

# GLOBAL STANDARDISATION OF MEASURING SYSTEMS

By: Corné Ilani van Staden  
26159504

Submitted in fulfilment of part of the requirements for the  
Degree of BSc (Hons) (Quantity Surveying)

In the faculty of Engineering, Built Environment and Information Technology



UNIVERSITEIT VAN PRETORIA  
UNIVERSITY OF PRETORIA  
YUNIBESITHI YA PRETORIA  
Denkeleers • Leading Minds • Dikgopolo tša Dihalefi

Study Leader  
Mr. J.H. Cruywagen

October 2010

## DECLARATION BY STUDENT

I, the undersigned, hereby confirm that the attached treatise is my own work and that any sources are adequately acknowledged in the text and listed in the bibliography.

\_\_\_\_\_

Signature of acceptance and confirmation by student

# ABSTRACT

Title of treatise : Global standardisation of measuring systems.

Name of author : Miss CI van Staden

Name of study leader : Mr. JH Cruywagen

Institution : Faculty of Engineering, Built Environment and  
Information Technology

Date : October 2010

Standardisation across the globe has become an important tool to enable all of the users do their duties in the most efficient way and with the least amount of mistakes present. Over the decades various countries observed that there is a need for a simpler measuring system that brings to light easier conversions between its units. Over a time period they fully converted from the imperial system to that of the metric. Most countries have undergone this conversion, but singled out countries still refuse to give in to any use of any other measuring system other than what they are used to. This study will show the various reasons behind their decision not to convert to the metric system, as well as the possible advantages and disadvantages thereof. The study will also investigate the possible metrification of building elements' units as well as time. This study will prove that there is a dire need for global standardisation and that the metric system will definitely be a better choice than that of the imperial measuring system.

## TABLE OF CONTENTS

### CHAPTER 1 – INTRODUCTION

1.1. Background_____	1
1.2. The main problem_____	2
1.3. The sub-problems_____	3
1.3.1. What is the difference between the metric and the imperial system?_____	4
1.3.2. Where does the current South African standard dimension for building elements come from?_____	5
1.3.3. What financial impact would the change of measuring system have on the construction industry as a whole?_____	3
1.3.4. How did the Standard Method of Measuring Work of South Africa document develop over the years?_____	3
1.3.5. Should the whole world convert to the measuring system that the leading country has implemented, or should we work according to what the majority of the world is working with?_____	3
1.3.6. Can the implementation of the possible metrification of time ever be implanted successfully?_____	3
1.4. The hypotheses_____	4
1.5. Delimitations_____	5
1.6. Definition of terms_____	5
1.7. Assumptions_____	6
1.8. Importance of the study_____	6
1.9. Research methodology_____	6

### CHAPTER 2 - *WHAT IS THE DIFFERENCE BETWEEN THE METRIC AND THE IMPERIAL SYSTEM?*

2.1. Introduction_____	6
2.2. Measuring system development_____	9
2.3. Easy conversion_____	13
2.4. Summary_____	19
2.5. Conclusion_____	20
2.6. Testing of hypothesis_____	20

**CHAPTER 3 - WHERE DOES THE CURRENT SOUTH AFRICAN  
STANDARD DIMENSIONS FOR BUILDING ELEMENTS COME FROM?**

3.1. Introduction_____	22
3.2. The standard brick_____	22
3.2.1. A brief history_____	22
3.2.2. Dimensions_____	23
3.3. Windows_____	25
3.4. Doors_____	26
3.5. Steel_____	27
3.6. Timber members_____	28
3.7. Testing of hypothesis_____	30

**CHAPTER 4 - WHAT FINANCIAL IMPACT WOULD THE CHANGE OF  
MEASURING SYSTEM HAVE ON THE CONSTRUCTION INDUSTRY AS A  
WHOLE?**

4.1. Introduction_____	31
4.2. New products_____	31
4.3. Maintenance_____	34
4.4. Conclusion_____	35
4.5. Testing of hypothesis_____	35

**CHAPTER 5 - HOW DID THE STANDARD METHOD OF MEASURING  
WORK OF SOUTH AFRICA DOCUMENT DEVELOP OVER THE YEARS?**

5.1. Introduction_____	37
5.2. Earthworks_____	38
5.2.1. Site clearance_____	38
5.2.2. Excavations, Filling, etc_____	38
5.2.2.1. Bulk excavations_____	38
5.2.2.2. Carting away of excavated material_____	38
5.2.3. Risk of collapse of excavations_____	38
5.2.4. Working space_____	40

5.3. Piling	40
5.3.1. Precast concrete piles	40
5.3.2. Permanent sheet piling	41
5.4. Concrete, formwork and reinforcement	41
5.4.2. Formwork	42
5.5. Masonry	43
5.6. Floor coverings, Plastic Linings, etc	46
5.7. Glazing	46
5.8. Paint	47
5.9. Testing of hypothesis	48

**CHAPTER 6 - SHOULD THE WHOLE WORLD CONVERT TO THE MEASURING SYSTEM THAT THE LEADING COUNTRY HAS IMPLEMENTED, OR SHOULD WE WORK ACCORDING TO WHAT THE MAJORITY OF THE WORLD IS WORKING WITH?**

6.1. Introduction	49
6.2. The importance of speaking on "language"	49
6.3. Where is imperial system still in use?	50
6.3.1. United Kingdom	51
6.3.2. Canada	51
6.4. What does the public think?	53
6.4.1. The group	53
6.4.2. Should the world convert to one measuring system?	54
6.4.3. Should building units be converted to the system that the applicable country is using?	55
6.4.4. Which elements in the construction industry should be standardised, if any?	58
6.5. Conclusion	58
6.6. Testing of hypothesis	59

**CHAPTER 7 - CAN THE IMPLEMENTATION OF THE POSSIBLE METRIFICATION OF TIME EVER BE IMPLEMENTED SUCCESSFULLY?**

7.1. Introduction	61
7.2. How to metrify time	61

7.3. Possible complications_____	63
7.4. What does the public think_____	64
7.5. Conclusion_____	65
7.6. Testing of hypothesis_____	65

**CHAPTER 8 - THE CONCLUSION**

8.1. Background_____	67
8.2. Summary_____	67
8.1.1. The difference between the metric and the imperial measuring systems_____	67
8.1.2. The history of building elements in South Africa's dimensions_____	68
8.1.3. Financial impact of change_____	78
8.1.4. The history of the Standard Method of Measuring Work of South Africa document_____	70
8.1.5. Global conversion to the metric or the imperial measuring system maintenance costs_____	70
8.1.6. The metrification of time_____	71
8.3. Conclusion_____	71
8.4. Suggestions for further research_____	73

**BIBLIOGRAPHY**

Bibliography_____	75
-------------------	----

**ANNEXURE**

Annexure A _____	Questionnaire
------------------	---------------

## LIST OF TABLES

Table 1:	Conversion from inches to millimetres _____	14
Table 2:	Conversion from feet to millimetres _____	14
Table 3:	Conversion from yards to meters _____	15
Table 4:	Conversion from miles to kilometres _____	15
Table 5:	Conversion from square feet to square meters _____	15
Table 6:	Conversion from square yards to square meters _____	16
Table 7:	Conversion from acres to hectares _____	16
Table 8:	Conversion from ounces to millilitres _____	16
Table 9:	Conversion from pints to litres _____	17
Table 10:	Conversion from gallons to litres _____	17
Table 11:	Conversion from ounces to grams _____	17
Table 12:	Conversion from pound to kilograms _____	18
Table 13:	Conversion from cubic feet to cubic metres _____	18
Table 14:	Conversion from cubic yards to cubic metres _____	18
Table 15:	Conversion from short tons to metric tons _____	19
Table 16:	Conversion from long tons to metric tons _____	19
Table 17:	Standard brick sizes across the globe _____	24
Table 18:	Standard timber sizes currently in use in South Africa _____	29
Table 19:	Comparison between the current block size to its similar sized nominal blocks _____	32
Table 20:	Specific savings in masonry – M290 versus the conventional brick _	33

Table 21:	Questionnaire participant's and related birth years_____	53
Table 22:	Global conversion to one measuring system _____	54
Table 23:	Construction units' conversion to the measuring system the country uses_	55

## LIST OF FIGURES

Figure 1:	An example of the scale rulers that had to be produced to enable the transition between the two measuring systems _____	9
Figure 2:	Measuring jug with both ounces and millilitres indicated _____	11
Figure 3:	A fuel pump that used to provide fuel by the gallons _____	12
Figure 4:	A speedometer that indicates ones speed in both kilometre and miles _____	12
Figure 5:	A scale to measure the weight of ones food in either pounds or kilograms _____	13
Figure 6:	Standard South African brick size _____	24
Figure 7:	Metal window frame NEX79 _____	25
Figure 8:	Metal window frame TD78 _____	25
Figure 9:	An example of the average internal door size _____	27
Figure 10:	The H-Sections _____	27
Figure 11:	An example of the average internal door size _____	52
Figure 12:	The possible outlay of a metric watch _____	64

## CHAPTER 1 – INTRODUCTION

### 1.1 Background

There are currently two ways of measurement across the globe. The first measuring system is the metric system and the other the imperial. These two methods have no similarities and are not in any way linked to each other. Most countries across the world make use of the metric system and strange enough there are still some countries, of which America is one, that is simply sticking to what they are used to, which is the imperial system.

Having two measurement systems across the globe means different ways of doing things. What is meant with that is that in certain parts of the world things are done in one way and in other parts of the world things are done in another manner. Take transportation for instance: in some countries the cars have to drive on the left hand side versus the right hands side in others; some cars' speed is measured in miles per hour others kilometers per hour. The road signs differ according to where you are situated and according to what the cars' speed is measured in. With this difference in various countries it forces all individuals that are visiting the countries (which have the opposite measuring system to their own) to adapt and to learn the ways of the country he is situated in at that point in time. In situations that are not as simple as the examples mentioned earlier adapting to these changes are more dramatic and if one does not put sufficient time and effort into trying to learn and adapt to the 'other' way of doing things, it could cause some individuals to lose out on great opportunities not to mention how it could have a huge financial impact as well.

Take members of the construction industry as an example, when a quantity surveyor measures something in one unit and the contractor prices according unit; or when an engineer has to perfect his design and uses units he is familiar with instead of using what is customary used in that specific location; and lastly imagine the great influence the wrong interpretation of specifications and drawings will have when the contractor or his

sub contractors has to construct the structure. The wrong specification and interpretation thereof might not only cause a cost overrun, but also that the structure that has been erected might not have the sufficient strength as it was originally designed for.

The RICS is an organization that represents the quantity surveying profession in various countries. This organisation physically visits every educational institution to ensure that these institutes are accredited by RICS to allow the students from these accredited institutions to be able to travel across countries and work at various firms abroad.

Although an institution is accredited by their local associations and the RICS, their skills are limited to the countries with the same measurement systems as they have. If they would wish to work in countries with the opposite measuring system as what they were trained in, they will have to run additional courses to ensure that they are trained to fully comprehend the differences in measurement. This leads to precious time being wasted as well as unnecessary money spent that could be utilised better elsewhere.

## 1.2 The Main Problem

### ***Why is there not one method of measurement across the globe?***

One works with constant measurement of various lengths, areas and even volumes, when you are in the construction industry. One becomes used to the methods of measurements as well as the shortcuts for diverting a larger unit of measurement into a “smaller” unit, thus to one with minimal digits and decimals.

The imperial system is an ancient measuring system that was developed from many centuries ago. The units were mostly compared to physical things, like the average male’s foot’s length is was classified as a physical *foot* length; the weight measured in stone was physically measured in various stones of a specific size weighed against the weight of the object in question. The list of these comparisons between the imperial units and the everyday things will go on and on.

The metric system was later discovered by scientists and it all works according to moving the decimals to the left or the right in order to make the units bigger or smaller. This is the more modern way of measuring and is extremely user friendly.

The reasons why there are still currently two major measuring systems is because the countries still using the imperial system is just 'stuck in their ways'. This system merely works for them and they can not see why there would be a need for any change as there is no lack in the system they already have implemented.

There should be one way of doing things across the world. The more developed countries might have a faster, more time efficient manner of getting things done but overall global standardisation is desperately needed.

## **1.3 The Sub Problems**

In order to answer and discuss the main problem in more detail the following four questions will have to be considered.

- 1.3.1 *What is the difference between the metric and the imperial system?***
- 1.3.2 *Where does the current South African standard dimension for building elements come from?***
- 1.3.3 *What financial impact would the change of measuring system have on the construction industry as a whole?***
- 1.3.4 *How did the Standard Method of Measuring Builders' Work of South Africa Document develop over the years?***
- 1.3.5 *Should the whole world convert to the measuring system that the leading country has implemented, or should we work according to what the majority of the world is working with?***
- 1.3.6 *Can the implementation of the possible metrification of time ever be implanted successfully?***

## 1.4 The Hypotheses

1.4.1 The major differences between the two systems is just in the unit of measurement as set out in the table below:

<b>METRIC</b>		<b>IMPERIAL</b>	
<b>LENGTH</b>	Millimeters	<b>LENGTH</b>	Inch
	Centimeters		Foot
	Meters		Yard
	Kilometers		Mile
<b>WEIGHT</b>	Milligram	<b>WEIGHT</b>	Grain
	Gram		Ounce
	Kilogram		Pound
	Ton		Stone

1.4.2 The standard dimensions for most of the building elements still currently in use are merely converted from the previous measuring system. The reason for this being that the cost and the effort to change them to rounded dimensions would have simply been too high. For example a standard door size is 813 x 2 023mm which in the old terms would have been 32 x 80 inches.

1.4.3 This section of the work will show if the dimensions were to be altered or adapted to those of the current measuring systems, thus “rounded” dimensions such as 900mm x 2 000mm for a door size instead of 813mm x 2 023mm and how such a change might affect the comfort of a person as well as cost of construction. The comfort ratio of the human being will be brought to light and the reason for certain standards of heights and widths will become clear.

1.4.4 The study will show that through the various editions of the Standard System of Measuring Builder’s Work of South Africa documents the basis of measurement have remained the same but the units have merely changed from imperial units to the closest of equal metric units.

1.4.5 The world as a whole will have to convert to the measuring system that the majority of the world is currently using, which means globally every country will have to adjust to the metric system.

1.4.6 Although there is a possibility of time to work on another basis other than what is none to all today, it will not be feasible to implement another time system as there is no need to change something that already works perfectly.

## 1.5 Delimitations

This study will be based on all the measuring systems across the globe, but the information will be applicable and gathered from only the larger countries.

The questionnaire that will be done will only be amongst South Africans as getting hold of people abroad will be of great difficulty.

## 1.6 Definition of Terms

£	Pound
cm	Centimeter
ha	Hectare
ISO	International Standards Organisation
l	Litre
km	Kilometer
m	Meter
mm	Millimeter
QS	Quantity Surveyor
RICS	Royal Institution of Chartered Surveyors
SABS	South African Bureau of Standards
SANS	South African National Standards
UK	United Kingdom

## **1.7 Assumptions**

Within the study it will be assumed that all the smaller towns will be using the same measuring systems as their leading countries. This for the purpose of the study only the larger countries will be taken into account.

## **1.8 Importance of the Study**

It is of great importance that a specific standard is maintained across the world. By having one measuring system, everyone across the globe is certain and adapted to using this one way of doing things. This will ensure that things get done in a uniform way, saving time and ensuring that errors are minimised.

It will take a little getting used to for the countries using the imperial system, to switch over to the metric system and changing their ways of doing things, but in the long run everyone would benefit from it as everyone will be 'speaking one language'.

## **1.9 Research Methodology**

A thorough investigation will take place to ensure that what the metric and imperial system entails are fully comprehended. After fully gaining the insight gathered from the various sources all the information will be sorted under the different headings to ensure the maximum information that was gathered can be carried across in the different chapters. Academic research and the survey research results will be clearly laid out and where possible compared to each other.

The study will show that the author (being from a South African background, using the metric system) thinks that a metric system should be used internationally.

