Chapter 14

Down Under in Oz

In the 1970's, Australia decided it would convert to the metric system. Australia would choose Alan Harper (1913-1991) to shepherd the change. He had been a research scientist, and would lead Australia's metric conversion board. Harper intended to change his nation to the exclusive use of metric measurements. The task was overwhelming, every aspect of measurement practice in Australia would need to be closely examined, and reformed. Alan Harper was the pilot who would guide the way, and make it happen.

On May 29, 1968 an Australian Senate Committee concluded unanimously to adopt the metric system exclusively as soon as possible. The majority of Australia's trade was with metric countries. It was a clear, practical, economic decision.

Harper realized that in countries where the metric system was implemented quickly and decisively by the government, conversion had gone well. In countries which allowed the process to shepherd itself (such as in Britain) momentum was lost and the country might end up in metric purgatory.

The process was to be voluntary, as far as how various industries would implement the new system, but pressure would be applied using strong legislative initiatives, and there would be significant penalties for non-compliance. Harper also saw that metrication should take place over as broad a spectrum of society and industry as possible all at once. This would immediately create a metric environment for as many citizens as possible, with no islands of Imperial ecosystems to hinder the transition.

Communication with the public was of paramount importance in order to enlist them, and make Australians understand the changes.

Perhaps the most important aspect of metric conversion was to use it as an opportunity for commerce to reexamine current industrial practices, and to streamline, simplify, and rationalize industries and practices. The Metric Board would act to shepherd and facilitate these activities, not to dictate details.

Alan Harper had a very effective partner in this undertaking, one John Norgard (1914-2010). He had the industry contacts which would smooth out, and help coordinate the metric conversion. The two complemented each other like salt and pepper. Norgard approached the heads of all the countries newspapers, and asked them not to take an editorial stand against metric. Only once was this promise violated.

The Metric Board enlisted an army of specialists in multiple fields to help with this broad transition. They would act as liaisons on behalf of the nation in the coming transition. Despite some wavering by the Government during the decade, the transition remained firm. Weather reporters started to convert in 1972, and were finished two years later. Dozens of industries followed suit. Strangely, the conversion of womens bras and biscuits (crackers) proved to be stumbling points.

The public demonstrated considerable anxiety over the single day change of all the road signs and traffic rules to metric. This was to take place on July 1, 1974. There were terrifying warnings of mayhem that would take place. In a non-event reminiscent of the Y2K bug, the ocean remained blue, and the cars on the freeways traveled as easily as they always had. When voluntary conversion time tables were violated, legal actions were taken to enforce the changes. The most important mandate was no use of dual units—they were not allowed. Direct metrication takes about a year, allowing dual units can inhibit conversion almost indefinitely. The Australian metric conversion was nearly 75% complete by 1976, and by 1980 the committees had essentially finished their tasks.

Historian Jan Todd summed up Australia's experience:

> Australia's conversion process had shown how a centralized, coordinated national program of measurement change could work. With strong government commitment, full legislative backing and a national body dedicated to developing policy and leading implementation, even a federation of six unruly states could be brought into uniform order.

While Australia was changing to metric, the US was holding metric hearings in 1975. Their assessment was that Australia is "Currently

moving rapidly toward a strongly metric environment–more quickly and easily than expected." [1] The American Bar Association understood the importance of what was occurring in Australia:

> The reason why the Australian Post Office is converting its internal operations is to avoid becoming a customary island in a metric ocean with all the permanent training and recruiting problems which would be incident to that status.
>
> Sports were selected as pacesetters because it was recognized that their early conversion would be a most effective way to generate public familiarity with metric usage on a widespread basis.

The ABA recommended much stronger legislation "So that the U.S. Metric Board may have a pole star to guide it rather than to be left to fend for itself without adequate congressional direction."

Esther Peterson (1906-1997) of Giant Food also understood the importance of following and learning from the Australian example:

> The Australians have given us a fine example of a smooth transition to metric which involved the public all the way. The primary aim of The Australian Metric Conversion Board was to overcome public apprehension. Dual labeling and conversion exercises were avoided for a "think metric" approach. The consumer was saturated with metric information. Special target dates were set for each sector—speed and road signs, temperature, clothing, et cetera—so the consumer knew what to expect and when. The board published booklets, distributed posters, showed films, gave speeches, and utilized the media. There were very few cases of unfair practice in the marketplace, because no-one dared to cheat the consumer with a metric-sensitive press watching every move.
>
> The success of the Australian metric program was also enhanced by a strong initial and sustained support by the Australian Government. We need that same kind of support from all branches of our own Government. Many agencies have already begun to prepare for metric. All need to move ahead.

> The most important point here is that the Australian legislation utilized a metric conversion board which kept their public informed right from the beginning. Today, a little over 5 years after legislation was passed in Australia, the conversion process is almost completed.

