pickled cod by the barrel. I have no desire to exaggerate the eccentric trade of earlier [illegible] among our Trans-Atlantic friends, so will [illegible] following [illegible] of British trade from a comparatively recent article by an English writer—Mr. Cousens, of Leeds. At Grimsby, an important fish market, a style of weights and measures, very different from that in use at Billingsgate is adopted. Thus, while the latter place [illegible] reports, fish may be disposed of by "the pound," "the stone," "the [illegible]," "the basket" and "the hundred," the Grimsby dealings in fish are conducted largely by "the box," and "the last." It is said that at Grimsby a customer recently called for a stone of oysters and was informed that oysters were not sold by weight, but by measure. "Ah," replied the intended purchaser, "let me have a yard." In Ireland, butter is sold by the cask, the firkin, in England by the pound (16 ounces), of the roll (24 ounces), by the stone, and the hundredweight, which last is not a hundred pounds, but 112. The writer just quoted asks, "What is a load?" and answers—A load of straw is 1,296 pounds, a load of old hay is 2,016 pounds, and a load of new hay 2,160 pounds, but my tables do not tell me at what age hay becomes old." [illegible] A firkin of butter is 56 pounds, a firkin of soap 64 pounds, and a firkin of raisins 112 pounds. A hogshead of beer is 54 gallons, of wine 63 gallons. A pipe of wine may be 93 gallons, or 92, or 117, or 100, or 105 gallons, depending upon the locality of the vintage. A stone weight of a man is 14 pounds, of a [illegible] 8 pounds; "a stone of cheese is 16 pounds, of glass 5 pounds, of hemp 32 pounds; a stone of flax at Belfast is 16 1/2 pounds, but at Downpatrick, 24 pounds; while a hundred weight of potatoes is 8 pounds heavier at Belfast than it is at Cork." Mr. Cousens adds: "A barrel of beef is 200 pounds; butter 224 pounds, flour 196 pounds, soft soap 256 pounds, beer 36 gallons, tar 26 1/2 gallons; while a barrel of herrings is 500 herrings."

Perhaps we console ourselves that we are far less eccentric in these matters than are our British relatives, but there is much reason to believe that by the time our civilization is as old as England's, should our present tendency undergo no change, we will be fully as blame-worthy as are they whom we now laugh at. There is a woeful lack of uniformity among the states of our Union; thus, in most of the states, a bushel of rye is 56 pounds avoirdupois, while in California it is 54 pounds, and in Louisiana 32 pounds. A bushel of oats is 26 pounds in Maryland, 30 pounds in Pennsylvania, Maine, New Hampshire and some other states; 32 pounds in Vermont, New York, Michigan and many others, 34 pounds in Nebraska, 35 in Montana and 36 in Washington. Potatoes, though designated by the bushel are usually sold by weight, 50 pounds to the bushel in Washington, 56 pounds in Ohio, and 60 pounds in most other states. Similar variations are found in the case of other commodities. With such irregularities, such vexing inconsistencies as these, is it strange that the world feels the need of a common and a common-sense system?

It was in 1790 that the French people asked and were refused British cooperation in determining the length of a second's pendulum as a basis of measurement. In 1791 France introduced a provisional system, which was revised in 1795. In 1840, however, a strictly decimal system was enforced in France, and in this undertaking many nations have joined. This is the basis of the metric system now so very generally employed.

In this system but one unit is determined as a basis for all tables; this is the unit of length, and is known as the metre (from Greek metron—a measure). The metre professes to be a certain fraction — the ten-millionth, part of the quadrant of the earth's meridian passing through Paris. In English units, the metre is equal to 39.37 inches. It has been claimed that the metric system is as purely arbitrary as any standards of measurements preceding its introduction; and no one can deny this with respect to the choice of a starting unit; there is no law of nature [illegible] for dividing any part of a meridian of the globe as a basis for selling cloth or laying hay; but the difficulties connected with the other systems lie in the facts that the unit standard cannot be replaced if injured, lost, or destroyed, and that the fractional and multiple parts of the unit are diverse and confusing. Both these objections are entirely overcome in the metric system, for the measurement of the [illegible] meridian could be again effected were the prototype of the standard lost; and all fractional and multiple secondary units are based on decimal grades. It has been [illegible] that the metre as now [illegible] is not in reality an exact [illegible] of the Paris meridian quadrant [illegible] errors in measurement and calculations have been discovered [illegible]. It is true that [illegible] meridian quadrant [illegible] actually measured, the calculations were then made on the supposition—at that time generally accepted—that the earth is in form an oblate spheroid with an ellipticity of [illegible]. It is now believed that the earth [illegible] is slightly different from that described, and it is calculated that the prototype of the metre is in reality about [illegible] shorter than the actual [illegible] of the Paris meridian quadrant [illegible] a variation is imperceptible; and [illegible] in no way with the possibility of reproducing the present metre, for the error [illegible] is due to incorrect [illegible] in the calculation and not to mistakes in measurement. Furthermore on the supposition that the revised figures regarding the figure of the earth be correct, the accepted metre, while not the [illegible] portion of the Paris meridian, is practically the exact [illegible] of the meridian of New York [illegible]. In 1870 [illegible] in the formation of an International Commission which met in Paris to [illegible] into the correctness of [illegible] of the metrical standard; the scope of this organization was enlarged, and in 1875 a permanent International Bureau of weights and measures was constituted, with headquarters at Paris.