The various resources that will be used is:

1. A book – Related to the subject of the study
2. [www.ask.com](http://www.ask.com)
3. [www.google.com](http://www.google.com)
4. [www.wikipedia.com](http://www.wikipedia.com)
5. A survey in which five people of various professions, including the construction industry, will fill in forms to provide me with their opinions. These opinions will then be captured in a graphical format and discussed (see Annexure A).
6. Interviews with an Architect as well as with a supplier of building materials

## CHAPTER 2

### ***WHAT IS THE DIFFERENCE BETWEEN THE METRIC AND THE IMPERIAL SYSTEM?***

#### **2.1 Introduction**

The imperial system came into being over a long time period. It started off being called the English units of measurement. Before 1066 this included some of the likely German origin influences (also known as Anglo-Saxon), but after the Norman conquest the Normans introduced the Roman measures. This caused a measuring system including the Anglo-Saxon and the Roman measures. In 1215 M. Carta reviewed this system and it was updated to be more user friendly to all its users. The UK Weights and Measures Act of 1824 was one of the later institutions that reviewed this measuring system and modified the types and sizes of units. They were also the institution that renamed the then known English units of measurement system to the Imperial System of measurement (<http://www.france-property-and-information.com/imperial-system-and-history.htm>, 2010/01/05).

At this time the USA was an independent state and they decided to not adapt to the new Imperial system. They instead adapted their measuring system to the English units system. This caused the English system to be developed in the USA, the UK and its colonised countries implemented the Imperial system.

Both of the above systems are based on the everyday objects and activities as well as nature itself. For example a grain is physically the weight of a grain of wheat. This weight measurement was used to determine the weight and value of precious metals. (<http://www.france-property-and-information.com/imperial-system-and-history.htm>).

Another example is foot; this length was physically taken as the average length of a full grown man's foot. The weight of stone was also taken as a specific size and material of stone (1 stone = 14 pounds). This was used for larger masses where grain was merely out of the question to use.

The problem arose that not all the grains were equal in size, and that not all the men's feet were equal in size making the comparison between these more difficult as time progressed. This caused values of material to be inaccurate (in some cases causing over valuated materials and in other under valuated materials and minerals). Queen Elizabeth I then called for standard samples to be produced. It was at this time that weights of an equal mass of that of a grain of wheat were produced. A ruler indicating the average foot was also introduced. The larger units such as miles and tons could not be feasibly produced and it was then made certain that it would from then be used as multiples of the smaller units. (For example 3 foot = 1 yard)

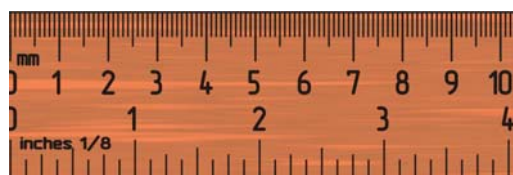
## 2.2 Measuring system development

The USA and the UK both individually developed their measuring systems. With these two countries not working together anymore, it caused a discrepancy in various units that are named the same but are merely not the same. The USA gallon was smaller than the Imperial gallon and there was not only referred to a ton but the USA wanted the tonnage in more detail thus separating it into short ton and long ton. (Example of this in Table 15 and 16)

In the mid-twentieth century all major countries using the imperial system have been adapting and replacing the imperial system with the metric system. This complete transition to another measuring system was timeous and took a lot of effort as most machinery had to be changed and the population itself had to be physically educated on how the new system was different from that of the old and how one should make use of it, not even to mention the financial costs that were carried to change all the measuring tools such as measuring tapes, rulers, scales and so forth.

FIGURE 1 An example of the scale rulers that had to be produced to enable the transition between the two measuring systems.

Source: <http://whatafind-antiques-collectibles.blogspot.com/2008/07/american-family-kitchen-scale-weighs.html> (2010/02/03)



All the metric system units are a multiple of 10. What is meant with this is that the units are multiplied by 10 to make larger units or divided by 10 to make smaller units.

According to <http://www.thefreedictionary.com/meter> (2010/09/30) the international standard unit of length of one meter is approximately equivalent to 39.37 inches. It was redefined in 1983 as the distance travelled by light in a vacuum in  $1/299,792,458$  of a second

According to <http://www.france-property-and-information.com/imperial-system-and-history.htm>, (2010/01/05) a kilometer is 1000 metres –  $10 \times 10 \times 10$ . If one would like to compare this to something of the imperial system one could use 1 mile equalling 5280 feet -  $8 \times 10 \times 22 \times 3$  (a mile is 8 furlongs, 1 furlong is 10 chains, 1 chain is 22 yards and then finally 3 feet to a yard).

As the above calculation shows, both measuring systems can be converted from a smaller unit to a larger unit but it is very clear that the conversion that the metric system uses is much simpler and clearer to all users.

The imperial units are not all handled equally and some of the units are lucky to still be in use today:

- Imperial units that are long forgotten:
  - Ounces
  - Gallons
  - Miles
  - Pints
  - Quarts
  
- Imperial units that are used hand in hand with their metric equivalents:
  - Inches
  - Feet
  - Yards
  - Degrees Fahrenheit
  
- Imperial units that are used till today:
  - Acres
  - Pounds

Some of the above units will not even be familiar to some of the people born after the 1980's as it most of the countries have already converted to the metric systems at that time.

Some examples where one might still find the above mentioned units all around the world:

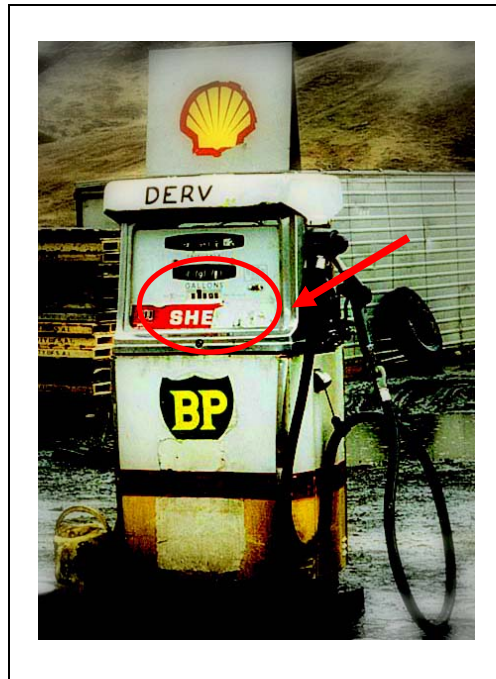
- Ounces      Some containers such as measuring jugs will indicate both ounces as well as millilitres as this made the conversion from imperial to the metric system much easier and with fewer errors. The example of the measuring jug only takes the liquid ounces into consideration and solid ounces usage are totally phased out.

FIGURE 2      Measuring jug with both ounces and millilitres indicated  
Source: <http://www.allianceonline.co.uk/chefs-utensils/measuring-jugs-and-scoops.html> (2010/03/10)



- Gallons      In some countries such as the United Kingdom one would have to ask for a certain amount of fuel in gallons, but one will be charged in £/ℓ

FIGURE 3 A fuel pump that used to provide fuel by the gallons  
Source: [http://becauseican.co.za/wp-content/uploads/2008/04/ruler\\_0\\_10.jpg](http://becauseican.co.za/wp-content/uploads/2008/04/ruler_0_10.jpg)  
(2010/03/11)



- Miles The European vehicles' speed is measured in km/h, the distance between towns will always be given in miles.

FIGURE 4 A speedometer that indicates ones speed in both kilometre and miles  
Source: <http://www.g9toengineering.com/resources/reverseengineering.htm>  
(2010/03/10)



- Pounds Some sports will give the weight of the competitors in pounds rather than kilograms as it is more precise and gives the supporters much more detail. Boxing, wrestling and horse riding

are just a few examples of sports that prefer pounds above kilograms.

FIGURE 5 A scale to measure the weight of ones food in either pounds or kilograms  
Source: <http://www.shrubs.co.uk/1-litre-measuring-jug-1483008-st-15702-p.asp> (2010/03/06)



- Pints In London one will always buy all liquids in pints with the containers millilitre value indicated on the container as well
- Quarts In South Africa one can buy alcohol in quarts containers which will consist of 750ml
- Inches Timber material's sizes are often still verified in inches
- Feet Most people's height will be given in feet in stead of metres
- Yards This phrase is used in the sport football and indicates a distance the player runs across the field. Football is more known amongst the Americans and they are familiar with the value of the length as they are still working with the imperial system
- Degrees Fahrenheit In recipe books both degree Celsius as well as degree Fahrenheit will be given as there are currently ovens that are manufactured in both degree Celsius as well as degree Fahrenheit thermometers. By showing both of these temperatures people across the globe can make use of these recipes with great success.

- Acres Farms and large pieces of land's size will still be given either in acres or more frequently used hectares.

## 2.3 Easy conversions

TABLE 1 Conversion from inches to millimetres

Source: LITTLE, A.B. 1970

<b>INCHES TO MILLIMETRES</b>										
Basis: 1 inch = 25.44mm exactly										
INCHES	0.00	1	2	3	4	5	6	7	8	9
<hr style="border: none; border-top: 1px solid black;"/>										
mm										
<hr style="border: none; border-top: 1px solid black;"/>										
0.0		25.40	50.80	76.20	101.60	127.00	152.40	177.80	203.20	228.60
10.0	254.00	279.40	304.80	330.20	355.60	381.00	406.40	431.80	457.20	482.60
20.0	508.00	533.40	558.80	584.20	609.60	635.00	660.40	685.80	711.20	736.60
30.0	762.00	787.40	812.80	838.20	863.60	889.00	914.40	939.80	965.20	990.60
40.0	1,016.00	1,041.40	1,066.80	1,092.20	1,117.60	1,143.00	1,168.40	1,193.80	1,219.20	1,244.60
50.0	1,270.00	1,295.40	1,320.80	1,346.20	1,371.60	1,397.00	1,422.40	1,447.80	1,473.20	1,498.60
60.0	1,524.00	1,549.40	1,574.80	1,600.20	1,625.60	1,651.00	1,676.40	1,701.80	1,727.20	1,752.60
70.0	1,778.00	1,803.40	1,828.80	1,854.20	1,879.60	1,905.00	1,930.40	1,955.80	1,981.20	2,006.60
80.0	2,032.00	2,057.40	2,082.80	2,108.20	2,133.60	2,159.00	2,184.40	2,209.80	2,235.20	2,260.60
90.0	2,286.00	2,311.40	2,336.80	2,362.20	2,387.60	2,413.00	2,438.40	2,463.80	2,489.20	2,514.60
100.0	2,540.00									

TABLE 2 Conversion from feet to millimetres

Source: LITTLE, A.B. 1970

<b>FEET TO MILLIMETRES</b>										
Basis: 1 foot = 0.3048 meter										
FEET	0	1	2	3	4	5	6	7	8	9
<hr style="border: none; border-top: 1px solid black;"/>										
mm										
<hr style="border: none; border-top: 1px solid black;"/>										
0.0		0.305	0.610	0.914	1.219	1.524	1.829	2.134	2.438	2.743
10.0	3.048	3.353	3.658	3.962	4.267	4.572	4.877	5.182	5.486	5.791
20.0	6.096	6.401	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	9.144	9.449	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	12.192	12.497	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	15.240	15.545	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	18.288	18.593	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	21.336	21.641	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	24.384	24.689	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	27.432	27.737	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	30.480									

TABLE 3 Conversion from yards to meters  
Source: LITTLE, A.B. 1970

<b>YARDS TO METRES</b>										
Basis: 1 yard = 0.9144 meter										
YARDS	0	1	2	3	4	5	6	7	8	9
m										
0.0		0.914	1.829	2.743	3.658	4.572	5.486	6.401	7.315	8.230
10.0	9.144	10.058	10.973	3.962	4.267	4.572	4.877	5.182	16.459	17.374
20.0	18.288	19.202	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	27.432	28.346	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	36.576	37.490	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	45.720	46.634	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	54.864	55.778	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	64.008	64.922	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	73.152	74.066	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	82.296	83.210	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	91.440									

TABLE 4 Conversion from miles to kilometres  
Source: LITTLE, A.B. 1970

<b>MILES TO KILOMETRES</b>										
Basis: 1 mile = 1.609344 kilometres										
MILES	0	1	2	3	4	5	6	7	8	9
km										
0.0		1.609	3.219	4.828	6.437	8.047	9.656	11.265	12.875	14.484
10.0	16.093	17.703	19.312	3.962	4.267	4.572	4.877	5.182	28.968	30.578
20.0	32.187	33.796	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	48.280	49.890	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	64.374	65.983	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	80.467	82.077	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	96.561	98.170	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	112.654	114.263	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	128.748	130.357	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	144.841	146.450	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	160.934									

TABLE 5 - Conversion from square feet to square metres  
Source: LITTLE, A.B. 1970

<b>SQUARE FEET TO SQUARE METRES</b>										
Basis: 1 square foot = 0.092903 square metres										
Sq FEET	0	1	2	3	4	5	6	7	8	9
m <sup>2</sup>										
0.0		0.093	0.186	0.279	0.372	0.465	0.557	0.650	0.743	0.836
10.0	0.929	1.022	1.115	3.962	4.267	4.572	4.877	5.182	1.672	1.765
20.0	1.858	1.951	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	2.787	2.880	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	3.716	3.809	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	4.645	4.738	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	5.574	5.667	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	6.503	6.596	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	7.432	7.525	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	8.361	8.454	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	9.290									

TABLE 6 Conversion from square yards to square metres  
Source: LITTLE, A.B. 1970

<b>SQUARE YARDS TO SQUARE METRES</b>										
Basis: 1 square yard = 0.836127 square metres										
Sq YARDS	0	1	2	3	4	5	6	7	8	9
m <sup>2</sup>										
0.0		0.836	1.672	2.508	3.345	4.181	5.017	5.853	6.689	7.525
10.0	8.361	9.197	10.034	3.962	4.267	4.572	4.877	5.182	15.050	15.886
20.0	16.723	17.559	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	25.084	25.920	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	33.445	34.281	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	41.806	42.642	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	50.168	51.004	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	58.529	59.365	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	66.890	67.726	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	75.251	76.088	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	83.613									

TABLE 7 Conversion from acres to hectares  
Source: LITTLE, A.B. 1970

<b>ACRES TO HECTARES</b>										
Basis: 1 acre = 0.404686 hectare										
ACRES	0	1	2	3	4	5	6	7	8	9
ha										
0.0		0.405	0.809	1.214	1.619	2.023	2.428	2.833	3.237	3.642
10.0	4.047	4.452	4.856	3.962	4.267	4.572	4.877	5.182	7.284	7.689
20.0	8.094	8.498	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	12.141	12.545	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	16.187	16.592	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	20.234	20.639	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	24.281	24.686	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	28.328	28.733	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	32.375	32.780	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	36.422	36.826	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	40.469									

TABLE 8 Conversion from ounces to millilitres  
Source: LITTLE, A.B. 1970

<b>FLUID OUNCES TO MILLILITERS</b>										
Basis: 1 fluid ounce = 28.4130 millilitres										
OZ	0	1	2	3	4	5	6	7	8	9
ml										
0.0		28.413	56.826	85.239	113.652	142.065	170.478	198.891	227.304	255.717
10.0	284.130	312.543	340.956	3.962	4.267	4.572	4.877	5.182	511.434	539.847
20.0	568.260	596.673	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	852.390	880.803	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	1,136.520	1,164.933	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	1,420.650	1,449.063	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	1,704.780	1,733.193	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	1,988.910	2,017.323	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	2,273.040	2,301.453	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	2,557.170	2,585.583	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	2,841.300									

TABLE 9 Conversion from pints to litres  
Source: LITTLE, A.B. 1970

<b>PINTS TO LITERS</b>										
Basis: 1 pint = 0.568261 litre										
PINT	0	1	2	3	4	5	6	7	8	9
	ℓ									
0.0		0.568	1.137	1.705	2.273	2.841	3.410	3.978	4.546	5.114
10.0	5.683	6.251	6.819	7.387	7.955	8.523	9.091	9.659	10.227	10.795
20.0	11.365	11.933	12.501	13.069	13.637	14.205	14.773	15.341	15.909	16.477
30.0	17.048	17.616	18.184	18.752	19.320	19.888	20.456	21.024	21.592	22.160
40.0	22.730	23.298	23.866	24.434	25.002	25.570	26.138	26.706	27.274	27.842
50.0	28.413	28.981	29.549	30.117	30.685	31.253	31.821	32.389	32.957	33.525
60.0	34.096	34.664	35.232	35.800	36.368	36.936	37.504	38.072	38.640	39.208
70.0	39.778	40.347	40.915	41.483	42.051	42.619	43.187	43.755	44.323	44.891
80.0	45.461	46.029	46.597	47.165	47.733	48.301	48.869	49.437	50.005	50.573
90.0	51.143	51.712	52.280	52.848	53.416	53.984	54.552	55.120	55.688	56.256
100.0	56.826									

