A metrication elephant

During the 2008 election campaign in the USA, '*Scientists and Engineers for America and fifteen other science organizations*' united to ask the congressional candidates seven questions in preparation for the Federal elections in the USA. See reference[i].

I was initially overwhelmed by the simple power of these seemingly innocent questions. Obviously, scientists and engineers are highly intelligent and knowledgeable people who should know and understand these issues, and I was especially impressed that so many organisations had been able to write, edit, and agree on such a diverse range of science and technology policy issues and then to reduce their ideas to seven apparently simple questions to test the political candidates.

But, as I read, a thought crept into my mind that, after a while, became impossible to ignore – there's an *elephant in the room*.

The highly original, smart, clever, and creative scientists and engineers who wrote the seven questions had not begun to address the most basic issue in science – how to measure things. They simply didn't seem to see that measurement was at all important to their nation.

When I read through the seven questions again, I realised that many of the troubling issues underlying these seven questions could be dramatically relieved if the USA upgraded to the same sane and rational measurement policy used by every other nation in the world, and promoted and used the metric system on a daily basis.

I am aware that the cliché, '*an elephant in the room',* is overused and I know that it usually refers to an issue that people try not to see, because it might embarrass them.

This example of an '*elephant in the room*' is mostly about how the USA is out of step with every other developed nation in the world, because the USA is now the only developed nation in the world that has not upgraded to the metric system. In the USA, the '*elephant in the room*' is a metrication elephant.

After a while, I had another thought. Perhaps it's me who is seeing an elephant in the room that's not there. Perhaps my belief in Condorcet's original thought – in the 1790s – that the metric system is '*For all time; for all people*' is colouring my judgement so badly that is creating a *metrication elephant* in my mind but nowhere else.

To see if this was so, I considered each of the questions raised by the *Scientists and Engineers for America and fifteen other science organizations* one at a time. Their seven questions are listed below; each question is *followed by my comments in italics,* testing my insight that all of these seven questions have metrication issues at their core.

Innovation

Science and technology have been responsible for half of the growth of the American economy since World War II. But several recent reports question America's continued leadership in these vital areas. What policies would you support to ensure that America remains the world leader in innovation?

> *Almost all scientists and engineers now use the metric system or SI units on a daily basis. The media and industry then go through complex and expensive steps to dumb these down to old pre-metric measures for the public and for politicians. As a media example, the National Geographic magazine dumbs down metric units on a regular basis, as does the Reader's Digest; the Associated Press in the USA actually has a policy in its Style Manual (in 2008) to dumb down all metric units to old pre-metric measures.*
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> *As an industrial example, the car industry designs and builds in metric units, then uses a thin veneer of old measures (mph, ml, psi), so that clients in the USA will not be aware that they have been driving all-metric cars, trucks, and tractors since the mid-1970s. This dumbing down for the public comes at a huge monetary cost to the nation. There was a*

video – which in 2015 is no longer anywhere on YouTube –
where mechanics took 2½ minutes trying to convert to inches and work out a calculation for an exhaust pipe in feet and inches. The exhaust pipe was designed and made as 180 millimetres at the front and 140 millimetres at the back, so they were actually working out 'What is 180 mm minus 140 mm?

Editor: I was, however, able to transcribe the conversation.
See *References* at the end of this article for a transcript of the mechanics' conversation.

Then try to work out the cost of this calculation applied to the whole nation of the USA.

Climate Change

The Earth's climate is changing and there is concern about the potentially adverse effects of these changes on life on the planet. What is your position on the following measures that have been proposed to address global climate change – a cap-and-trade system, a carbon tax, increased fuel-economy standards, and research? Are there other policies you would support?

There are two sadnesses about the closely related issues of climate change and energy. The first is that the British Association for the Advancement of Science (BAAS) made clear the differences between energy and power in the 1880s, and published their results in 1889. The BAAS defined the unit joule for energy and the unit watt for power in 1889. Most of the media and our world politicians have not yet caught on to this 120-year-old distinction. Unfortunately, understanding the concepts of energy and power lie at the very heart of our understanding of the greenhouse effect, global warming, and climate change. Without understanding the two simple units joules and watts, and their underlying concepts, we are condemned to talking about the climate change issues as if we were trying to find our way into the future, at high speed, in a fog.

Energy

Many scientists and policymakers say energy security and sustainability are major problems facing the United States this century. What policies would you support to meet the demand for energy while ensuring an economically and environmentally sustainable future?