Esther argued that "guidance in the form of Federal Legislation is needed, We need a uniform approach in order to implement a smooth and total conversion in all areas . . .where standards are set and followed, target dates are met, and uniformity in practice exists." Her words proved prophetic, and the vacuous US metric non-legislation would not be strengthened.

Donald Peyton (1925-2004) of the American National Standards Institute (ANSI) used a football analogy and said that comparing the US with Australia "is like comparing a high school football team with the Green Bay Packers." Statements like this assume there is no economy of scale to be exploited during a metric switch-over in the US, as compared with a smaller country.

Australia's metrication was misrepresented in the US as a *totally* voluntary "program" by participants who testified at the 1975 metric hearings. Australia's metrication program was characterized as a product of spontaneous generation, which aligned nicely with US economic mythology dating back to at least the 1920s, if not before. Alan Harper took note of this misrepresentation and wrote a letter, which is included in the record of the 1975 hearings. He told the assembled Congressmen in his epistle, that Australia's metrication was voluntary, only as far as how industry would implement metric in each of their trades, but not *if* they would convert to metric.

In April 1979, Mr. Harper was asked in person, by a US Metric Board member, if Australia could have accomplished what it did, had it been working under metric legislation similar to the U.S. Metric Conversion Act of 1975

"No" was his emphatic single word answer.

By 1992, the metrication of Australia was complete enough for the government to commission a study of the subject. The work *Metrication in Australia*, written by Kevin Joseph Wilks, documents the metric changeover, and details how it was successfully accomplished in the myriad sectors of the Australian economy. The book makes this observation about the decision to implement metric:

> It was sometimes asked why the decision to go metric was not reached by referendum. This would have presupposed that people would have had a comparable knowledge of both the imperial and the metric systems and of the impact such a change might have. While metrication has certainly had a massive cultural impact on people in their lives as ordinary citizens it is, nevertheless, a predominantly technical change, affecting commerce, industry, engineering, science and education. For referendum purposes, relatively few people would have had sufficient knowledge of both systems to make an informed decision.
>
> The decision to go metric was achieved through an open committee of inquiry, appointed by the Government, which collected evidence from any person who felt interested or competent enough to give it.

The statement demonstrates that the Australian government did not get caught up in the idea that metrication is a social change, but saw it as essentially a technical one. The inflated costs of metrication, as quoted by critics of metric, were simply a red herring. The effectiveness of setting an M-Day for each industry was of paramount importance to the transition. There would be planning and preparation, so that on a particular M-Day, the industry involved would switch overnight to metric. The avoidance of dual markings was explicit, and so there was no opportunity for metric backsliding on the roads, at work, or anywhere. The book, *Metrication in Australia*, is very much a "how to guide" which would be of great utility in the event the US decided to become metric.

In the United States, the history of the metric system non-implementation was slowly being distorted into a patriotic social myth. It has become a political proverb, propagated by anti-metric people, that the government tried to impose the metric system on the citizens in a heavy-handed manner, which caused a great amount of suffering and disorientation. In this myth, the public rose up and revolted, they held their democratic representatives accountable, and had the metric system imposition terminated.

As one can see from the testimony in the 1975 metric hearings, this is all buncombe, but this myth has provided a quick, effective, sanctimonious response to those who question the lack of metric in the US.

Anyone who questions the US lack of metric system implementation, is assumed to be against democracy, and may be dismissed. Often anti-metric people will say "we tried in the 1970s, but it just didn't happen" and that defeat should be accepted as "the people spoke."

In 2004, the work *For Good Measure: The Making of Australia's Measurement System* by Jan Todd was published, and offered a look back at Australian metrication, which was becoming a distant and fading memory for many of the citizens there. For people in their mid twenties, it was the only system they had ever known.

Australian metrication is probably the most successful of all the former British territories. As the decades passed, the Australian metrication period dimmed, and became a part of the past. America remained in its Olde English coma as the Twenty-First Century unfolded.

The fact that the United States had not embraced metric became more and more of an enigma to one resident of Australia. His name is Pat Naughtin, and he lived in Geelong Australia. Naughtin created a website called *Metrication Matters*, and on June 10, 2003, he published the first of his 100 newsletters about the metric system. Naughtin had spent his career guiding his fellow Australians in the current best-use implementation of the metric system. Certainly, one would expect that in Australia, his job was mostly dealing with the few remaining hold-outs in industry, education and government, and helping usher along metric. It would appear that after his career in Australia, Pat saw it as important to do his best, to bring what he learned to the US, and also to understand why the US was the lone metric hold-out. His first Newsletter has a question:

> I wonder why the USA is the last nation in the world to admit the extent to which they use the metric system of measurements. For example, of the 10 000 parts in a modern car, made in the USA, all of them are measured in millimetres to the nearest tenth of a millimetre. But because the speedometer is labelled with the letters 'mph', drivers in the USA are generally convinced that they are driving an 'English Units' automobile.