TABLE 10 Conversion from gallons to litres  
Source: LITTLE, A.B. 1970

<b>GALLONS TO LITERS</b>										
Basis: 1 gallon = 4.54609 litres										
GALLONS	0	1	2	3	4	5	6	7	8	9
	ℓ									
0.0		4.546	9.092	13.638	18.184	22.730	27.277	31.823	36.369	40.915
10.0	45.461	50.007	54.553	59.099	63.645	68.191	72.737	77.283	81.829	86.375
20.0	90.922	95.468	100.014	104.560	109.106	113.652	118.198	122.744	127.290	131.836
30.0	136.383	140.929	145.475	150.021	154.567	159.113	163.659	168.205	172.751	177.297
40.0	181.844	186.390	190.936	195.482	200.028	204.574	209.120	213.666	218.212	222.758
50.0	227.305	231.851	236.397	240.943	245.489	250.035	254.581	259.127	263.673	268.219
60.0	272.765	277.311	281.857	286.403	290.949	295.495	300.041	304.587	309.133	313.679
70.0	318.226	322.772	327.318	331.864	336.410	340.956	345.502	350.048	354.594	359.140
80.0	363.687	368.233	372.779	377.325	381.871	386.417	390.963	395.509	400.055	404.601
90.0	409.148	413.694	418.240	422.786	427.332	431.878	436.424	440.970	445.516	450.062
100.0	454.609									

TABLE 11 Conversion from ounces to grams  
Source: LITTLE, A.B. 1970

<b>OUNCES TO GRAMS</b>										
Basis: 1 lb = 16 oz = 453.59237g (exactly)										
OUNCES	0	1	2	3	4	5	6	7	8	9
	g									
0.0		28.350	56.699	85.049	113.398	141.748	170.097	198.447	226.796	255.146
10.0	283.495	311.845	340.194	368.544	396.893	425.243	453.592	481.942	510.291	538.641
20.0	566.990	595.340	623.689	652.039	680.388	708.738	737.087	765.437	793.786	822.136
30.0	850.486	878.835	907.185	935.534	963.884	992.233	1020.583	1048.932	1077.282	1105.631
40.0	1,133.981	1,162.330	1,190.680	1,219.029	1,247.379	1,275.728	1,304.078	1,332.427	1,360.777	1,389.126
50.0	1,417.476	1,445.826	1,474.175	1,502.525	1,530.874	1,559.224	1,587.573	1,615.923	1,644.272	1,672.622
60.0	1,700.971	1,729.321	1,757.670	1,786.020	1,814.369	1,842.719	1,871.068	1,899.418	1,927.767	1,956.117
70.0	1,984.467	2,012.816	2,041.165	2,069.515	2,097.864	2,126.214	2,154.563	2,182.913	2,211.262	2,239.612
80.0	2,267.962	2,296.311	2,324.661	2,353.010	2,381.360	2,409.709	2,438.059	2,466.408	2,494.758	2,523.107
90.0	2,551.457	2,579.807	2,608.156	2,636.506	2,664.855	2,693.205	2,721.554	2,749.904	2,778.253	2,806.603
100.0	2,834.952									

TABLE 12 Conversion from pound to kilograms  
Source: LITTLE, A.B. 1970

<b>POUNDS TO KILOGRAMS</b>										
Basis: 1 POUND = 0.45359237kg (exactly)										
OUNCES	0	1	2	3	4	5	6	7	8	9
kg										
0.0		0.454	0.907	1.361	1.814	2.268	2.722	3.175	3.629	4.082
10.0	4.536	4.990	5.443	5.896	6.350	6.803	7.257	7.710	8.164	8.618
20.0	9.072	9.525	9.978	10.432	10.885	11.339	11.792	12.246	12.699	13.153
30.0	13.608	14.061	14.515	14.968	15.422	15.875	16.329	16.782	17.236	17.689
40.0	18.144	18.597	19.051	19.504	19.958	20.411	20.865	21.318	21.772	22.225
50.0	22.680	23.133	23.587	24.040	24.494	24.947	25.401	25.854	26.308	26.761
60.0	27.216	27.669	28.123	28.576	29.030	29.483	29.937	30.390	30.844	31.297
70.0	31.751	32.205	32.658	33.112	33.565	34.019	34.472	34.926	35.379	35.833
80.0	36.287	36.741	37.194	37.648	38.101	38.555	39.008	39.462	39.915	40.369
90.0	40.823	41.277	41.730	42.184	42.637	43.091	43.544	43.998	44.451	44.905
100.0	45.359									

TABLE 13 Conversion from cubic feet to cubic metres  
Source: LITTLE, A.B. 1970

<b>CUBIC FEET TO CUBIC METRES</b>										
Basis: 1 cubic foot = 0.028317 cubic metres										
Cu. FEET	0	1	2	3	4	5	6	7	8	9
m <sup>3</sup>										
0.0		0.028	0.057	0.085	0.113	0.142	0.170	0.198	0.227	0.255
10.0	0.283	0.311	0.340	0.368	0.397	0.425	0.454	0.482	0.511	0.539
20.0	0.566	0.595	0.623	0.652	0.680	0.709	0.737	0.766	0.794	0.823
30.0	0.850	0.878	0.907	0.935	0.964	0.992	1.021	1.049	1.078	1.106
40.0	1.133	1.161	1.190	1.218	1.247	1.275	1.304	1.332	1.361	1.389
50.0	1.416	1.444	1.473	1.501	1.530	1.558	1.587	1.615	1.644	1.672
60.0	1.699	1.727	1.756	1.784	1.813	1.841	1.870	1.898	1.927	1.955
70.0	1.982	2.011	2.039	2.068	2.096	2.125	2.153	2.182	2.210	2.239
80.0	2.265	2.294	2.322	2.351	2.379	2.408	2.436	2.465	2.493	2.522
90.0	2.549	2.577	2.606	2.634	2.663	2.691	2.720	2.748	2.777	2.805
100.0	2.832									

TABLE 14 Conversion from cubic yards to cubic metres  
Source: LITTLE, A.B. 1970

<b>CUBIC YARDS TO CUBIC METRES</b>										
Basis: 1 cubic yard = 0.764555 cubic metres										
Cu. YARDS	0	1	2	3	4	5	6	7	8	9
m <sup>3</sup>										
0.0		0.765	1.529	2.294	3.058	3.823	4.587	5.352	6.116	6.881
10.0	7.646	8.410	9.175	9.939	10.704	11.468	12.233	12.997	13.762	14.527
20.0	15.291	16.056	16.820	17.585	18.349	19.114	19.878	20.643	21.408	22.172
30.0	22.937	23.701	24.466	25.230	25.995	26.759	27.524	28.288	29.053	29.817
40.0	30.582	31.347	32.111	32.876	33.640	34.405	35.169	35.934	36.698	37.463
50.0	38.228	38.992	39.757	40.521	41.286	42.050	42.815	43.579	44.344	45.108
60.0	45.873	46.638	47.402	48.167	48.931	49.696	50.460	51.225	51.989	52.754
70.0	53.519	54.283	55.048	55.812	56.577	57.341	58.106	58.870	59.635	60.399
80.0	61.164	61.929	62.693	63.458	64.222	64.987	65.751	66.516	67.280	68.045
90.0	68.810	69.575	70.339	71.104	71.868	72.633	73.397	74.162	74.926	75.691
100.0	76.456									

TABLE 15 Conversion from short tons to metric tons  
 Source: LITTLE, A.B. 1970

<b>SHORT TONS TO METRIC TONS</b>										
Basis: 1 short ton = 0.907185 metric ton										
Short Tons	0	1	2	3	4	5	6	7	8	9
	Metric Tons									
0.0		0.907	1.814	2.722	3.629	4.536	5.443	6.350	7.257	8.165
10.0	9.072	9.979	10.886	3.962	4.267	4.572	4.877	5.182	16.329	17.237
20.0	18.144	19.051	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	27.216	28.123	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	36.287	37.195	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	45.359	46.266	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	54.431	55.338	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	63.503	64.410	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	72.575	73.482	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	81.647	82.554	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	90.719									

TABLE 16 Conversion from long tons to metric tons  
 Source: LITTLE, A.B. 1970

<b>LONG TONS TO METRIC TONS</b>										
Basis: 1 long ton = 1.01605 metric ton										
Long Tons	0	1	2	3	4	5	6	7	8	9
	Metric Tons									
0.0		1.016	2.032	3.048	4.064	5.080	6.096	7.112	8.128	9.144
10.0	10.161	11.177	12.193	3.962	4.267	4.572	4.877	5.182	18.289	19.305
20.0	20.321	21.337	6.706	7.010	7.315	7.620	7.925	8.230	8.534	8.839
30.0	30.482	31.498	9.754	10.058	10.363	10.668	10.973	11.278	11.582	11.887
40.0	40.642	41.658	12.802	13.106	13.411	13.716	14.021	14.326	14.630	14.935
50.0	50.803	51.819	15.850	16.154	16.459	16.764	17.069	17.374	17.678	17.983
60.0	60.963	61.979	18.898	19.202	19.507	19.812	20.117	20.422	20.726	21.031
70.0	71.124	72.140	21.946	22.250	22.555	22.860	23.165	23.470	23.774	24.079
80.0	81.284	82.300	24.994	25.298	25.603	25.908	26.213	26.518	26.822	27.127
90.0	91.445	92.461	28.042	28.346	28.651	28.956	29.261	29.566	29.870	30.175
100.0	101.605									

## 2.4 Summary

Both the metric and the imperial systems have come a long way and have been in use for some time (of course the imperial is a much older system than the metric) and the users of both systems feel that their system of use is truly useful and sufficient.

The conversion of the imperial to metric system was an intensive process but at the end of the day the easier conversion of units leads to optimum time usage thus causing savings in costs.

## 2.5 Conclusion

There are two measuring systems due to the fact that the original measuring system was found to be insufficient and the units supposedly differed across the globe because the average sizes of items used (such as feet and stones) differed from place to place. This caused the starting of the change in the measuring system.

The big reason why there are still currently two major measuring systems across the world is because when the change originally started in the mid twentieth century not all the countries were willing to take a step towards change and they settled for the known and remained in their comfort zone.

## 2.6 Testing of Hypothesis

The hypothesis was:

**The major differences between the two systems is just in the unit of measurement as set out in the table below:**

<b>METRIC</b>		<b>IMPERIAL</b>	
<b>LENGTH</b>	Millimeters	<b>LENGTH</b>	Inch
	Centimeters		Foot
	Meters		Yard
	Kilometers		Mile
<b>WEIGHT</b>	Milligram	<b>WEIGHT</b>	Grain
	Gram		Ounce
	Kilogram		Pound
	Ton		Stone

The hypothesis has been found to be partially correct. Yes the quick comparison between the metric system and the imperial system, according to ranking the measuring units from small to larger units might give you a large overview and the general picture of what the

major differences are. There are much more complicated underlying factors that give reason to why there isn't merely just one system in use, this being from the history and how the system came into being, to the conversion from smaller units to larger units within the system itself (foot to miles or metres to kilometres).

## **CHAPTER 3**

### ***WHERE DOES THE CURRENT SOUTH AFRICAN STANDARD DIMENSIONS FOR BUILDING ELEMENTS COME FROM?***

#### **3.1 Introduction**

In the beginning everything man made was done with proportions in mind. The human elements, such as feet, ones thumb, the hand and so on was used to make sense of the average measurement of items such as building blocks, door frames, window openings and many more such items needed to build a structure fit for its purpose.

This chapter is briefly going to explain the origin of a view building elements as well as the reasoning of the why the dimensions and the sizes of such units are what it is today.

#### **3.2 The standard brick**

##### **3.2.1 A brief history**

'Bricks dated 10 000 years old were found in the Middle East, and the earliest mention of brick making was found in the Bible (Reference to Genesis 11:3; Exodus1:14; Exodus 5:4-19). <http://en.wikipedia.org/wiki/Brick> (2010/07/01)

Known record shows that the Egyptians made their bricks from earth and straw, which they then made a mixture of and put it in the sun to allow it to dry properly. Those who had access to clay soil, merely shaped that into a reqtangular shape and allowed it to sun bake as well.

The Romans made use of a similar process but instead of making use of the sun to dry and bake the bricks, they made use of kilns to bake the rectangular shaped bricks for a specific period of time. The Romans were also required to stamp each brick manufactured to ensure that the production thereof can be traced back to the labourers supervisor. This

process were only developed some 3 800 years ago and is very similar to the modern processes still in use today.

According to Innocent (1961) King Eduard IV of England already called for a standard brick size to be poured in a standard sized template of 9 inches in length and 4 ½ inches wide in 1477. After the baking of the bricks the minimum size of 8 ½ x 4 x 2 ½ inches had to be maintained. Even after a few centuries these specific bricksizes are still in use in various countries, as quoted by van Zyl (1985).

The bricks that were produced were of a standard size of roughly 42cm long, 20cm wide and 10cm thick.

According to <http://en.wikipedia.org/wiki/Brick> (2010/07/01) during the Renaissance and the Baroque period, brickwork was mostly covered with plaster as the visible brick walls were very unpopular during those periods. The mid eighteenth century ensured that the visibility of the brick regained its popularity.

A trend for higher skyscraper like buildings came to light during the nineteenth century, which brought the limitations of the brick forward. The 'Monadnock' Building in Chicago (1896) is a seventeen story high building built with mere bricks and the necessary reinforcement. Needless to say the ground walls are almost 1.8m (6 feet) thick, to ensure the suitable stability for the structure of its height. This caused a great loss of internal floor space of all the lower floors. Lessons were learnt and alternatives were developed and since 1950's bricks are limited to low and medium rise buildings, leaving the high rise buildings to their fellow construction elements such as steel and concrete.

### 3.2.2 Dimensions

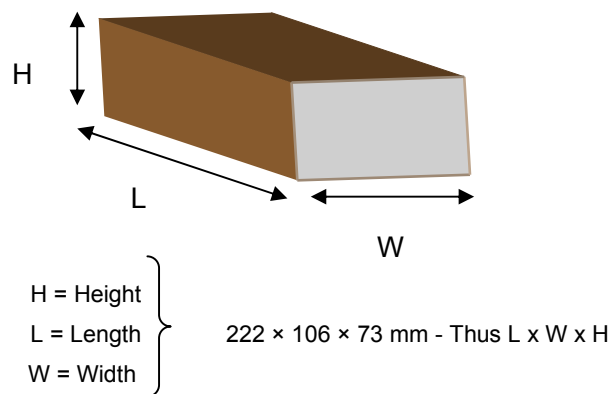
The brick's size is determined to enable a comfortable handle of the brick by the bricklayer, thus it must be light enough to be picked up with one hand, leaving the other hand free to work with the trowel. The weight of a standard brick is approximately 2,7kg.

According to <http://en.wikipedia.org/wiki/Brick> (2010/07/01), bricks are mostly laid flat (stretcher bond) and as a result the effective limit on the width of a brick is set by the distance which can conveniently be spanned between the thumb and fingers of one hand, normally about four inches (101.6mm). The length of the brick is twice its width, about 8 inches (203mm) or more. This ratio allows bricks to be laid in a structure to increase its

stability and strength, when the English or the Flemish bond is used. The width-length ratio also ensures that the “lines” of the structure aligns which is a huge aesthetical aspect from any architectural perspective.

Climatic conditions and various temperatures caused the bricks in various countries to vary from others as indicated in table below.

**FIGURE 6** Standard South African brick size  
*Source: Own*



“In England, the length and the width of the common brick has remained constant over the centuries, but the depth has varied from about two inches (50.8mm) or smaller in earlier times to about two and a half inches (63.5mm) more recently. In the United States, modern bricks are usually about 8 x 4 2.25 inches (203 x 102 x 57mm). In the United Kingdom, the standard size of a modern brick is 215 x 102.5 x 65mm (approximately 8.5 x 4 x 2.5 inches), which, with a nominal 10mm mortar joint, forms a fitted size of 225 x 112.5 x 75mm, for a ratio 6:3:2” as indicated on <http://en.wikipedia.org/wiki/Brick> (2010/07/01)

**TABLE 17** Standard brick sizes across the globe.  
*Source: <http://en.wikipedia.org/wiki/Brick> (2010/07/01)*

Face brick ("house brick") sizes, (alphabetical order)		
Standard	Imperial	Metric
<a href="#">Australia</a>	9 × 4½ × 3 inches	230 × 110 × 76 mm
<a href="#">India</a>	9 × 4¼ × 2¾ inches	228 × 107 × 69 mm
<a href="#">Russia</a>		250 × 120 × 65 mm
<a href="#">South Africa</a>	8¾ × 4 × 3 inches	222 × 106 × 73 mm
<a href="#">Sweden</a>		250 × 120 × 62 mm
<a href="#">United Kingdom</a>	8½ × 4 × 2½ inches	215 × 102.5 × 65 mm
<a href="#">United States</a>	8 × 4 × 2¼ inches	203 × 102 × 57 mm

### 3.3 Windows

Windows have been used for decades to allow light into the building whilst at the same time allowing the user to control the ventilation of the room.

