Metrication in Kinematography

A Reprint

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The United Kingdom is changing to the metric system coincident with the adoption internationally of a rationalised system of metric units of measurement, the Systême International d'Unités to be known by the abbreviation S.I. Units.

A programme of implementation has been laid down and much work has already been done. All new British Standards are being issued with metric sizes and in many industries and professions advisory panels are being set up to consider the implications and to assist in making the changeover meet the programme and to avoid the pitfalls before they occur.

The use of film, sound recording and television now reaches all parts of the globe and with the increase in the exchange of material between one country and another and the consequent widening of the export market, the consideration of interchangeability is of vital importance.

Over the past years the International Standards Organization has endeavoured to produce international recommendations covering a variety of aspects of our industry. In some cases these recommendations have only been reached as a result of compromise, and individual countries have retained a national standard which has varied slightly from the International Standard.

The decision of this country to adopt the metric system and the phasing of the programme related to this changeover is another link in the chain towards international interchangeability. But simple conversion of inch dimensions to metric equivalents will not be all that is required.

B.S. Publication PD5686 April 1967 'The use of S.I. Units', states that, 'The UK will not gain full advantages of adopting the metric system by a mere mathematical conversion of existing designs and products'.

This article is intended to stimulate thought among members of the effect the change will have on various aspects of our industry and to start the process of 'thinking metric'.

Historical Background

The growth of science in the eighteenth and nineteenth centuries and the impact of the industrial revolution in the nineteenth century hastened the need for a unification of existing systems of weights and measures.

Although the idea of a decimal system of units was conceived by Simon Stivon (1548-1620) the adoption of the metric system as a practical method of measurement was not established until the improvement in administrative activity following the French Revolution.

The metre was defined as the distance between two lines marked on a metal bar of platinum and iridium and was intended to represent one ten-millionth part of the earth's meridional quadrant.

The unit for weight was to be the mass of one cubic centimetre of water at 0°C.

In 1873 the British Association for the Advancement of Science adopted the centimetre and gramme as basic units for length and mass for physical purposes.

The growth of science and technology requires even more refined degrees of accuracy and the metre is now defined in terms of a number of wavelengths of a particular radiation of light. In 1960 the metre was stated to be equal to 1 650 763,73 wavelengths in a vacuum of the orange radiation ($2p_{10}$ - $5d_5$) of a Krypton atom of mass 86.

The importance of this method of defining the metre lies in the fact that the natural standard of length can be reproduced anywhere in the world and needs no reference to metal bars fixed in France or elsewhere.

Units for time (the second) and electrical current (the ampere) had already been widely adopted and at its tenth meeting in 1954 the Conférénce Générale des Poids et Mesures (CGPM) with participation by the United Kingdom, adopted a rationalised and coherent system of units based on the four mentioned, length, mass, time and electric current plus two additional units, the degree Kelvin for temperature and the candela as the unit of luminosity.

The eleventh CGPM in 1960 formally gave the title to these 6 basic units 'Systême International d' Unitésto, with the abbreviation 'SI' in all languages.

Implications within the Industry

How much will it cost?
Will it affect tooling?
Does the design or size need to be coordinated with other units?
When does the changeover take place?
How much existing stock will need modification or scrapping?

These are only one or two types of questions that will need to be dealt with by any expert panel that may be set up.

The cost of the exercise will be directly proportional to the smoothness of the changeover. A rational understanding of all the isues involved is desirable. Exaggeration of the difficulties will, without doubt, hamper metric education, but equally harmful will be a superficial attitude that will gloss over the problems and miss the essential points.

One of the chief difficulties in accepting and working to the new system will be to get the 'feel' of new sizes. At the same time it must be remembered that film sizes have been metric from the early days, 35, 70, 65, 8, 9.5 mm have easy visual response. What we need to avoid is saying to ourselves, '35 mm, ah yes, that's just over 1 $\frac{3}{8}$ inches'.

The introduction of metric measuring instruments well before the changeover will greatly assist in achieving familiarity with metric sizes.

There will of course be a reasonable period of dual use with the possibility of the provision of adaptors where necessary, and some elements will be taken care of at a time of normal replacement and new design.

A typical example that springs to mind is that of film length measurers. Footage Counters will need a new name and will need to measure metres and feet for a period of time.

Another similar problem is $\frac{1}{4}$ inch tape. The equivalent in metric is 6.35 mm to two decimal places. This will no doubt be rounded off to 6.4 mm. On the other hand it may be rounded off to 6 mm. In the one case existing reels could be used, in the other they might be too small.

Much the same problem could occur over spool spindles for 16 mm and 8 mm projectors and the bore size of the reels. Spindles on these projectors are a nominal (.312") = inches in diameter to allow, where design is suitable, for the use of stock material. The corresponding bore of the reel is 8 mm or .315".

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This allows for interchangeability plus some small degree of misalignment of the two reel flanges.