Part of the answer to Naughtin's query, which he later stated himself, is that in the US, a majority of people have no idea what measurement system was used to build cars, refrigerators, televisions, washers, and

all manner of consumer products they use. They only know what the system is they use to interface with them. He also appeared to believe that much more metric usage was occurring in the US than probably exists, and over a longer period of time than is warranted. The first *Hidden metric* section of his newsletter asserts:

> As vinyl records developed, in the 1920s, they were designed and made 250 millimetres and 300 millimetres in diameter. In English speaking countries, they have been called 10 inch and 12 inch records ever since.

This correlation is a metric coincidence. The RIAA specifications for records is written in fractions: "The Diameter of a 12" record is: 11 7/8" + 1/32"." The specification as written produces an average diameter of 302.0 mm for a 12 inch record, 251.4 mm for a 10 inch record and 175.4 mm for a 7 inch record. Metric coincidences occur, and it is a small but illustrative peccadillo that Naughtin would embrace this belief. He loved the metric system. The values are so close, that one could easily measure vinyl records, and become convinced they were designed in metric. Compact Discs were designed to be 120 mm, and 90 mm computer floppy disks, were also design in metric, but called 3 1/2 inch floppy disks in the US.

In his quest to understand why the US had not become metric, it was postulated by Naughtin that decimalization might be to blame, that in the US, the use of decimals had obscured the need for this aspect of the metric system. It is true that in engineering, decimal inches are common, but a trip to any US hardware store will reveal that tape measures and rulers are all marked in fractions of an inch: 1/2, 1/4, 1/8, 1/16, and on the first and last inch, 1/32 of an inch graduations are often found. There are no decimal markings. Entering any US garage owned by an amateur mechanic, or other technical person, one almost immediately will see a fraction to decimal conversion chart. This is the height of inefficient measurement use, yet it lingers and remains. Naughtin's decimal hypothesis explains his confusion as to why the US is not metric. His lack of experience with America, and how ordinary people design and build there, encouraged his optimism. The non-metrication of the US was a metric puzzle.

Naughtin appeared as an Australian metric ambassador to the US, at a time when the United States had no metric spokesperson, nor seemed

aware one might be needed. Pat embraced international standards that Americans had only encountered minimally. He championed A-series paper, which is used internationally, except for the US and Canada. Naughtin encouraged the use of international dating. His first newsletter was on 2003-06-10 and dated this way.

Pat had an unrequited desire to help the US become metric, and educate its citizens on the most effective ways to use metric, which were discovered during the Australian metrication period, and also what has worked during the metric conversions of a few stragglers.

One of the first points he makes about metric system conversion, concerns the use of centimeters versus millimeters. He wrote an in-depth, detailed discussion analyzing the merits of both. In the end, he suggested millimeters—period. The pragmatic point he made in 2008 was about how the two are embraced by industry:

> If you choose millimetres as your small unit for a metrication upgrade then the metric transition is smooth, rapid, and so economical that the companies involved save so much money that their net profits increase dramatically..... It's hard to know how long a metric transition using centimetres will take as no one has completed one yet.

This emphasis on millimeters is a subset of what Naughtin called "The Rule of Thousands." The best way to use the metric prefixes is in groupings of 1000 magnitude. In the US this is often called "Engineering Notation." It simplifies metric usage considerably, and provides a more intuitive experience for the user. A list of these prefixes is presented in Table 14.1

Naughtin also stressed the importance of M-Days. This would be the single date on which a group would become metric. Metric would appear to have occurred in a single day, but this would only happen with careful preparation. An important point Pat made, was that the task of preparation should not be delegated to someone unfamiliar with metrication. In some cases, during Australia's metric transition, the management of one particular company had tasked a secretary to purchase new scales and tools. Attempting to demonstrate her frugality, dual-scale tools were purchased. Two scales were thought to be a bargain compared with a single scale. Experience had shown that if you offer dual-scale tools, the people using them just continue to use the

Metric Prefixes

Name and Symbol	Multiplier
yocto (y)	10^{-24}
zepto (z)	10^{-21}
atto (a)	10^{-18}
femto (f)	10^{-15}
pico (p)	10^{-12}
nano (n)	10^{-9}
micro (μ)	10^{-6}
milli (m)	10^{-3}
1 (unity)	10^{0}
Kilo (K)	10^{3}
Mega (M)	10^{6}
Giga (G)	10^{9}
Tera (T)	10^{12}
Peta (P)	10^{15}
Exa (E)	10^{18}
Zetta (Z)	10^{21}
Yotta (Y)	10^{24}

Table 14.1: List of metric prefixes with separations in magnitude of 1000, sometimes called Engineering Notation in the US. This eliminates the notational congestion caused by the "prefix cluster around unity."

more familiar non-metric scale. Naughtin estimated that the presence of dual scale tools might delay metric adoption for 200-300 years. He often stated "don't dual with dual."