For the purpose of this example, “Durowin’s” catalogue was used to obtain steel window sizes.

FIGURE 7 Metal window frame NEX79  
Source: *Durowin Catalogue*

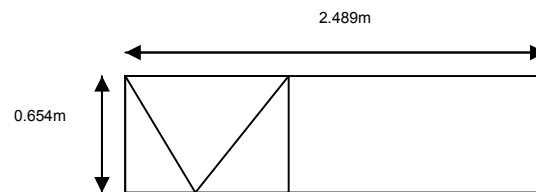
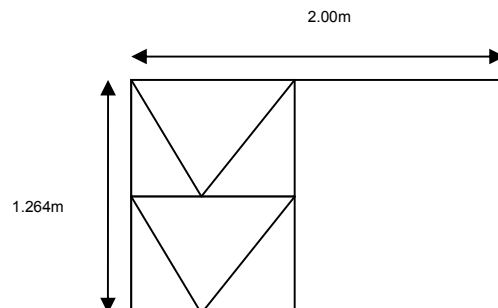


FIGURE 8 Metal window frame TD78  
Source: *Durowin Catalogue*



The window type NEX79’s width of 2 489mm can directly be converted to 98 imperial inches. Its height is a totally different story, as it can’t seem to be linked to any imperial units nor does it line up with the dimensions of the average brick size (with the mortar sizes taken into account). The same problem is experienced with window TD78 as its width can be linked with 9 bricks’ width, but with the height of 1 264mm not linking to any applicable values.

### 3.4 Doors

One of the earliest records of doors being used is those used in the Egyptian tombs. All these ancient doors were hung by pivots at the top and bottom of the hanging. The doors were hung in two leaves of about 8 feet 4 inches wide (2.54m) and approximately 27 feet high (8.2m). They were hung from a stile of over 14 inches (360mm) in diameter and the door was on average 3 inches thick.

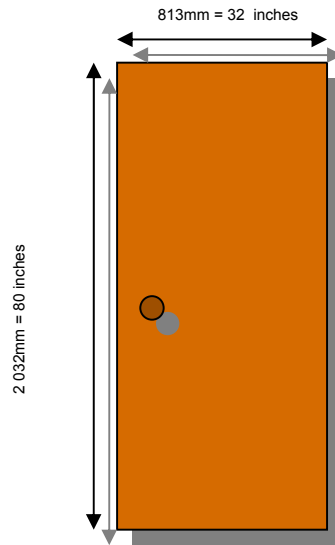
Doors were more frequently used as the centuries proceeded, different materials were tried and tested and various countries made use of different decorative methods to represent various cultures and purpose of what the door is intended for. The bigger and higher the door, the higher the power the building represents. Needless to say, all churches had very high and heavy doors that needed more than one man to open it, due to its mere weight.

As the time progressed people realised that the mere size of the door did not necessarily have the desired symbolic representation, and so doors became thinner and smaller over time. The focus of the symbolic representation were shifted from the doors and windows to that of the interior finishes, such as decorative ceilings, very high walls as well as well crafted statues that symbolises what the people of the specific century believed in or experienced.

The focus of the door shifted from its great size to its user friendliness. Door materials, finishes as well as physical size were changed drastically over the past few centuries to make sure that it serves the purpose it was designed for.

Today various doors and sizes are found, each with its own designed position and purpose. The current standard door as we know it was originally designed to fit the average man standing up straight and with his arms next to his side, and then to allow him to move through the door very comfortably.

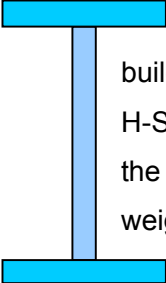
FIGURE 9 An example of the average internal door size.  
Source: [Own](#)



The height of the door, 2 032mm allows for 24 brick layers. The alignment of the brick layers applicable to the standard door size allows the builder to build in a lintel above the door frame. A lintel provides proper weight distribution of the wall above the door opening. The lintels needs to be supported by 150mm on either sides of the opening, thus linking up to 6 inches as referred to before, when the imperial system was still in place.





### 3.5 Steel

FIGURE 10 The H-Sections.  
Source: [Own](#)

 For the purposes of the exercise of converting the various sizes of building units to that of the metric system to the imperial system, only the H-Section will be taken into consideration. These elements are always given in the same manner namely mm x mm x kg/m. These standard lengths of steel's weight is calculated and has to be included in each description. By always adding the weight at the back of the description,

the user is then absolutely certain which member is applicable and calculating the total tonnage (the method in which steel is priced and bought in) is then calculated with great speed and with little effort.

The imperial system use to give their steel elements in the same way, with the relevant units of course, inches x inches x pounds/yards.

152mm x 152mm x 23,4kg/m		6 inches x 6 inches
203mm x 203mm x 46,2kg/m		8 inches x 8 inches
254mm x 254mm x 72,9kg/m		10 inches x 10 inches
305mm x 305mm x 96,8kg/m		12 inches x 12 inches

### 3.6 Timber members

According to “Contract Carpentry” South African Pine (S.A.P) are manufactured in various standard sizes and lengths. The shortest standard length a S.A.P member is sold is 1.8m, after which it is available in increments of 300mm. These various lengths were directly obtained from the imperial system and merely rounded to the nearest 1 decimal.

There are numerous timber elements that are available in various sizes and finishes. For example:

- 50 x 152mm Rought sawn
- 48 x 148mm Sized
- 44 x 144mm Planed PAR

The differences between the above are very small, but yet it makes a difference and is priced differently. The rough sawn timber is basically the size the timber element is cut from the log and as it is received by the saw mill. The rough sawn timber elements are mostly used where they are not visible to the human eye after construction, as it will give way to the aesthetics of the structure as a whole. The sized timber is machined in order to

ensure that all the pieces are of standard width and thickness. These timber elements are those mostly found in the roof structure industry as we know it today. Using these standard size timber units, ensures that the aesthetics of the building is maintained and that construction can take place at a greater rate due to the ease of work with standard sized timbers as they easily align with the related building elements. The planed PAR is the rough sawn timber that was cut to size and planed to an extreme smooth finish, thus making it perfect for the use of joinery and finishing carpentry.

The 50 x 152mm element was previously known as a “two by four”. This term is still frequently used in the industry today as the labourers are actually referring to a 2 x 4 inch timber element. Even though 2mm are roughly taken off of each timber member when the surface is finished to a higher level, one would still refer back to its original size, but at the same time ensuring that you specify what “grading” it has to be as well.

TABLE 18	Standard timber sizes currently in use in South Africa. <i>Source: Own</i>
----------	---

Current metric measurements	Previous imperial measurement
1.8m	71 inches = 1 803.4mm
2.1m	83 inches = 2 108.2mm
2.4m	95 inches = 2 413.0mm
2.7m	106 inches = 2 692.4mm
3.0m	118 inches = 2 997.2mm
3.3m	130 inches = 3 302.0mm
3.6m	142 inches = 3 606.8mm
3.9m	154 inches = 3 911.6mm
4.2m	166 inches = 4 216.4mm
4.5m	177 inches = 4 495.8mm
4.8m	189 inches = 4 800.6mm
5.1m	201 inches = 5 105.4mm
5.4m	213 inches = 5 410.2mm
5.7m	225 inches = 5 715.0mm
6.0m	237 inches = 6 019.8mm
6.3m	248 inches = 6 299.20mm
6.6m	260 inches = 6 604.0mm

### 3.7 Testing of Hypothesis

The hypothesis was:

***The standard dimensions for most of the building elements still currently in use is merely converted from the previous measuring system. The reason for this being that the cost and the effort to change them to rounded dimensions would have simply been too high. For example a standard door size is 813 x 2 023mm which in the old terms would have been 32 x 80 inches.***

The current dimension the professional team is faced with on a daily basis can cause a bit of confusion when one is not used to it. The dimensions of each building does not always make complete sense and the origin of these dimensions is of little importance to the users. Most of the team members are merely focused on the issue whether the material is of a standard nature (standard dimensions) or whether the needed dimensions will lead to these materials being custom made. The cost of the latter is substantially higher for both the initial cost as well as the maintenance thereof.

Initially it was believed that all the current dimensions of the various building elements are of the origin of either a standard brick size or of the metric equivalent thus the size is be converted to rounded imperial sizes. The dimensions of the windows proved the statement wrong as it was very difficult to convert both the width and the length to either the standard brick size (including its mortar) or the either the metric meter's equivalent imperial value.

## **CHAPTER 4**

### ***WHAT FINANCIAL IMPACT WOULD THE CHANGE OF MEASURING SYSTEM HAVE ON THE CONSTRUCTION INDUSTRY AS A WHOLE?***

#### **4.1 Introduction**

The initial need for standardization in South Africa originated with the development of the gold mining industry at the turn of the previous century. Official recognition and formal development of standardization only came with the establishment of the South African Bureau of Standards (SABS) in 1945, which was largely the standardisation of dimensions and quality of items, (van Zyl, 1985). Throughout the historic development of standardization, building products were high on the priority list, which lead to standardisation becoming a necessity for the building industry.

During the official metrification transition of South Africa in 1967 there was a huge load put on the decision makers' shoulders to make the choice of whether the materials that are being manufactured should also be done so to ensure that everything aligns with the metric units.

The transition process had to be planned in such a manner to ensure for easy adaptation for all the users, the industry as well as the easy transition of all the related documentation.

#### **4.2 New Products**

The International Standards Organisation (ISO) published a guideline in 1976 wherein the term standardisation is defined as "...a technical specification or other document available to the public, drawn up with the cooperation and consensus or general approval of all interests affected by it, based on the consolidated results of science, technology and experience, aimed at the promotion of optimum community benefits and approval by a

body recognised on a national, regional or international level” (ISO Guide 2, 1976, p5), as quoted by van Zyl (1985, p24).

There were plenty of debate on whether the products that were in use at the time of metrification, should have a design change or whether their dimensions should remain the same. At the time, the professionals who made the decisions decided that it would be best to keep the dimensions of the current building elements that were in use, the same size. The main reason for this being that all the moulds and construction methods of the various products was already in use. Changing these moulds to make all the dimensions metric, e.g. 813mm taken to the larger extent 900mm, would simply not suffice. The financial cost to be carried would only be an expense on the industry and the cost will never be returned by means of sales. There was also argued that if there was an attempt to recover these costs by means of working it in to the price of the material, that the material’s cost would purely be too high, causing the building cost of a simple structure to sky-rocket.

Van Zyl (1985), investigated this matter more closely. He believed that that if the brick’s (whether clay or concrete) face surface had to be increased it could possibly satisfy two needs at once, one being a possible saving in cost, and the other metricification of the size of the brick. He states that according to SABS 1206 there are four masonry units which are applicable to the various concrete brick sizes.

Table 19 below compares the current block sizes to its similar sized nominal brick.

TABLE 19 Comparison between the current block size to its similar sized nominal blocks  
Source: van Zyl p145

	Nominal size mm	Actual work size mm	Area of face surface, mm <sup>2</sup>	Advantage above the conventional block
1.	300 x 100 x 100	290 x 90 x 90	26 100	61%
2.	200 x 100 x 100	190 x 90 x 90	17 100	+5,5%
3.	300 x 100 x 75	290 x 90 x 65	18 850	+16%
4.	200 x 100 x 75	190 x 90 x 65	12 350	-24%
	Conventional brick	222 x 106 x 73	16 206	

For practical purposes size 1 and 2 and size 3 and 4 can be used together as the only difference between these bricks is the variance in their lengths. Size 3 is long and flat and

is aesthetically not suitable for use. Sizes 1 and 2 are acceptable sizes and are individually weighed at 3,75kg and 2,5kg compared to the conventional brick's weight of 2,7kg. Both sizes are 20mm smaller than the conventional, which makes it much easier to handle and use.

There are various advantages to having the nominal sized brick, seeing that it is a larger brick, the brick laying will be much faster.

“During July 1974 Coronation Brick (Pty) Ltd (currently known as Corobrik) did a comparative study between the M290-brick (size 1 and 2 in table 19) and the conventional brick.” As quoted from van Zyl (p148). The work was supervised closely and was undertaken under exactly the same circumstances. The following results were compiled:

TABLE 20 Specific savings in masonry – M290 versus the conventional brick  
Source: van Zyl p148

	M290	Conventional	M290 % Saving
Quantity of bricks used	32	52	38,5
Time per m2 wall per hour	0,395	0,550	28,2
Mortar per m2 wall (m3)	0,035	0,039	10,2

Van Zyl also quotes “The findings were that M290-bricks covered approximately 25% more wall area per day when compared to the conventional bricks. The cost advantage when taking into account cost of the bricks, the mortar and the labour, was 31% lower per brick unit in the M290's favour.” He also added the disadvantages which included the fact that when the nominal sized bricks were to be used that a half brick wall would only be 90mm thick compared to the 106mm of the conventional brick, and a one brick wall would only be 190mm thick compared to the 230mm thick wall when conventional bricks are used. The main question remained, which was whether the thinner wall would still have the characteristics needed to carry equal loads to what the traditional walls carried.

The users, taking architects as an example are so well trained that they know exactly what length of building can be produced with a specific amount of bricks being laid in stretcher bond. They got to know the relationship and ratios between the various elements such as bricks and the openings such as door and window frames, and have become very familiar with what would fit where and whether it would work or not.

There are various consequences of the elements' sizes being changed, one being that this familiarity with the product won't be as easy and a little adapting to these new developed products might take a quite a bit of time. On the other hand one could argue that there could be an advantage to the change of dimensions of the various elements, and that one would be able to calculate the structure's size by minimal arithmetic and simple sums. This is quite true as multiplication of a rounded "number" is much simpler and faster than the more complex "numbers" that was converted from the imperial system to the current metric system.

### **4.3 Maintenance**

Most people only concentrate on the initial cost of a structure of building, but the maintenance cost of such a structure far exceeds the initial capital cost as the cost of maintenance will last the life of the building.

If the dimensions of any of the main building elements were to change, elements as mentioned in chapter 3, such as brick sizes, timber and steel dimensions as well as the shapes and sizes of doors and window etc, it would make the task of maintenance to the existing building extremely difficult and much more of a challenge, which will lead to increased rates where maintenance with regards to these elements are concerned.

Take tiling as a simple example. If one does not buy extra tiles at the construction stage and keep it aside for the purpose of replacing broken tiles during the lifetime of the building, one would have to source those specific tiles from the original suppliers. In most cases trendy tiles do remain on the shelves for a long time, as they get replaced with a better more attractive and more up to date product after a certain amount of time. Circumstances such a this, would force the building owner to choose an alternative similar tile (leaving the repaired work patchy and unsightly) or to provide large capital for the replacing of the whole area of the tiles, in order to maintain the aesthetics of the room. Such a capital outlay might be unplanned and could lead to a possible increase in rent of the area, as the owner would slowly but surely have to work back his money.

If the brick sizes were to change, alterations and additions to buildings would be merely impossible as “toothings” of the old brickwork to the new would not fit as the holes left would not be enough to fit the new sizes of the bricks. This will then cause the developer or contractor to either have the needed bricks purpose made, or the alternative of additions of a loose standing structure, without any interlinking to the current structure.

Say a timber member were to rot for any possible reason and the member needed replacement (say in the case of roof trusses), the revised timber size might either be smaller or more likely be larger in size causing that section of work to be out of proportion with the rest. This might cause the roof covering (either concrete tiles or corrugated iron sheeting) to either sag or to stand out above the rest, leading to additional potential material damage and even worse water damage.

#### **4.4 Conclusion**

The decision of changing of basic product's specification and dimension should not be taken lightly. A lot of thought and research went into deciding whether to adjust the dimensions of specific building elements to suit the metric system as a whole, or to merely convert their current dimension from the imperial units to those of the metric.