Now, concerning the simplicity of the system, the simple unit, the metre, is multiplied and divided to represent the secondary units of length. The fractions are designated by the Latin prefixes deci, centi and milli signifying [illegible]; and the multiples are expressed by the Greek prefixes deka, hekto, kilo, and myria, signifying 10, 100, 1000 and 10,000. Thus the table of linear measure can be memorized in a few minutes as follows:

10 millimetres make 1 centimetre.
10 centimetres make 1 decimetre.
10 decimetres make 1 metre.
10 metres make 1 dekametre.
10 dekametres make 1 hectometre.
10 hectometres make 1 kilometre.
10 kilometres make 1 myriametre.

By way of comparison between this table and that of the ordinary English linear measure, let us work a simple [illegible] under each.

Reduce two miles to terms of lower denominations; [illegible] inches; there we have five [illegible] multiplications, each with a different factor. Now reduce two myriametres to centimetres. Here we have to descend through six stages of reduction, and we accomplish each stage by multiplying by 10, or simply by adding ciphers; 2,000,000 centimeters. In ascending reduction we divide with similar ease—thus, to reduce 172.9 millimetres to meters we divide by 1000 and the answer is [illegible] meters, or [illegible] meters, 2 decimeters, 9 centimeters and [illegible] millimeters.

Having thus obtained our units of length, the square and the cubic units are easily derived; thus we speak of square meters, centimeters, decimeters, millimeters, dekameters, hectometers, etc. As we consider in square measure, extension in two directions we increase or decrease by [illegible] factor 100, [illegible]; 100 sq. cm. make 1 sq. dm. 100 sq. dm. make 1 sq. meter and so on.

In cubic measure 1000 c. mm. make 1 c. cm. 1000 c. cm. make 1 c. dm. 1000 c. dm. make 1 cu. m.

The unit of weight is thus derived: The weight of one cubic centimetre of pure water at its temperature of greatest density constitutes the gram, equal to 15.432 grains; of this unit fractions and multiples are obtained as before, thus milligrams, centigrams, decigrams, dekagrams, hectograms, kilograms, and myriagrams.

Many people express fear that should the metric system be adopted, the work of transforming readings from one system to the other would prove most burdensome. Should the metric system be used, we ought to strive to render such transformations unnecessary as soon as possible, by making the new system universal; but during the transition period, the use of tables showing the relation between the two denominations will effect the purpose. As examples: To transform grams into grains ×15.432; centimetres into inches ×0.3937; litres into United States quarts ×1.057; litres into imperial quarts ×0.880. (The litre is the common designation of 1000 cubic centimetre measure.)

A number of rules calling for the simplest of arithmetical operations have been formulated for the rapid changing of any expression from one system to the other.

Such facts as these, proving the great simplicity of the metric system must appeal to all true educators. In a report on the metric system made by the House committee on coinage, weights and measures to the Forty-sixth Congress, the remark of an experienced writer is quoted with approval, "that the adoption of the metric system in [illegible] saving [illegible] one full year's hard study in a boy's or girl's [illegible] course. If this is true, and there is no reason to doubt, it is an unanswerable argument in favor of the adoption of this system in our public schools, and [illegible] at once."

The metric system is used almost exclusively for all scientific work; in the laboratories in our own University the system has long been in service. It has been legalized in the United States since 1866, but the enactment being only a permissive instead of an obligatory measure, the adoption has not become general. In view of the many advantages promised by its use, one may well ask why this delay continues? It is due to the [illegible] cause that has operated in all ages to keep men in ruts, confined to a narrow, muddy, stony road, when the great [illegible] without [illegible]. It is because that holds the old-fashioned [illegible] in favor in spite of the [illegible] that 99 per cent of the [illegible] is wasted; it is the cause that operates to turn a healthful reverence toward the past into a species of [illegible] worship; the cause that makes a man afraid to [illegible] they be hereditary [illegible].