The second sadness is that we have yet to decide and agree on how we measure energy. Most discussions about energy (such as a cap-and-trade system, a carbon tax, increased fuel-economy standards, and research) quickly dissolve into discussions about how to convert between the various randomly generated ways that individual industries have decided to try to measure energy. Although the idea of energy has only been fully understood since 1889, getting to grips with the idea of energy is now crucial to our understanding of issues such as: energy pricing, energy conservation, peak energy, and peak oil. We urgently need to have a common language to discuss these issues rationally and these should be encapsulated in the single energy unit, ***joule****, which should be used by all industries, in all nations, in any discussions about energy pricing, energy conservation, peak energy, or peak oil. In the article, 'A word about global warming'[iv] there is a list of some of the different ways of measuring energy used in 2008. Any politician who tries to gain a basic understanding of global warming will need to learn most, or all, of the 198 different old pre-metric measures and the 39 006 conversion factors between them.*

Education

A comparison of 15-year-olds in 30 wealthy nations found that average science scores among U.S. students ranked 17th, while average U.S. math scores ranked 24th. What role do you think the federal government should play in preparing K-12 students for the science and technology driven 21st Century?

Every child, in every school, in every subject, who uses a computer, writes every report and every essay on an all-metric computer. They do this while believing that they are working with old pre-metric equipment measured in inches. This is because the computer industry in the USA designs integrated circuit chips using nanometres and micrometres,

which are then placed into 'mother-boards' in cases built to millimetre precision; the computers are then sold to the students using words like the 'seventeen inch model'.

And software writers are no help to the children of the USA. For example the widely used Microsoft Word (Education Edition) has measurements such as its rulers, margins, and column spacing all set with defaults in inches, half inches, and quarter inches. If an enterprising student changes the defaults to metric (say to the worldwide printing industry default of millimetres) they will meet such oddities as rulers with groups of ten millimetres divided into quarters that are 2 1/2 millimetres long.

Enormous effort, and cost, is spent teaching children in the USA about the use of old pre-metric measures, about the metric system, and about how to convert between the new and the old. This expense of money and children's time does not happen in any other nation except the USA. Children in all other advanced countries simply learn the metric system, and then use it.

Meanwhile school children in the USA leave school to join a workforce predominately using metric measurements. Manufacturing industry must then pay the cost of retraining their USA workforce to work with the metric units used in USA industry. Some companies don't do this for their new staff; they simply import immigrants who have acquired their metric skills from anywhere else in the world.

Water

Thirty-nine states expect some level of water shortage over the next decade, and scientific studies suggest that a majority of our water resources are at risk. What policies would you support to meet demand for water resources?

Both industry and individual citizens need to know how to measure water so that we can all understand how to collect it, and to share it wisely and fairly. This is enormously difficult to do using inches of rain, gallons per cubic foot, cusecs of flow, and acre-feet of water; water calculations are only attempted by specialists in the USA. On the other hand (say in Australia) any child can work out that when a millimetre of rain falls on a square metre of roof, a litre of water flows into a rain water tank, so it is easy to work out that a 6 millimetre shower of rain on a 200 square metre roof will collect 1200 litres of rain (6 x 200 = 1200 litres). Any senior primary school child in Australia can do a calculation that requires a specialist expert in the USA, and being able to 'do the sums' soon leads to an understanding of water issues.

Research

For many years, Congress has recognized the importance of science and engineering research to realizing our national goals. Given that the next Congress will likely face spending constraints, what priority would you give to investment in basic research in upcoming budgets?

What is the cost, both in time and in money, of doing research using international metric units, and then having to dumb these down for politicians and for the public? The Mars Climate Orbiter springs to mind.

Health

Americans are increasingly concerned with the cost, quality, and availability of health care. How do you see science, research, and technology contributing to improved health and quality of life?

It is reported that, at present, there is an average of 1.7 medical errors per patient per day in USA hospitals. Many – but I don't know how many– of these are due to conversion errors when converting patient's body mass from pounds to kilograms (or in the case of babies from pounds and ounces to kilograms and/or grams).

Many, many, people die every day as a result of errors in unnecessary conversions. Note that the only reason for these conversions is to maintain the thin veneer of misinformation that doctors and nurses in the USA are using old pre-metric measures in their surgeries and hospitals – but this is simply not true and it has not been true for decades. All medical research in the world (including the USA) is done using SI metric units, medical drug products are developed and tested using SI metric units, and the doses are then refined and delivered with dosage units like milligrams per kilogram.

Conclusion

So how would anyone go about explaining to the highly intelligent and well educated '*Scientists and Engineers for America and fifteen other science organizations'* that there is an '*elephant in the room*' if they haven't yet seen it for themselves. I suspect that saying, even yelling, '*Hey, look, there's an elephant in the room*' won't do much good.

Of course if it was a real elephant, I might just point out the droppings. And that thought gives me a clue. What are the droppings from not having a measurement policy in the USA (despite the best efforts of George Washington, Thomas Jefferson, and Benjamin Franklin in the 1780s and 1790s)? The 'droppings' are the financial costs to the citizens of the USA that have built up each year for the last 220 years and that will continue to build into the future – there's quite a pile.

As I am not a citizen of the USA, I suppose that I am not able to ask questions about policies in an election year in the USA. However, if someone were to ask policy makers a question on my behalf it might go something like this:

Not fully adopting the metric system with respect to innovation, climate change, energy, education, water, research, and health is costing the USA a great deal of time, money, and international opportunities. What is your estimate of the cost to the USA of these losses internationally, and what is your estimate of the cost of supporting both old-pre metric measures and metric units inside the USA?