The decision makers made themselves proud by announcing that only the conversion from imperial to metric will take place and that the basic dimensions of various building elements will not be altered in any way possible.

#### **4.5 Testing of Hypothesis**

The hypothesis was:

**The reasoning behind not metrifying standard and most used building elements would be positive and logical.**

It is clear that making drastic changes to any of the dimensions of the building elements, would only affect all the consumers in a negative way. Regular maintenance and possible additions to structures would not be possible as the new and the old materials would merely not align. The financial expense to change such elements will only be negative to both the consumer and the supplier and one of these parties will lose out to a large extent due to the cost undergone in changing the basic moulds of such products.

Although the study that Coronation Brick (Pty) Ltd (currently known as Corobrik) had undergone proved that the nominal bricks (being thinner) will be able to carry the same load as the traditional wall, it will still make maintenance of buildings with different bricks merely impossible. It could be produced as an alternative but it is not recommended to be the sole masonry size on the market as it will cause various other problems to arise.

It was a clear, well thought of and a positive judgment made by experienced professionals in their fields and any thoughts of attempting such changes in the future would unquestionably be impossible.

## **CHAPTER 5**

### ***HOW DID THE STANDARD METHOD OF MEASURING WORK OF SOUTH AFRICA DOCUMENT DEVELOP OVER THE YEARS?***

#### **5.1 Introduction**

The Standard System of Measuring Building Work is a publication issued by The Association of South African Quantity Surveyors, to assist the quantity surveyors in their way of measurement and quantification of materials.

This document ensures that everyone that takes part in the quantification of the necessary building material, do so in a uniform manner. By making use of the ways and methods laid out in the Standard System, it provides for an even basis for comparisons, thus the contractor can easily compare materials and their related quantities, to what was measured by the quantity surveyor.

The Standard System of Measurement of Builders Work was first published in 1906 by the Transvaal Society of Quantity Surveyors. It was believed that this document was the first of its type in the world. The Chapter of South African Quantity Surveyors issued the second edition in 1930. The standard system was first issued in both languages (Afrikaans and English) with the third edition which was published in 1966. The fourth edition (which was published in June 1971) was the first edition to incorporate metrication. The fifth edition was published in 1977, and it proved to have been much more developed than all of the previous editions. The sixth edition, which is currently in use today, was published in November 1991 by the Association of Quantity Surveyors in consultation with the Building Industries Federation of South Africa.

This chapter is going to give a brief overview of a few differences between the third edition and the sixth edition with regards to the measuring units used as well as how certain of the elements are measured.

All the applicable clauses with regards to the third edition will be listed in orange, whilst the sixth edition clauses will be indicated in blue.

## 5.2 Earthworks

### 5.2.1 Site Clearance

***“The removal of trees shall be given in number, the girth around the trunk 3 feet above ground level being stated, grouped in sizes exceeding 6 inches and not exceeding 12 inches girth, and thereafter in stages of 12 inches.”***

***“The removal of trees shall be given in number, the girth around the trunk 1m above the ground level being stated, grouped in sizes exceeding and not exceeding 500mm girth and thereafter in stages of 500mm”***

6 inches = 152.4mm

12 inches = 304.8mm

Some of the removal of trees are more difficult than others, due to the type of tree, the ground conditions, its position, age and lastly but most importantly its size. The only method of splitting up which trees should be included with the general site clearance and which ones shouldn't, is by allocating a trunk diameter at a specific distance from the ground. This will allow all the trees to be judged equally. There was found that the category as stated in the third edition (6 inches to 12 inches) did not prove to be difficult enough to justify cost related to removal. They thus increased the categories as well as the diameter stages of the tree trunks to 500mm girth and 500mm stages.

### 5.2.2 Excavations, Filling, etc

#### 5.2.2.1 Bulk Excavations

***“Bulk excavations shall be given in cubic yards and, except in open face excavation such as cutting or levelling or sloping sites, shall be separate into successive depths of 6 feet and shall include staging.”***

**“Circular work shall be given separately, no distinction being made for different radii unless otherwise stated”**

**“The classification of excavations in successive depths of 6 feet shall be related to the average ground”**

6 feet = 1.829 meter

1 yard = 0.9144 meter

1 cubic yard = 0.764554858m<sup>3</sup>

During the metrification of the Standard System 6 feet was merely rounded off to the next “round” number, which in this case was 2m. The difference between 1 yard and 1 meter is not that great, but as soon as one makes use of cubic yard versus cubic meter the values differs by almost a third. When the adjustments to units took place, the rates to the applicable elements also had to be adjusted.

#### 5.2.2.2 Carting away of Excavated Material

**“...setting aside for use as filling, or depositing on site within 50 linear yards of the perimeter of the building”**

**The location and the approximate distance of the location from site must be stated**

**In the case of the material that would possibly have to be hauled on, the distance will have to be stated if it is further than 100m away**

The contractor is allowed to price/claim for the expense undergone due to the fact of travelling to expose of the excavated material. 100 meters does not seem like a significant distance but when a large area’s soil has to be disposed of the kilometers will add up very quickly.

#### 5.2.3 Risk of Collapse of Excavations

**“...excavations from ground level to not exceeding 5 feet deep and from ground level to exceeding 5 feet deep. The area shall be given in superficial yards...”**

**“The risk of collapse of excavations shall be given in square meters and shall be measured to all sides of excavations whether working space is given or not”**

**“Separate items shall be given for “bulk” and “trenches and holes” as well as for excavations from ground level to exceeding 1.5m deep and from ground level to exceeding 1,5m deep”**

5 feet = 1.524 meters

1 square yard = 0.83612736 square meters

6 feet was taken to the closest possible metric value, in this case 1.5m. The difference between 5 feet and the new 1.5m category was minimal and only minor adjustments, if any adjustments had to be made to the rates.

#### 5.2.4 Working Space

**“Sides of excavations occurring in strata of a more difficult character shall be given in superficial yards as ‘extra over’.”**

**The sides of the excavations for the purpose of working space shall be given in square meters and shall be grouped together in overall successive depths of not exceeding 500mm; exceeding 500mm and not exceeding 1.5m and thereafter in 1.5m stages.**

With the new clause, working space is not considered to be ‘extra over’ any longer as the work itself justifies an allocated rate. In the third edition the average depth of the working space required merely had to be stated, but in the sixth edition categories were created to narrow down the applicable rates more appropriately.

## 5.3 Piling

### 5.3.1 Precast Concrete Piles

**“...given in linear feet for the designed length of pile before being driven...”**

**“...given in meters for the designed length of pile before being driven...”**

The metric meter's direct imperial equal is yards. Piling is a very expensive item and therefore it was very suitable to have measure it in feet. The sixth edition created categories of not exceeding 10m deep and where after successive depths of 5m have to be utilised. This method ensures easy pricing as well as grouping similar piles together.

### 5.3.2 Permanent Sheet Piling

**“...given in linear feet measured along the length to be retained, stating the height of both the piling and the face to be retained.”**

**“....given in square meters measured for the designed height of piling before being driven and along the length to be retained.”**

The third edition required you to measure sheet piling in linear length and merely stating the depth of the pile, the latest edition is just a simpler process allowing for shorter descriptions as the sheet will be measured in square meters.

## 5.4 Concrete, Formwork and Reinforcement

### 5.4.1 Scope of measurement

**“All concrete shall be given in cubic yards unless otherwise herein stated.”**

**“All concrete shall be given in cubic meters unless otherwise stated.”**

**“Walls not exceeding 6 inches thick shall be given separately.”**

**“No deductions in the measurement of concrete shall be made for voids not exceeding 1 cubic foot, pipes not exceeding 6 inches diameter, small chamfers and sinkings, and for reinforcement, conduits, bolts and the like.”**

**“No deductions shall be made for voids not exceeding 0,1m<sup>3</sup>, longitudinal pipes not exceeding 200mm diameter, reinforcement, conduits, etc.**

6 inches = 152.4mm

The latest edition does not require one to separate the walls that are thicker than say 150mm from the rest. All the concrete to walls are lumped together.

1 cubic foot = 0.028372625 cubic meter

The quantity that can be justified to be deducted has been reduced from 0.03m<sup>3</sup> to 0.01m<sup>3</sup>, thus ensuring for less “waste” not paid for.

**“Quantities given in fractions shall be to the nearest ¼ yard.”**

All the quantities with regards to the metric system will always be given to the closest two decimals, except where the items are measured in number or as an item.

#### 5.4.2 Formwork

**“Circular formwork shall be given separately, distinction being made between work exceeding and not exceeding and not exceeding 3 feet radius.”**

**“Circular and flowing formwork shall be given separately. Distinctions shall be made between circular and spherical work and also between work exceeding and not exceeding and not exceeding 1m radius.”**

In the third edition there was no separation between circular and spherical work. Spherical work is much more labour intensive and the nature of work of higher difficulty.

**“No deductions in the measurement of formwork shall be made for openings not exceeding 15 superficial feet in soffits, and not exceeding 30 superficial feet in walls.”**

**“No deductions shall be made for openings not exceeding 3m2...”**

15 superficial feet = 1.393 square meter

30 superficial feet = 2.787 square meter

Currently the categories of before were lumped together and taken to the nearest 1. The rate of the formwork does not justify deducting any smaller area than 3m<sup>2</sup>.

**“Formwork to edges and risers not exceeding 12 inches high shall be given in linear feet and kept separate in stages of 6 inches.”**

**“Formwork to edges, risers, ends and reveals not exceeding 300mm high or wide shall be given together in meters.”**

There is only one category as this item will mostly be used for area such as the risers of stairs which would only at very rare occasions exceed the 300mm as mentioned before.

**“Boxing in to form small chases, grooves, rebates, etc. shall be given in linear feet ...”**

**“Formwork to form projections, chamfers, splayed edges, grooves, rebates, etc shall be given in meters....”**

The reason why both of the editions specify that boxing in, chamfers, etc should be given in linear meter is because it is normally applied to such a small area of the concrete surface that measuring it in square meters will make the effort not worth ones time.

## 5.5 Masonry

**“In rough work distinction shall be made between work exceeding and not exceeding 6 feet extreme radius.”**

**“Circular work shall be given separately, no distinction being made for different radii unless otherwise stated”**

**Face brickwork – “distinction between work exceeding and not exceeding 2m radius.”**

At first one had to stick to the categories of exceeding and not exceeding 6 feet (1.829 meters) as the work not exceeding the 6 feet radius was seen as work with a higher difficulty level.

Today it is not used as much as it was before, but the provision of keeping it separate, thus allowing the contractor to apply his rate accordingly, have been included in the clause. Face brick still makes use of the categories, as before merely due to the fact that there is no room for error and that the possible errors in workmanship can not be patched up by means of plaster.

**“Mass and irregular brickwork shall be given in cubic yards. Piers not exceeding six bricks in girth shall be given separately.”**

**“Mass brickwork and piers shall be given in cubic meters. Irregular shaped piers shall be given separately from rectangular stating the shape.”**

The labour involved with building a pier in any shape other than rectangular, is much more extensive and that is why it is critical to keep all the different shapes and sizes of the columns separately. One would for example pay much more for a circular column as there would be a substantial amount of cutting of bricks involved to ensure the required shape is achieved, thus more material and labour justifies the higher rate of the element.

**“No deductions shall be made for voids not exceeding 1 cubic foot”**

**“No deductions shall be made for voids not exceeding 0.1m<sup>2</sup>”**

1 cubic foot is the equivalent of 0.0283 cubic meters. There was decided that the monetary value of the deductions is not worth the effort of calculating the openings in their cubic meter values. There is thus currently the rule of making deductions of square meters.

Example: 350mm x 350mm opening in a one brick wall (220mm wall) = 0.0270m<sup>3</sup>

350mm x 350mm opening in any wall thickness = 0.1225m<sup>2</sup>

The first example would thus not have been deducted if the third edition rules were still in use, but due to the minor rule adjustment this opening now qualifies to be deducted from the overall masonry area.

**“Walls shall be given in superficial yards”**

**“Walls and linings shall be given in square meters”**

Measuring walls in square meters is the most logical way, but one must ensure that the wall thicknesses are included in the description. In the situation where there are a very small amount of masonry walls or where they are all similar in nature, one can measure them in meters as well, as long as the wall thickness as well as the total height is included in the description.

**“No deductions shall be made for openings and recesses not exceeding 1 superficial foot”**

**“No deductions shall be made for openings and recesses not exceeding 0.5m<sup>2</sup>”**

1 superficial foot is the equivalent to 0.093 square meters. Today the opening has to substantially larger than before to qualify to be deductible. It was found that the money being saved previously by calculating the opening to be deducted did not justify the effort and the time spent doing the calculations.

**“Beamfilling between plate level and the underside of roofing shall be given in linear feet stating the extreme height.**

**“Beamfilling shall be given in square meters.”**

Before beamfilling was measured in square meters, it was measured in a linear unit and the height of the filling had to be stated. Under the current rules one does not have to state the height as an overall square meterage is calculated.

**“Leaving toothings shall be given in superficial yards”**

**“Forming toothings and bonding new brickwork to existing shall be given in square meters.”**

The principles are the same the units of measurements merely changed. The unit of measurement is the imperial yard's direct metric equivalent of meters.

## **5.6 Floor Coverings, Plastic Linings, Etc.**

**“Coverings to treads and risers shall be given in superficial yards, separating winding and skew portions of stairs.”**

**“Covering to treads and risers shall be given in square meters separating winding stairs.”**

Floor coverings covers a large part of the floor area and the only logical way will be to give it in square meters. The change between the third edition and the sixths is merely changing imperial yards to its metric meters.

## **5.7 Glazing**

**“Glass measured in superficial feet shall be given in the following categories:**

**not exceeding 1 superficial foot;  
exceeding 1 and not exceeding 6 superficial feet;  
exceeding 6 and not exceeding 25 superficial feet;  
thereafter in stages of 25 superficial feet.**

**“Glass shall be given in square meters unless otherwise stated and shall be grouped according to size in the following categories:**

**not exceeding 0.1m<sup>2</sup>  
exceeding 0.1m<sup>2</sup> and not exceeding 0.5m<sup>2</sup>;  
exceeding 0.5m<sup>2</sup> and not exceeding 2m<sup>2</sup>;  
thereafter in stages of 2m<sup>2</sup>.”**

During the metrification these categories were kept to the similar sizes and was just rounded off to the closest 0.5m<sup>2</sup> to prevent any confusion for both the supplier and the quantifier.

## **5.8 Paint**

**“Paintwork shall generally be given in superficial yards.”**

**“Paintwork shall generally be given in square meters.”**

**“No deductions shall be made for openings, wants, etc not exceeding 0.5m<sup>2</sup>”**

Although both the mentioned editions measure the paint finish as an area, the third edition did not have a category that does not need to be deducted. The sixth edition allows for the areas not exceeding 0.5m<sup>2</sup> as deducting these areas will not make the quantifier's time worth the cost he is 'saving'.

**“Paintwork not exceeding 12 inches wide or girth and not adjoining similarly painted work shall be given in linear yards, and classified into groups exceeding and not exceeding 6 inches wide or girth.”**

**“Paintwork not exceeding 300mm wide or girth and not adjoining similarly painted work shall be given in meters.”**

The work falling into this category should be kept separate due to the fact of that there is more labour involved doing this paint in comparison of normal paint as the line of the paint has to be taken into account as it has to be perfect, leaving to margin of error.

12 inches width is the same as 304.8 millimetres, thus there was decided to merely round it off to the nearest 100mm, making the new limit 300mm.

## 5.9 Testing of Hypothesis

The hypothesis was:

***The study will show that through the various editions of the Standard System of Measuring Builder's Work of South Africa documents the basis of measurement have remained the same but the units have merely changed from imperial units to the closest of equal metric***

It is clear that plenty of hard work and a huge effort to accommodate the changes had to be made. The transition was not done over a period of time, but was simply implemented when the government made it law to make use of the metric system in all ways possible. The transition between the various editions were not very drastic and the publishers tried to make adapting to such changes as easy as possible to its user, by means of keeping the principles the same, and merely changing the units from the imperial, to its metric equivalent e.g. yard to meter.