What happens when all metal sizes are metric? Will the spindles be machined down to 7.92 mm and the bore remain at 8 mm or will the spindle change to 8 mm and the reel bores enlarged to 8.1 mm?

Quite clearly, going metric will mean no more than converting dimensions from English to metric in some cases, whilst in others the change will be more concerned with future design and new dimensions conceived from the first in metric form.

Even our paper work and filing systems become involved with the introduction, now becoming wide spread, of the 'A' series of paper sizes. (Table IV).

These are but a few random examples showing the implications within the industry and little thought is needed to realise that all aspects of the cinematograph, sound and television industries will be affected to a greater or lesser degree.

It would appear that some system of priorities will be needed within the framework of the changeover programme. Within the broad national framework, a six year period from 1970 to 1975 inclusive is envisaged with preparatory work on BSI standards preceding this period.

Between now and 1970/1971 much will need to be done and much thought given to this radical change in our national system of measurements.

Vigilance on the part of members who represent the society on various BSI Committees will be necessary and close collaboration between these representatives and the Engineering Steering Committee will be an important factor in leading to a unified policy within the industry.

Correspondence, through the Journal of the BKSTS will be welcomed as a means of keeping the matter fully aired and to ensure all aspects of the subject shall be taken into account.

TABLE I

The six basic units of the SI system

Quantity	Name of Unit	Symbol
Length	Metre	m
Mass	Kilogramme	kg
Time	Second	s
Electric current	Ampère	A
Thermodynamic temperature	degree Kelvin	°K
Luminous intensity	Candela	cd

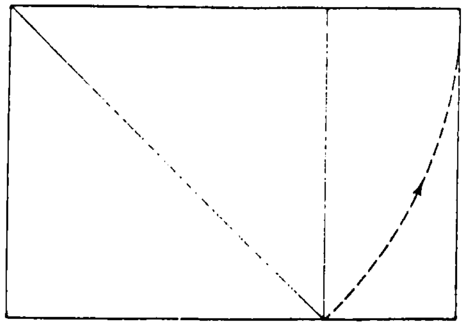
TABLE II DERIVED SI UNITS

Physical Quantity	*SI Unit*	*Symbol*
Force	Newton	N=Kg m/s^2
Work, energy	Joule	J=Nm
Power	Watt	W=J/s
Electric charge	Coulomb	C=As
Electric potential	Volt	V=W/A
Electric capacitance	Farad	F=As/V
Electric resistance	Ohm	Ω=V/A
Frequency	Hertz	Hz=s^{-1}
Magnetic flux	Weber	Wb=Vs
Magnetic flux density	Tesla	T=Wb/m^2
Inductance	Henry	H=Vs/A
Luminous flux	Lumen	Lm=cdsr
Illumination	Lux	Lx=Lm/m^2

TABLE III MULTIPLES AND SUBMULTIPLES

Factor	*Multiple*	*Prefix*	*Symbol*
One million	10^6	mega	M
One thousand	10^3	Kilo	K
One hundred	10^2	hecto	h
Ten	10^1	deca	da
One tenth	10^{-1}	deci	d
One hundredth	10^{-2}	centi	c
One thousandth	10^{-3}	milli	m
One millionth	10^{-6}	micro	μ

TABLE IV PAPER SIZES



Golden square as the basis of A series of paper sizes

A size	*dimensions in mm*
A0	841×1189
A1	594×841
A2	420×594
A3	297×420
A4	210×297
A5	148×210
A6	105×148
A7	74×105
A8	52×74
A9	37×52
A10	26×37

TABLE V CONVERSION FACTORS

Metric Unit	*British Unit*	*Metric to British*	*British to Metric*
Length			
Kilometre (km)	Mile	0.621 mile	1,609 km
Metre (m)	Foot (ft)	3,281 ft	0.305 m
Millimetre (mm)	Inch (in)	0.0394 in	25.4 mm
Mass			
Kilogramme (kg)	Pound (lb)	2.205 lb	0.454 kg
Gramme (g)	ounce (oz)	0.035 oz	28.35 g
Area			
Square kilometre (km^2)	Square mile (mile^2)	0.386 mile^2	2.590 km^2
Hectare (ha)	acre	2.471 acre	0.405 ha
Square metre (m^2)	Square foot (ft^2)	10.764 ft^2	0.093 m^2
Square millimetre (mm^2)	Square inch (in^2)	0.00155 in^2	645.16 mm^2
Volume			
Cubic metre (m^3)	Cubic foot (ft^3)	35.315 ft^3	0.028 m^3
Capacity			
Litre (l)	UK gallon (gal)	0.22 gal	4.546 litre
Force			
Newton (N)	Pound Force (lbf)	0.225 lbf	4.448 N

Full conversion tables can be obtained from BS350 Part 2: 1962. (Conversion Factors and Tables)