During recent years British consuls have repeated [illegible] reports to their home government that [illegible] England is losing a vast amount of trade. Foreign [illegible] will have little to do with a people [illegible] and price lists in a style which to them is unintelligible and one which they have no [illegible]. Are the people of the United States [illegible]? To consider [illegible] the extent to which the new system has been adopted, let us consider the following list of countries using the metric system exclusively:—Algeria, Argentine Confederation, Austria-Hungary, Belgium, Brazil, Canary Islands, Chili, [illegible], Cuba, Denmark, Ecuador, Egypt, France and colonies, Greece, Guatemala, Honduras, Iceland, Italy, Mexico, [illegible], Netherlands, Norway, Paraguay, Peru, Portugal, Russia, Turkey, Spain and colonies, Sweden, Switzerland, Venezuela. The system has been legalized in many other countries.

There is perhaps no one thing which would accomplish more than would the universal adoption of the metric system of weights and measures toward uniting the nations by ties of [illegible]. This has long been recognized. In 1819 Hon. John Quincy Adams, then secretary of state, wrote:

"The system approaches to the ideal perfection of uniformity applied to weights and measures, and whether destined to succeed or doomed to fail, will shed unfading glory upon the age in which it was conceived, and upon the nation by which its execution was attempted, and has been in part achieved. In the progress of its [illegible] it has often been brought [illegible] with the laws of physical and moral nature, with the impenetrability of matter, and with the habits, passions, prejudices and [illegible] of man. It has undergone [illegible] [illegible] for universal adoption. But [illegible] earth be an improvable being, if that universal peace which was the object of a Saviour's mission, which is the desire of the philosopher, the longing of the philanthropist, the trembling hope of the Christian, is a blessing to which the [illegible] of mortal man [illegible], if the spirit of evil is, before the final consummation of things, to be cast down from his dominion over men and bound in the chains of a thousand years, [illegible] then this system of [illegible] the [illegible] between the inhabitants of the most distant regions, the metre will surround the globe in use as [illegible], and one language of weights and measures will be spoken from the equator to the poles."

Again in 1821, Mr. Adams said:

"Uniformity of weights and measures, permanent, universal uniformity, adapted to the nature of things, to the physical organization and moral improvement of man, would be a blessing of such transcendent magnitude that if there existed upon earth a combination of power and will adequate to accomplish the result by the energy of a single act, the being who should exercise it would be among the greatest benefactors to the human race."

I [illegible] commend to your study the [illegible].

NOTICE OF SPECIAL STOCKHOLDERS' MEETING OF THE PEOPLE'S EQUITABLE CO-OPERATIVE ASSOCIATION.

NOTICE IS HEREBY GIVEN THAT A special meeting of the stockholders of the People's Equitable Co-operative Association [illegible] Salt Lake City, Utah [illegible]

Dated this 9th day of November, 1894.
GEORGE M. CANNON,
President of the People's Equitable Co-operative Association.

Notice to Debtors of Teasdel & Sons.

To all debtors of Teasdel & Sons or S. P. Teasdel, take notice: You are requested to call immediately and settle your indebtedness to either of the above named parties, otherwise the said indebtedness will be placed in our attorneys' hands for collection.

J. E. DOOLY,
JOS. GEOGHEGAN,
Assignees.

Office, 156 Main Street, Salt Lake City, Utah, Oct. 29th, 1894.

Receiver's Sale.

The receiver of the Ryan & Beam Cattle Company herds, offers for sale about 2000 head of stock cattle, ranging at and near Milford, Utah. Sale subject to approval of the court. For particulars apply or address

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Woman's Suffrage Meeting.

The regular meeting of the W. S. A. will be held in the [illegible] ward until Tuesday, Nov. 20th. A full attendance of the members is desired to [illegible] for the ensuing year and attend to other important business. A cordial invitation is extended to the general public.

M. E. LYMAN, Secy.

Battery A's Ball.

Governor West and staff have been appointed a reception committee for the ball and entertainment to be given at the Continental Hotel hall on Wednesday evening next. General [illegible] and staff [illegible] have been invited, as have also the members of the National Guard of Utah. The affair is being [illegible]

AUCTION SALE.

The [illegible] of Fine [illegible] Goods, next Tuesday and Wednesday. See [illegible] and Monday Evening papers for items and location.

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