## CHAPTER 6

***SHOULD THE WHOLE WORLD CONVERT TO THE MEASURING SYSTEM THAT THE LEADING COUNTRY HAS IMPLEMENTED, OR SHOULD WE WORK ACCORDING TO WHAT THE MAJORITY OF THE WORLD IS WORKING WITH?***

### 6.1 Introduction

The initial seed of metrication was initially planted by the scientist Gabriel Mouton in 1670 ([http://answers.ask.com/Reference/Other/who\\_created\\_the\\_metric\\_system](http://answers.ask.com/Reference/Other/who_created_the_metric_system), 2010/04/07). He believed that even in those years there was a lack of a standard size of various elements, not only those mentioned in the construction industry. His biggest argument was that there had to be an easier method of converting from smaller units to larger ones in stead of making use of factors of 12 and 16 and any similes thereof such as 2, 3 and 4. He investigated the idea of working with 10 as a base and making use of the decimals in stead of totally doing a multiplication of the related numbers. In those days there where no such things as calculators and all these conversion sums had to be done by head, and where it got complicated, by a long method multiplication on paper.

Some countries underwent the metrication process as early as the end of the 17<sup>th</sup> century, such as France in 1875. Others were short on their heels and undergone the metrication process in the early 18<sup>th</sup> century such as countries as the Netherlands, and Algeria in 1840. More examples can be seen in table 19 below.

### 6.2 The importance of speaking one “language”

McEwatt (1987) states that modular coordination sets a common dimensional language and a set of conventions appropriate to the design, manufacture as well as the assemble processes that is quite independent of the technology employed, the size of the company or the availability of skills.

What he meant with this statement is that by simply having standard dimensions for various products, it will be clear to all parties what can be expected from such a product such as its weight, handability, how many of such products can fit into a certain space and the average cost of this specific product over a specific time frame.

In the broader picture this refers to the public, the user and the systems are all set on what their country has adopted as a measuring system and their customary dimensions of the most popular building units.

Any person is adaptable to his environment, but when the methods of doing things are different, this process can be a little more challenging. Let's take a consultant such as an architect, engineer or quantity surveyor as an example, they are used to working with a specific measuring system and according set of rules, regulations and standards. When these individuals are taken out of their comfort zone and put in a situation where they would be forced to adapt, they will most definitely manage but they might not work as efficiently in the beginning as they have before. After a little bit of research of the change in rules, regulations and methods of getting work done, these individuals will train themselves to also be a trained professional in that specific area. The overall method of construction related work, whether it is designing, measuring, building or procuring the project will basically remain the same with just a few changes made to the way in which one would have to work according to, to reach the end result such as different methods of presenting information and comparing costs and the various ratios with regards to that.

The only limitation of such a process, that might cause possible problems, is if it is not made totally clear what is expected as an end result. Assumptions are a quick road to failure, and one should always make sure of what is expected of you, so that one could get to work to try and achieve the required outcome and the necessary results as soon as possible by using the correct methods from the get go.

### **6.3 Where is Imperial system still in use?**

To date countries still make use of limited imperial measurements such as Australia, India, Malaysia and New Zealand. "The real estate agents continue to use acres and square feet to describe area in conjunction with hectares and square metres. Measurements in

feet and inches, especially for a person's height, are frequently met in conversation and non-governmental publications." ([http://www.answerbag.com/q\\_view/582411](http://www.answerbag.com/q_view/582411) (2010/01/05))

### 6.3.1 United Kingdom

According to <http://www.statemaster.com/encycolpedia/imperial-unit> (2010/05/01) the United Kingdom completed its legal transition to metric units in 1995, but a few imperial units are still in official use such as beer being sold in pints, road-sign distances must be in yards and miles and speed limits in miles per hour, therefore instruments in British-registered vehicles must be capable of displaying miles per hour. The British railways are also a big user of imperial units, with distances officially measured in miles and yards or miles per hour, although many modern metro and tram systems are entirely metric. London's 'underground' uses both the metric (for distances) and imperial (for speed).

Milk is available in both half litre and pint containers. Many people still measure their weight in stones and pounds, and their height in feet and inches. This personal information must still be converted to metric if recorded officially for example in passports and most medical charts because this is a requirement from the local government.

Petrol is frequently quoted as being a certain monetary value per gallon, despite the fact that fuel has been sold exclusively in litres for two decades. Fuel consumption for cars is still often in miles per gallon, though official figures always include litre per 100km equivalents. Fahrenheit equivalents are occasionally given after Celsius in weather forecasts, especially for high temperatures.

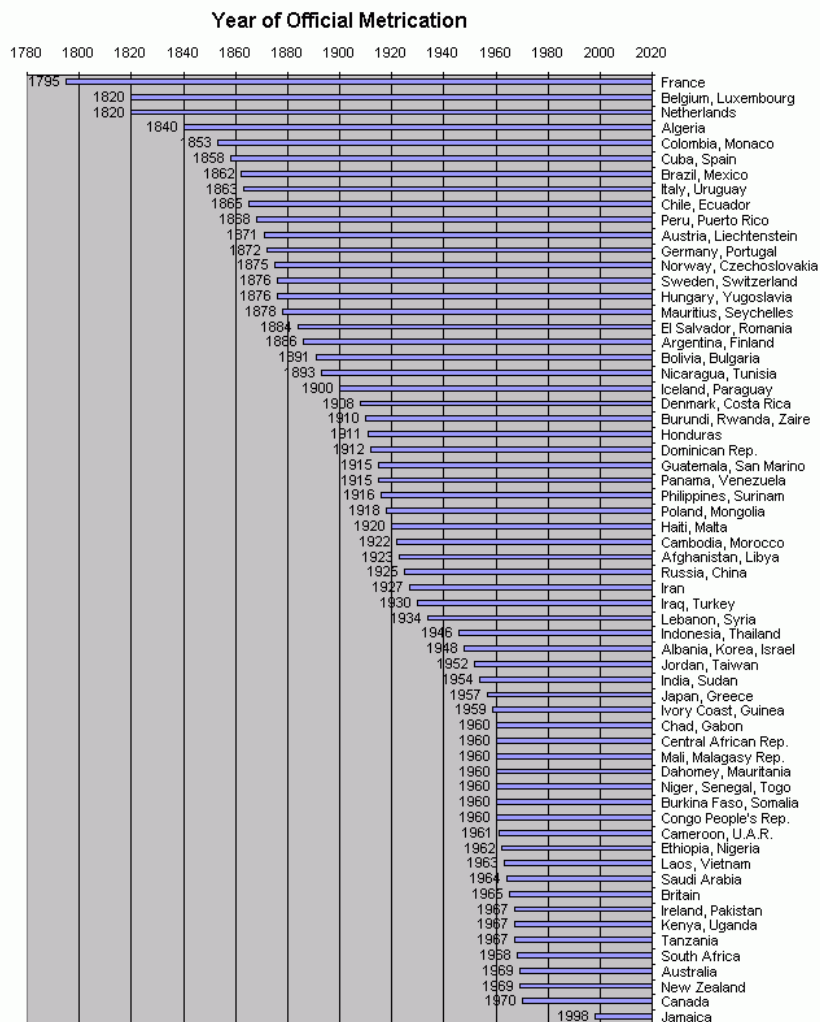
### 6.3.2 Canada

According to <http://www.statemaster.com/encycolpedia/imperial-unit> (2010/05/01) Canada was introduced to the metric system in the 1970's. With this introduction the imperial units were totally eliminated from all public signs, One will still find both system of measurements on privately owned signs at for example a height warning at a parkade with various levels. Temperatures are mostly reported in degrees Celsius, but the radio stations closer to the United States will still today mainly use the imperial units to report on all weather.

Land has to be surveyed and registered in the adopted metric system, but the Canadians still find themselves making use of imperial units when busy with construction and most recipes.

<http://www.statemaster.com/encycolpedia/imperial-unit> (2010/05/01) also states that imperial units are still in daily use where firearms and their ammunition are concerned. The calibre is expressed in decimal fractions of an inch but where ammunition is concerned they make use of the metric units (e.g. 9mm), however during the manufacturing processes of the ammunition the bullet and its powder weights are expressed in term of the imperial grain (1 grain = 64.8mg).

**FIGURE 11** Various years of metrication.  
*Source: [http://www.google.co.za/#hl=en&q=imperial+vs+metric+countries+&aq=&aqi=aql=&oq=imperial+vs+metric+countries+&gs\\_rfai=&fp=fbalcd88f79eeba9](http://www.google.co.za/#hl=en&q=imperial+vs+metric+countries+&aq=&aqi=aql=&oq=imperial+vs+metric+countries+&gs_rfai=&fp=fbalcd88f79eeba9) (2010/08/17)*



**Advance of Metric Usage in the World**

According to [http://hubpages.com/hub/metric\\_system\\_vs\\_imperial\\_system](http://hubpages.com/hub/metric_system_vs_imperial_system) (2010/05/01) the United States is the only industrialized country in the world that doesn't use the metric system as its predominant system of weights of measures. The United States of America, Liberia and Myanmar still use the old English Imperial system, as apposed to the rest of the world that currently make use of the metric measuring system

## 6.4 What does the public think?

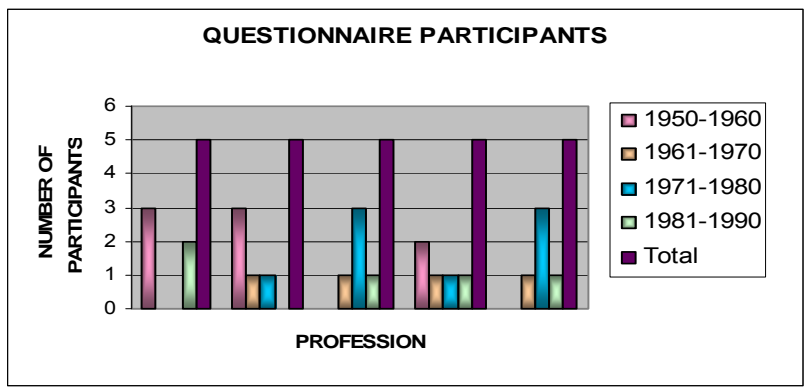
A questionnaire was compiled and issued to various members of the public in the hope that the need and opinions are brought to light (See Annexure 1 for an example of the questionnaire).

### 6.4.1 The group

The group of people that was targeted with the questions were a combination of various professions as listed below:

1. Construction related individuals
2. Information technology (IT) experts
3. Education related – such as secondary school teachers and tertiary institution lecturers
4. Managers – from an owner of his own business, a bank manager to a hospital manger
5. Manufacturers and Importers/Exporters

TABLE 21 Questionnaire participant's and related birth years  
*Source: Questionnaire results*



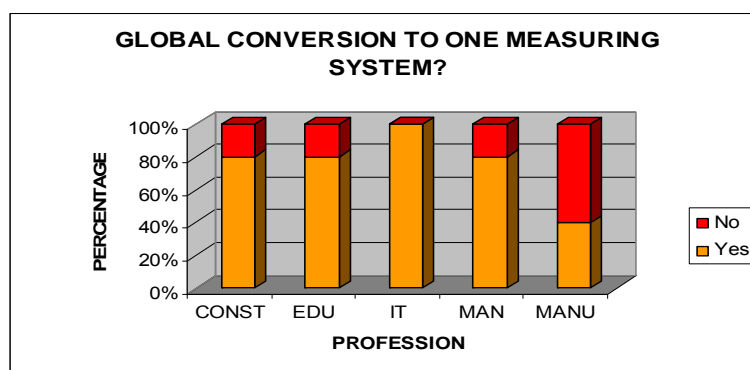
A wide age range has been selected to ensure that a perspective from various eras and angles can be stated and evaluated.

#### 6.4.2 Should the world convert to one measuring system?

The majority of the results showed that most of the individuals would prefer it, if there was only one measuring system all over the world. They argue that things will be easier to measure up against, as one would then be comparing apples with apples and not apples with oranges in a manner of speaking. Those that believed that the world shouldn't all have a universal measuring system believe that it gives character to the various countries and the excitement of adapting to the different measurements such as travelling in miles, weighing in pounds (some places even stone) and cooking with ounces. They believed that it makes one appreciate the countries culture and uniqueness.

Some individuals in the construction industry believe it is impractical to try and convert everyone, including a huge imperial user such as America. He believes that the chances of universal transition to one measuring system are not very likely and trying to implement it would be a waste of time and effort.

**TABLE 22** Global conversion to one measuring system  
*Source: Questionnaire results*

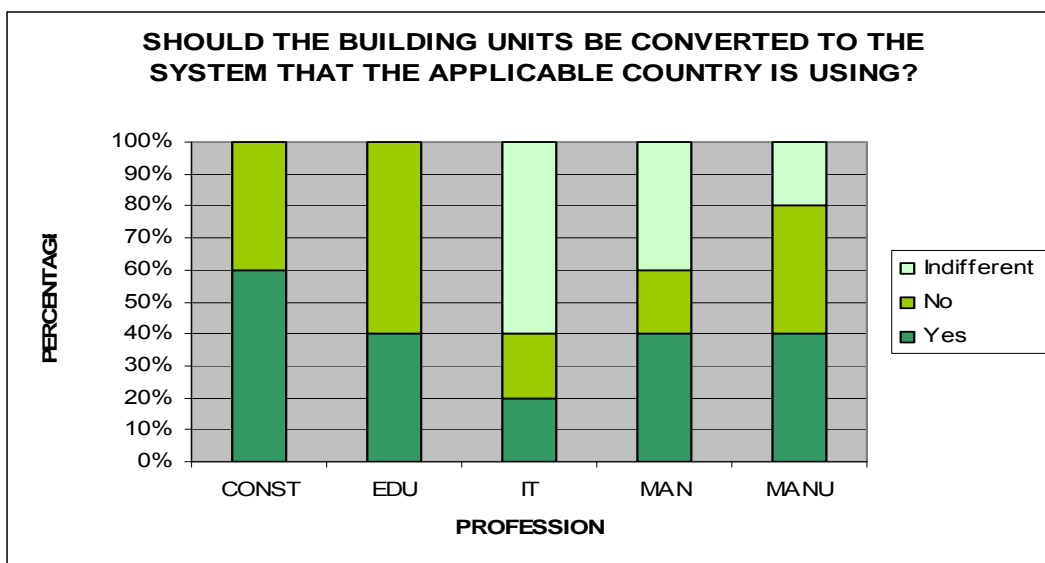


One of the results showed that the lack of uniformity could and has caused major problems in the past. It was believed that one measuring system is needed especially in the shipping industry, as there has been cases where cargo has been received measured in one systems weight unit for example kilograms, and then the conversion was done

incorrectly which lead to major damages due to the crane failing due to the underrated weight. Some ports that mostly work with other ports of the same measuring system is not used to this transition as they are not faced with it a lot in their working environment at a permanent basis. Small errors like these could lead to a huge financial loss.