In a submission to the President's Math Panel, Pat Naughtin, an Australian expert in metrication, which is the process of upgrading to the metric system, observed that not using the metric system is costing the USA roughly 1.27 trillion dollars a year (about three times the USA military budget). Pat Naughtin's submission contains the line: If Richard P Phelp's estimate of 10% wasted costs in education were applied to the whole economy, the loss would be about $1.27 trillion per year.

To paraphrase the USA Senator Everett McKinley Dirksen (1896/1969):

... **a trillion this year, and a trillion next year, pretty soon adds up to real money**.

References:

See **http://sharp.sefora.org/innovation2008/#questions**

See: **http://www.worldwidewords.org/qa/qa-ele2.htm**

See the article *A Word About Global Warming*.

In an article, 'The Case for U.S. Metric Conversion Now' (1992, December 9) Richard P. Phelps stated that:

> *It (USA education system) teaches two systems of measurement in the schools and, the confusion from learning two systems aside, there is a cost to the time spent in teaching two systems. A full year of mathematics instruction is lost to the duplication of effort.'*

You can view Richard P. Phelps' article after you register on the Education Weekly database at: **http://www.edweek.org/ew/articles/1992/12/09/14phelps.h12.html**

In her paper presented to the National Math Panel, *Teach Only the Metric System*, Lorelle Young stated that industry in the USA is now more than 60% metric. Lorelle Young's paper can be found **at http://www.scribd.com/doc/1233594/-description-tags-8-metric20system**

According to a report at **http://www.aarp.org/research/health/carequality/Articles/aresearch-import-711-IB35.html** '*The average number of errors per patient per day was 1.7.*

Go to **http://www.visicu.com/solving/research/mederrors.html** to see quotations like this: ' ... medical errors were estimated to kill up to 98,000 Americans each year and to be due to human error "60-80%" of the time. That is more people in one year than died in the entire Vietnam War. That is more people than die from automobile accidents, AIDS or breast cancer yearly.'

Search for Benjamin Franklin, Thomas Jefferson, and George Washington in '*A chronological history of the modern metric system*' to see the part these three played in the development of the international system of units – the modern metric system.

You can see Pat Naughtin's submission to the National Math Panel by doing an advanced search for 'Naughtin' at: **http://www.ed.gov/about/bdscomm/list/mathpanel/index.html**

See the article *Cost of non-metrication* for a summary of where these costs arise.

Transcript of motorbike mechanics' conversation – 2½ minutes.

Start of conversation	*… continued*
BOSS MEASURING AN EXHAUST PIPE	**BOSS** 5⅝
BOSS Are you ready? 6⅞ right? 7¼. What's the difference between 6⅞ and 7¼	***M1*** I'll write this down
M1 ⅜ and ⅜ … ⅜	**BOSS** 5⅝ and 7¼
M2 ⅜	***M2*** Oh well 5⅝ gives you another ⅜ that's 6¼
BOSS inch&⅜	***M1*** Two inches minus ⅜
M1* & *M2 ⅜	***M2*** So an inch and ⅞
M1 6⅞ to 7¼	***M1*** ⅝
BOSS 6¼	***M2*** inch and ⅝?
M1 Oh 6¼	***M1*** inch and ⅝
BOSS and 6⅞	***M2*** OK inch and ⅝
M1 That's very different to what he said	**BOSS** What is it? I'll write it down and I'll figure it out
BOSS 7⅛ right	***M2*** Well it was 5¼
M2 7⅛ right and 6¼? … 6⅞?	**BOSS** 5¼ What was the other one?
BOSS 6⅛ and 7¼	***M1*** It's 5⅝ to 7¼
M2 6⅞	**BOSS** 5⅝ to 5¼ What was the other number? 7¼?
M1 An inch and an eighth	***M2*** Yeah.
BOSS An inch and what	***M1*** It's 5¼
M1 An inch and one eighth	**BOSS** It's two inches
M2 Did you say 7⅛ and 6¼?	***M2*** It's two inch – It's just a hair under two inches
M1 6⅛ to 7¼	**BOSS** When are you figuring it out for me?
BOSS No - I said - you're right	***M2*** It's an inch⅞ between the front and the back
M2 You said 6⅛?	**BOSS** I'll buy that
BOSS 6⅛	***M2*** Right
M1 It's changed	***M1*** And and - ah – 5⅝?
M2 Yeah - changed four times. What's the numbers?	**BOSS** No. 5 and - ah - Did I say 5⅝?
M2 6 and 1	Laughter
BOSS 6⅛	***M1*** It's higher in the front than the back. I thought you said fried eggs
M2 Check	**BOSS** 5½
BOSS I'm sorry. It's actually 5⅝	***M1*** 5½
Wow	***M2*** What does it say right there?
Laughter	**BOSS** 5½ - over here – 7⅛
M2 and what?	***M2*** 5½ to 7⅛ is an inch ⅝

Actual sum

180 mm – 140 mm = 40 mm