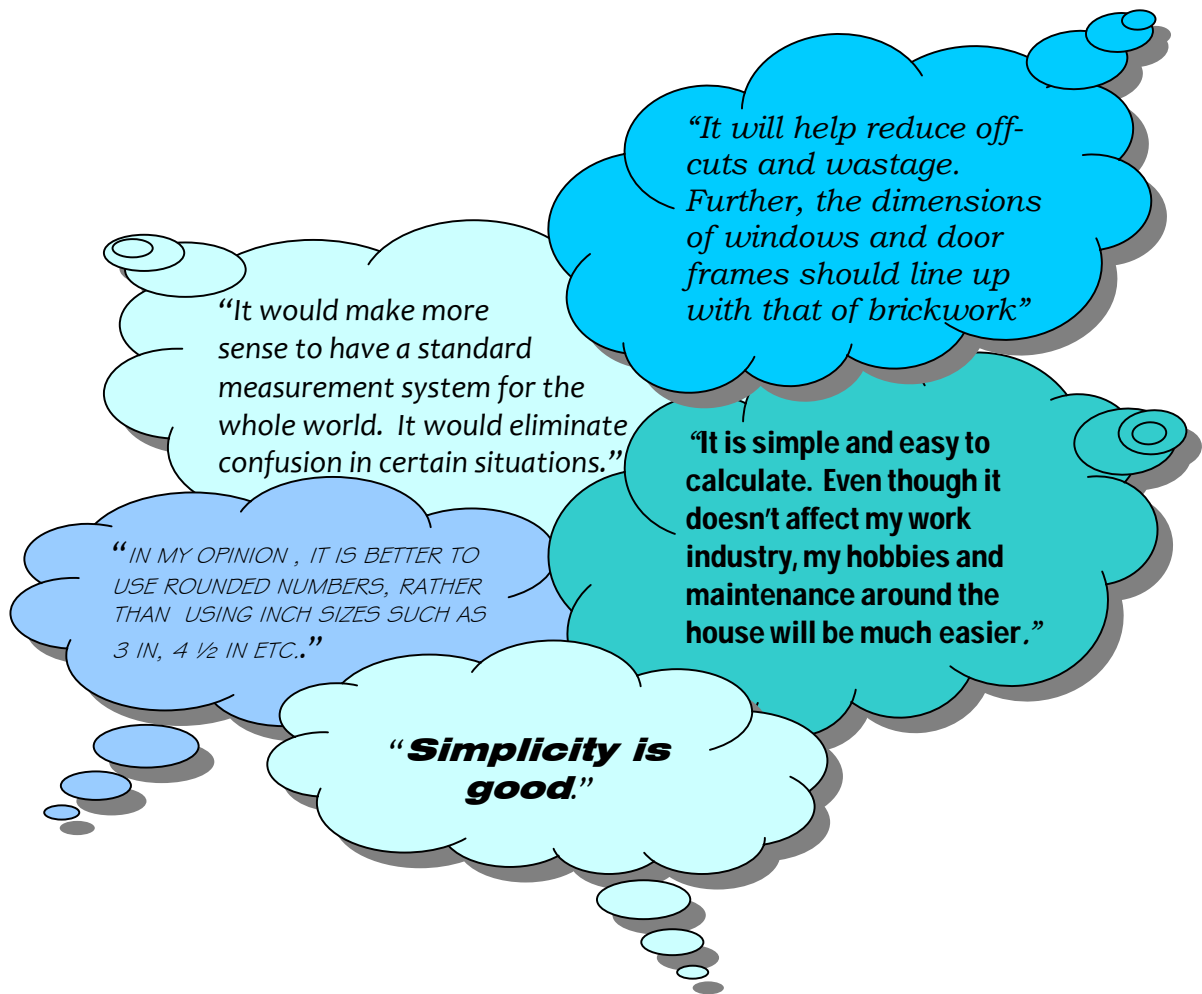
#### 6.4.3 Should building units be converted to the system that the applicable country is using?

**TABLE 23** Construction units' conversion to the measuring system the country uses  
*Source: Questionnaire results*



The results showed that out of this small group of people, it was voted that the various construction units indeed should be all converted to the applicable measuring system that the various countries use. The “No’s” were short on the “Yes’ “ heels and it was clear that this was an issue that the public hasn’t quite made up their mind about.

Some of the people who was all for the total metrification of all the building units had the following comments

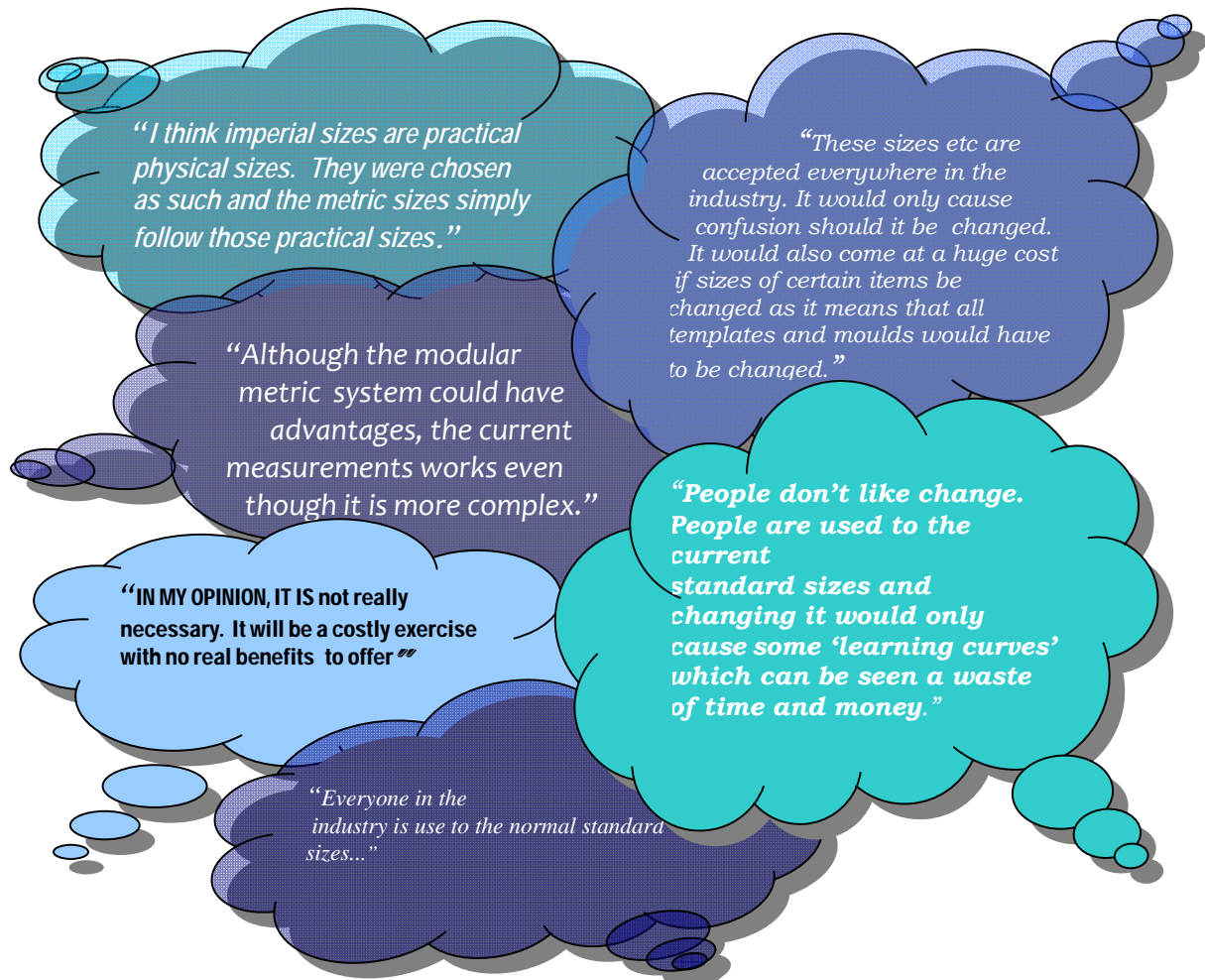


Most of these individuals that were for the metrification for the building units (as also discussed in more detail in chapter 4) was merely concerned with the ease of work and none of these individuals stopped to think of the possible cost implication of the mould materials and maintenance of the existing structures to ensure proper blending in of the old with the new.

Those individuals that argued that it should remain as is went into more detail en reasoning why they believe it works as it is at the moment.

From a practical point of view the main issue from the professionals' point of view is whole process of getting use to the new system. It will have an effect on the productivity initially as the quantity surveyors, architects and engineers will have to adapt their measurements and designs as well as their standards to that of the new prescribed dimensions and standards. This learning process won't take too long, but sooner rather than later the

professionals will get use to these measuring units and it will be use to it as well as making use of it with ease!



The comments of those who doesn't think it is a good idea to change the building elements' units , when into a little more depth with the reasoning behind their choice of not changing the elements' dimensions in any manner what so all, as this is what everyone in the industry is use to. Any alterations to these dimensions will merely cause everyone that is involved in the building industry to learn and adapt to these dimensions. The current ratios and fast calculations would be a thing of the past as although the new metric units is much easier to adapt to the calculations thereof is not the problem, but adapting to the use of such elements physically on site. The whole process of ensuring everything fits into the big picture as it is suppose to, including all the possible alignments and specific positions of the various elements could be something to get use to as it is something totally out of the ordinary and thus something to get use to.

#### 6.4.4 Which elements in the construction industry should be standardised, if any?

From a practical point of view the main issue from the professionals' point of view is whole process of getting used to the new system. It will have an effect on the productivity initially as the quantity surveyors, architects and engineers will have to adapt their measurements and designs as well as their standards to that of the new prescribed dimensions and standards. This learning process won't take too long, but sooner rather than later the professionals will get used to these measuring units and it will be use to it as well as making use of it with ease!

The basic elements that definitely should be considered for official standardisation are doors and windows

There are currently numerous variations of window sizes. The sizes differ as the materials changes, meaning that the timber frames, aluminium and metal window frames will all be similar in size but the dimensions will not be similar in any matter. If window dimensions could be standardised the whole process of measuring it and doing the necessary adjustments (in the case of the compilation of the bills of quantities by the quantity surveyor). This will ensure faster more efficient working methods as one would work with the same sized window frame sizes, whether it is made of metal or timber.

Another aspect that should be standardised is the gridlines of the various drawings issued by both the architects and the various engineers. By standardising these gridlines a very accurate quick calculation can be done without the use of scale rulers or measuring programmes, because the values of the gridlines would be general knowledge.

## **6.5 Conclusion**

Where recipes are concerned it will make sense to leave the recipes as is, due to the fact that each recipe has a little piece of history attached to it. Some recipes are still laid out in the imperial system and it makes sense as all the recipes of the past few decades have been written in this manner, but it is critical that all the newly released recipe books must have the metric as the main measurement and only references to the imperial units to

ensure user friendliness of the book to people of all ages. Most recipe books today found in South Africa will only have a conversion table in the front of the book and won't even make any mention of imperial units within the recipe itself.

From a practical point of view the main issue from the professionals' point of view is whole process of getting used to the new system. It will have an effect on the productivity initially as the quantity surveyors, architects and engineers will have to adapt their measurements and designs as well as their standards to that of the new prescribed dimensions and standards. This learning process won't take too long, but sooner rather than later the professionals will get use to these measuring units and it will be use to it as well as making use of it with ease.

## 6.6 Testing of Hypothesis

The hypothesis was:

**The world as a whole will have to convert to the measuring system that the majority of the world is currently using, which means globally every country will have to adjust to the metric system.**

From the results of the questionnaire it was made clear that the majority of the South African public thinks that the world should all be working under the same measuring system. This should be done to limit any possible confusion due to the fact of not speaking the same language.

A mere handful of countries are still practicing with the imperial system and due to the fact that they are merely a handful, the world as a whole should convert to the measuring system that the majority of the world uses, which is the metric system. The reasoning behind this is the fact that the transition from one system to the other would be much more achievable for the minority that still has the imperial incorporated, rather than turning back the clock and asking the converted countries to return to the imperial system. The only thing this would to prove, if it had to happen, is that the whole original transition was a waste of time and money.

The results of the public's questionnaire made it clear that even though the majority of members that took part in the questionnaire believed that there is a need to standardise and thus metrify some of the building elements. The other members made it clear that the small change of these dimensions will not make the effort and cost related to the change of the moulds and manufacturing processes, worth while. It is believed that everyone that is currently working with such items and their dimensions, are already used to the dimensions and the change thereof will merely just cause confusion and take time to totally adapt to the new dimensions and the way things are done. This effort is not worth the time and money spent if it had to be done.

## CHAPTER 7

### *CAN THE IMPLEMENTATION OF THE POSSIBLE METRIFICATION OF TIME EVER BE IMPLEMENTED SUCCESSFULLY?*

#### 7.1 Introduction

Time as we know it has been calculated according to the basic principles of a circle, thus working with 360 degrees and dividing all the other units in accordance to that. The seconds, minutes, hours, days, months and finally years have all been calculated in accordance with the earth's position in relation to the sun.

Although the current time units are in working condition and has equal value across the globe, surely there is a possibility of metrifying time in some way. By doing this one would be able to convert seconds to years with ease.

#### 7.2 How to metrify time

Time is the same all across the world and everyone has the same amount of seconds in a minute, minutes in an hour, hours in a day, days in a month and then of course months in a year.

Here is a basic outlay of time as we know it at the moment:

$$60 \times \text{seconds} = 1 \text{ minute}$$

$$60 \times \text{minutes} = 1 \text{ hour}$$

$$24 \text{ hours} = 1 \text{ day}$$

$$365 \frac{1}{4} \text{ days} = 1 \text{ year}$$

As a basic outlay of the new metric way of measuring time, only the conversion of one day will be taken into account for this study's purpose. The value of a year's duration will remain as is, so will the amount of months in a year and so will the amount of days

allocated to each month. One would start with the conversion of seconds, minutes and hours to form the value of one day.

The current value for a days worth of seconds are 60 seconds in 1 minute, 60 minutes in an hour and 24 hours in each day, thus  $60 \times 60 \times 24 = 86\,400$  seconds in each day.

The new system will have to work with four units of time measurement. For this study's purpose we will take it as A, B, C, D.

A = Similar to the second but its value will differ slightly

B = Similar to the minute but its value will also differ

C = This will still be referred to as days as the conversion from days to months will remain unchanged.

To keep the value of each day, therefore the duration of each day, from sunrise to sunrise exactly the same, one would have to work with 86 400 current seconds as a base

When the conversion process is done, D will have a value of 10, meaning there would be ten "*metric hours*" in a day.

B will also have a value of 100, and let's refer to it as the "*metric minutes*"

This will mean that 86.4 seconds as we know it will have to be converted into metric "*seconds*". The second's value as we know it will fall away and the new revised value for a second will be 0.864 of a second's value. This however will be taken as 1 metric second.

When the whole process is put into action, the ease of time conversion will then be taken as follows:

100 metric seconds = 1 metric minute

10 metric minutes = 1 metric hour

10 metric hours = 1 day as we know it

Thus  $100 \times 10 \times 10 = 10\,000$  metric seconds in 1 day as we know it. A quick and simple way of transition of seconds to days by the mere movement of the decimal when timing with 10 or a multiplication thereof, will be the new everyday method.

Just a quick calculation to ensure that the current seconds in a day would have the same worth for the day (thus each day must remain the same length). Remember the base of the metric second is 0.864 of the current second, and that is what the following calculation will be built on.

$$0.864 \times 100 \text{ (metric seconds in each metric minute)} = 86.4$$

$$86.4 \times 100 \text{ (metric minutes in each metric hour)} = 8\,640$$

$$8\,640 \times 10 \text{ (metric hours in each day)} = 86\,400 \text{ seconds in each day as we know it}$$

This calculation proves that the value of each day, thus the duration thereof will remain the same.

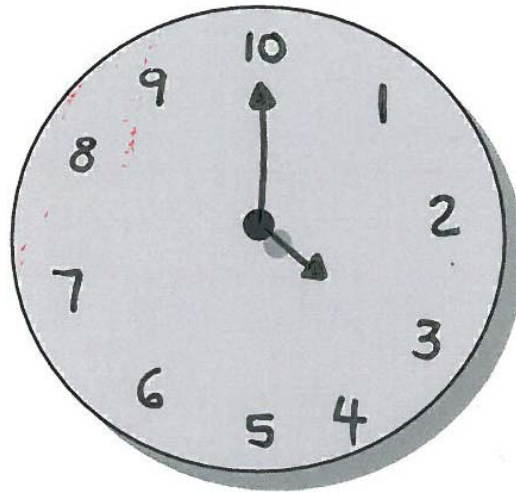
Where one works an 8 hour job currently, which is a third of your 24 hour day, one would merely work 3.33 metric hours, which companies would round to either 3 or 3.5 metric hours. One would thus work 3.5 hours  $\times$  5 days in the week, thus working 17,5 metric hours a week.

This kind of time measurement might have a positive effect on the employees as working 17,5 metric hours surely sounds more positive than 40 current hours.

### **7.3 Possible complications**

The main concern would be that the watch as we know it will have to be changed completely. The world as a whole will probably have to be converted to digital watches and clocks as it they will be the easiest to read. The face of a watch could also be altered but the seconds and minutes will have to be based on 10. The figure below is just a simple example of what it could look like.

FIGURE 12 The possible outlay of a metric watch.  
Source: Own



The second and most important constriction of metrifying time is the fact that it would take a long time before the public will take to this. The value of all the world records will have to be adjusted to suite the new revised metric second.

#### 7.4 What does the public think?

According to the questionnaire (more discussed in detail in chapter 6) the decisions and the opinions of the public was made clear.

**“I think that is a brilliant concept and is certainly possible. The display of watches need be re-calibrated only”**

**“Very interesting scenario! Although it will make conversions between time elements much easier, it is not very practical to change”**

**“The current system of 60 seconds to a minute is universal and to my knowledge do not pose problems. While a metric system could possibly work, there would be no valid reason to change”**

“Change is possible, I think the ‘getting use to’ will take some time though, because people are use to it as it is at the moment”

“It could be possible and it could be well implemented, but this process will take years to complete and billion of dollars, rands, euros etc. to complete. Personally I don’t think it is worth the effort”

“No! I don’t think that it would be successful to change that”

“It is possible, but not feasible. People don’t like change. I would not stand for it!”

“No! It will just confuse people. If there is one thing in this world that shouldn’t change it is time.”

“No! It will only cause confusion and why change it if it works. Why try and fix something if is not broken.”

## 7.5 Conclusion

As it was made clear from the public, why try and fix something that is not broken. It has worked from the beginning of mankind and there is absolutely no need to change. If it was to be implemented it would only cause confusion. The transition to the new system will only cost the government (and therefore the tax payers) a tremendous amount of money with now real benefit attached to the transition.

## 7.6 Testing of Hypothesis

The hypothesis was:

**The metrification of time is an interesting concept and will make the conversion of for example minutes to days a breeze. Although the conversion will be done with**

**much more ease, the effort behind the whole process of converting time as we know it, to a whole new system will not be worth while and totally impractical.**

The hypothesis was proven to be true as it would not be a feasible idea to convert time as we know it to a metric version of time. Time as we know it is working perfectly as is, and although the conversion of say days to seconds could be troublesome, it is not a calculation that has to be done often, and when such a calculation needs to be done one can merely make use of basic multiplication, and a calculator is always an option for those who might struggle with that.

The world as a whole has implemented the same time method and although time of night and day might differ from place to place, the general principles of time remains the same doesn't matter where you are. There is absolutely no need to try and fix something that is already in perfect and ideal working order. Time is what it is because of in depth studies of the earth in correlation with the rest of the universe and altering time and its units and values, will not only cause confusion, unambiguosness but also a rippling effect of uncertainty.

## CHAPTER 8

### *THE CONCLUSION*

#### 8.1 Background

In this modern world of great technology and other wonders, the world as we know it, still has two official measuring systems that various countries has incorporated as their official measuring systems.

Although the imperial system was the first to be used in history, the later developed metric system has proven to have mainly advantages to its usage. These two systems have no similarities and are in no way linked to each other.

Having two measuring systems across the world means different methods in doing things, thus with different costs involved and therefore leading to the lack of possible comparative studies being done between different countries or simply between the different documents.

Even though technology does provide us with the methods and ways of crossing these boundaries, such as measuring programmes and conversion programmes which allows one to change from metric to imperial with the click of a button, there is a dire need for the standardisation of the measuring systems across the globe.

#### 8.2 Summary

##### 8.2.1 The difference between the metric and the imperial measuring systems

The imperial system is an ancient measuring system that was developed from many centuries ago. The units were mostly compared to physical things, like the average male's foot's length was classified as a physical *foot* length; the weight measured in stone was

physically measured in various stones of a specific size weighed against the weight of the object in question. These examples are just to mention a few.

This method was an acceptable one, but became problematic when it became clear that not all grains were equal in size, and neither were the average male's foot. The lack of equal standard sizes caused values of material to be inaccurate. Queen Elizabeth the first called for a standard sample of each measurable unit be produced and kept for easy referral. This was the first step to proper standardisation.

The metric system was later discovered by scientists and it all works according to moving the decimals to the left or the right in order to make the units bigger or smaller. This is achieved by making use of the number 10 or any multiplications thereof. This method has become the more frequently used system across the world as it is an extremely user friendly method of working with measurements as the conversion between the different units is a simple process

In the mid-twentieth century all major countries using the imperial system have been adapting and replacing the imperial system with the metric system. The transition was a timeous process that needed a lot of care and attention to ensure that it was done properly. Although there was a huge financial implication attached to the transition, these countries were willing to sacrifice the money for a possible better future. Some of the countries merely did it to ensure that they keep up with the rest of the world.

The reasons why there is still currently two major measuring systems is because the countries still using the imperial system could be one of a few reasons being that they might either just be 'stuck in their ways', or that they are unwilling to change or that they can simply not justify the financial implications that the transition might have.

There should be one way of doing things across the world. The more developed countries might have a faster, more time efficient manner of getting things done but overall global standardisation is desperately needed whether one refers to proper documentation, technology or the measuring system.

### 8.2.2 The history of building elements in South Africa's dimensions

In the beginning all things made, was done in such a way as to keep the human proportions in mind. Everything was designed to ensure maximum comfort to the human being, whether it is for the everyday living situation, or the construction or repairs thereof.

In the beginning all the construction elements were physically larger in size, because back in those days the bigger the elements, the greater and more special the building. Window and door sizes started off as very small, with the reasoning behind that being that mankind was not aware of any method of closing these holes other than covering the openings with material. Later when glass was invented, window and door sizes increased dramatically and through the decades it carried the symbol of greatness.

The brick's current size is what it is to because it maintains a ratio between its length, height and its length. It is also a comfortable size with a weight that is easily accommodated.

### 8.2.3 Financial impact of change

During South Africa's official metrification in 1967, a very important decision had to be made of whether the materials that are being manufactured should also be done in a metric way to ensure that everything aligns with the metric units as implemented at the time.

Plenty of meetings were held on this issue of whether the common building elements' dimensions, such as the brick, doors and windows, steel sections etc should remain the same (with a simple direct transition between the imperial system and the metric system) or whether these elements should undergo a total design change.

The decision was made against a total design change of these elements as the decision makers argued that the existing moulds are all in working order. They made it clear that if new moulds had to be made, that the financial cost would only be an expense on the industry and the cost will never be returned by means of sales. There was also argued that if there was an attempt to recover these costs by means of working it into the price of the material that the material's cost would simply be too high, causing the building cost of

any structure that involves such elements to increase dramatically, possibly making the project as a whole totally unfeasible.

#### 8.2.4 The history of the Standard Method of Measuring Work of South Africa document

The Standard System of Measurement of Builders Work was first published in 1906 and it was believed to be the first document of its kind. The second edition was issued in 1930. The third edition followed in 1966, which in turn was followed by the fourth edition in 1971. Six years later, 1977, the fifth edition was issued. The fifth edition remained the one in use for a substantial amount of years. The sixth edition as we know it was finally issued in 1991.

The basic differences between the various editions were basic admin and outlay differences. When the metrication process took place the document's imperial units all had to be changed to those of the metric system, all the categories and limitations also had to be adjusted in accordance with that.

Over the last few editions most of the labour items that did not have a high financial impact on the project were removed as a whole, as the professionals believed that the effort of measuring these items (and thus the professional's time and money) was not worth the small value it carries when compared to the contract's bigger picture (the contract sum).

#### 8.2.5 Global conversion to the metric or the imperial measuring system

The initial seed of a standard measuring method was planted by Gabriel Mouton in 1670. He believed that standard sizes for various elements were a necessity for the world to move forward in life. Even though he grew up with the imperial system, and that he was aware of its working inside and out, he believed that there should surely be an easier method of converting between its units, instead of making use of factors of 12 and 16 (and any similes thereof). Mouton came up with the initial idea of working with 10 as a base, this using the decimal to move between the various units.

A mere handful of countries still have the imperial measuring system in place. Some countries, even if they make use of the metric system in full, still has some of the imperial

methods of measuring in place, such as road signs, distance, speed and cooking recipe measurements.

Global standardisation to one measuring system is a necessity and has to be done to ensure minimal errors in measurements, documentation and other general communication. At the moment the world is coping with having both the systems in place, but in order for the world to move forward and become a greater success, universal standardisation is a must.

#### 8.2.6 The metrification of time

The current method of reading time has been the same for centuries. Prior to the current method of reading time, people used to rely on the sun and the shadows that were cast to determine the time of day. Later on the Greek applied the shadows that the sun cast on a standard figure that looks similar to the watch that we know today. From there reading time by means of a standard method has only become easier.

Although the current method of reading time is impeccable and no reasonable faults can be related to it, the alternative metric method of time reading has to be considered. What is meant with this is that time as it is known today, 24 hours in a day, 60 minutes in a day and 60 seconds in a minute, will be converted to 10 metric hours a day, 10 metric minutes in a metric hour and 100 metric seconds in 1 metric minute.

The metric time method will simply make the transition between different metric units a very easy process, for example 30 days is 300 metric hours or 3 000 metric minutes. All of the calculations are done by moving the decimals around.

## **8.3 Conclusion**

Standardisation is an essential element to enable the world to move forward and grow their methods and ways of doing specific things. By having one system in place the world would be speaking one language, and although the countries that need to still convert will have to get used to the new system, no conversion between various measuring systems

will be needed and that value will be taken as its value without trying to convert it to something else.

The world as a whole should convert to the metric system. The method in which it operates is so much simpler than that of the imperial measuring system. It is time that the world faces these facts and looks past the fact of the possible financial stumbling block that has to be faced and actually takes the step into a new and faster world. Surely approximately ninety seven percent of the world population can't be wrong in making use of the metric system.

As for the construction elements, it should remain the way it is at this point in time. All the moulds are in place, the quality and dimensions are all of acceptable standard, not to mention that all the users are use to the dimensions of the different elements as it is currently. They are trained to use them in their current form and trying to change it will only cause confusion.

Designers work according to certain modules. A module relates to a certain number of bricks (75mm x 11mm x 220mm). Changing brick sizes (as an example) would cause designers having to change their design approach and the way that they are used today for designing purposes.

The financial cost related to changing the moulds of such products will not be worth the end result as the cost will never be regained. It will be for the manufacturer's loss, because if he tried to incorporate such cost into the cost of the material, the cost of construction will most likely not make any project feasible, consequently possibly leading to an increasing and continuous financial loss.

As for time, the seconds, minutes, hours, days, months and finally years have all been calculated in accordance with the earth's position in relation to the sun. It has been a successful measuring tool for so many eras and no serious problems have been found with the current measuring system. It is well known and fully understood across the world.

Time across the world is already standardised, and trying to convert it to metric will only be a waste of resources, effort and precious time. As the saying goes "Why try and fix it, if it is not broken".

The main problem of this study was why there is still currently two measuring systems across the globe. The study clearly showed that most countries around the world already recognised that the metric system offers easy conversion between the units. They were willing to go the extra mile to get to know the system and systematically convert their ways and methods to suite this new system that they were implementing. The other countries still currently using the imperial system believes that the system works for their country. They see no need for the change. At this point in time they don't find the cost and effort involved with regards to the conversion, worth the advantages that the metric system has to offer.

According to this study's research and what the public had to say, this problem will be resolved over a long period of time. People do not like to change something that they are familiar with, thus making change a very difficult process. The total conversion to one system, namely the metric system has already taken place in numerous countries, and time is the only limitation between the current situation and global metrification. The process of conversion is now a slow process and the countries still currently making use of the imperial system prefers it this way, as their citizens will then slowly get used to it. The advantage of this way of conversion being followed is that people do not object against something that is done gradually, they make less mistakes because they have time to get to know the new system, and the country doesn't experience one lump sum of money being spent, but rather a certain amount of money spent over a planned period of time. The disadvantage is that there will remain confusion amongst the people of various industries making use of both systems, and until there is no complete unity between all the countries across the globe, mistakes will be made and money will be lost.

#### **8.4 Suggestions for further research**

Another study can be done on exactly the reasoning behind the few countries that are still making use of the imperial system, and why they believe it is better to keep using the imperial compared to the metric system. Their reasoning might be from the fact that they are used to that system and are not willing to change, to the fact that they are not willing or capable to present the capital to bring the change to light.

The metrification of time as discussed in chapter 7 can be elaborated a little more in detail, comparing exactly what effect it would have on all mankind. A comparison of the previous studies done, with regards to the metrification of time, can be clearly laid out to see to what conclusions the various studies came to and the reasoning behind the fact that it has never been introduced.

## BIBLIOGRAPHY

### BOOKS

LITTLE, A.B. 1970. *Kearlands' Metric Conversion Tables*. Johannesburg: Hugh Kearnland Publishers

ASSOCIATION OF SOUTH AFRICAN QUANTITY SURVEYORS IN CONSULTATION WITH THE BUILDING INDUSTRIES FEDERATION (SOUTH AFRICA), 1971. *Standard System of Measuring Builders Work in South Africa and South West Africa*. Kaapstad: Kaap en Transvaal Drukkers BPK

CHAPTER OF SOUTH AFRICAN QUANTITY SURVEYORS IN CONSULTATION WITH THE NATIONAL FEDERATION BUILDING TRADE EMPLOYERS IN SOUTH AFRICA, 1966. *Standard System of Measuring Builders' Work in South Africa*. Pietermaritzburg: Natal Witness (Pty) LTD.

McEVATT, W. 1987. "Modular Co-ordination", *Batiment International, Building Research And Practice, Citation 15 (1): p17-21*

### PUBLICATIONS

International Standards Organisation (ISO) published a guideline in 1976

### INTERNET SITES

[http://answers.ask.com/Reference?Other?who\\_created\\_the\\_metric\\_system/](http://answers.ask.com/Reference?Other?who_created_the_metric_system/) Access: 7 April 2010

[http://answers.ask.com/Reference?Other?who\\_created\\_the\\_metric\\_system/](http://answers.ask.com/Reference?Other?who_created_the_metric_system/) Access: 7 April 2010

[http://becauseican.co.za/wp-content/uploads/2008/04/ruler\\_0\\_10.jpg/](http://becauseican.co.za/wp-content/uploads/2008/04/ruler_0_10.jpg/) Access: 11 March 2010

[http://becauseican.co.za/wp-content/uploads/2008/04/ruler\\_0\\_10.jpg/](http://becauseican.co.za/wp-content/uploads/2008/04/ruler_0_10.jpg/) Access: 3 February 2010

[http://hubpages.com/hub/metric\\_system\\_vs\\_imperial\\_system/](http://hubpages.com/hub/metric_system_vs_imperial_system/) Access: 1 May 2010

<http://whatafind-antiques-collectibles.blogspot.com/2008/07/american-family-kitchen-scale-weighs.html/> Access: 3 February 2010

<http://whatafind-antiques-collectibles.blogspot.com/2008/07/american-family-kitchen-scale-weighs.html/> Access: 9 March 2010

<http://www.allianceonline.co.uk/chefs-utensils/measuring-jugs-and-scoops.html/> Access: 10 March 2010

<http://www.allianceonline.co.uk/chefs-utensils/measuring-jugs-and-scoops.html/> Access: 10 March 2010

[http://www.answerbag.com/q\\_view/582411/](http://www.answerbag.com/q_view/582411/) Access: 5 January 2010

[http://www.answerbag.com/q\\_view/582411/](http://www.answerbag.com/q_view/582411/) Access: 5 January 2010

<http://www.economicvoice.com/wp-content/uploads/2009/11/Petrol-Pump.jpg/> Access: 11 March 2010

<http://www.france-property-and-information.com/imperial-system-and-history.htm/> Access: 5 January 2010

<http://www.g9toengineering.com/resources/reverseengineering.htm/> Access: 10 March 2010

<http://www.g9toengineering.com/resources/reverseengineering.htm/> Access: 10 March 2010

[http://www.google.co.za/#hl=en&q=imperial+vs+metric+countries+&aq=&aqi=aql=&oq=imperial+vs+metric+countries+&gs\\_rfai=&fp=fbalcd88f79eeba9/](http://www.google.co.za/#hl=en&q=imperial+vs+metric+countries+&aq=&aqi=aql=&oq=imperial+vs+metric+countries+&gs_rfai=&fp=fbalcd88f79eeba9/) Access: 17 August 2010

<http://www.shrubs.co.uk/1-litre-measuring-jug-1483008-st-15702-p.asp/> Access 6 March 2010

<http://www.shrubs.co.uk/1-litre-measuring-jug-1483008-st-15702-p.asp/> Access: 6 March 2010

<http://www.statemaster.com/encycolpedia/imperial-unit/> Access: 1 March 2010

<http://www.thefreedictionary.com/meter/> Access: 30 September 2010

**ANNEXURE A:**  
**Questionnaire**



5. In what way can your industry possibly be standardised and what effect would it have on efficiency and user friendliness?

---

---

---

---

---

---

---

---

---

---

6. If material manufacturers in your industry are to change to the imperial measurements, what will the influence be on the cost of the applicable material and thus the cost of service that you offer?

---

---

---

---

---

---

---

---

---

---

7. Do you think that the possible metrification of time could ever be implemented successfully? Eg. Where there is now 60 seconds in a minute, 60 minutes in a hour and 24 hours in a day - now all time elements will be linked with the numeric ratio of 10 for eg only having ten hours in a day or 100 seconds in a minutes etc. Thus making the transition from eg days to second a very simple calculation?

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

8. Any other comments

---

---

---

---

---