One of Naughtin's metrication pamphlets describes how to achieve *Metrication in a Day*. It is a step-by-step guide that uses, as an example, how a group of plumbers were converted to metric. The plumbers (and other tradesmen) were informed their company was "going metric." They were told they would attend a Metric Information and Training Day in the future. The plumbers were instructed "to bring along all their company owned rulers and tapes as they would be doing some practical measuring exercises during the day." When they arrived for training, the employees were directed to bring the tools to desks where

"the old rulers and tapes were exchanged for brand new high quality rulers and tapes marked in millimetres only." The workmen were also provided with rugged calculators.

The men were then given a short lecture on the importance of changing to metric, and quick instruction in the use of the system. The workers were invited to a beverage break, and offered their preferred beverage in robust 250 mL mugs, which they were instructed to take with them. While the plumbers were on this break:

> . . .their old feet-and-inches tapes and rulers were ceremoniously wheeled, in labeled 200 litre drums, into the centre of the courtyard. Flame accelerant was poured on to them and the old rulers and tapes were burned to total destruction. This dramatic demonstration made it absolutely clear that the object of the day's training was to change completely to metric system units and to do it now.

The workers would then use the new measures to determine the length of their finger and palm width, which are often near 100 mm for men. The width of a fingernail is measured, which is often about 10 mm. Pat argued that this session must not be hurried, and to let the people involved, experiment with their new measurement tools. After lunch, the basics of the metric system would be explained, and exercises in metric estimation would take place. Clearly all the new tools had to be purchased well before the M-day, but not revealed until the exchange. It is imperative to use quality tools to replace all those taken from the workmen. If the replacement tools are of inferior quality, it would endanger success. Naughtin goes into great detail as to why this metrication in a day method worked so well. He has a final note:

> In later interviews the plumbers reported that they 'changed their mind to metric' on that day and then consolidated their metric knowledge on the job over the next two weeks. Surveys of participants a month later showed that they, personally, saw their metric transition as complete by then. The plumbers and their unqualified labourers were comfortably using millimetres for all of their work. They reported that critical factors in their success were using only millimetres so they didn't have to mix measurements or to use any fractions or decimals at all. They particularly liked avoiding

> the confusion that comes from using centimetres and from "slithering decimal points all around the place".

Pat Naughtin's expertise was in understanding human psychological barriers to adopting metric, and implementing ways to overcome them to produce a smooth metric transition. He had helped to usher along metric changeovers in Australia, but then began to turn his attention toward the most incorrigible metric holdout on Earth, the United States.

In 2007, Naughtin traveled in the US, and gave a lecture on the metric system to a group at Google. In his lecture, Naughtin relates that the head of AVJennings, a construction firm in Australia, had two identical houses constructed side by side. One used Imperial units, and the other metric. All the waste was kept on site. The Imperial (feet-inches) house had two five tonne trucks of waste. The metric house? The waste "wouldn't fit in a wheel barrow." The difference was dramatic. The cost savings is probably about 10–15%. The important ingredient needed to realize this savings is to use only millimeters when constructing the house. No fractions, only whole numbers are used, and people are willing to cut to a mm if possible.

The standard two by fours used to construct Australian houses were of a nominal size. Each individual two by four varied considerably (which is still true in the US). Some are bowed which requires planing. Currently builders here in the US have to select the best two by fours they can find as they purchase them. When placing drywall, shims and planing are required to even out the wall. This all adds labor costs and time. The Australians used their metric conversion as an opportunity to re-write the regulations for building materials. In Australia if a stud is 35 mm x 90 mm, it's very, very close to that, so no preparation work is required. This saves considerable time.

During the 2008 US election campaign, a group called *Scientists and Engineers for America*, and fifteen other science organizations, developed a list of questions they believed the candidates should address. It surprised Naughtin that:

> 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 of the USA

This is a very revealing observation about the situation with scientists and engineers in the US. The technical culture of the US in 2008 was completely oblivious to the metric system. The very people who represent the professions which rely directly on measurement, saw the metric system in the US as a non-issue. Many technical professionals in the US see measurement as a long ago settled issue, and one way is as good as another. This cultural inculcation has been passed down generation after generation, and Naughtin, an Australian, did not understand how deeply this pervasive viewpoint is embraced in the US. John Kasson had only made metric measurements permissible in the mid-nineteenth century, and after that, all measurement units became equal, and the issue was settled.

Another US cultural issue that Pat Naughtin did understand, is the pernicious idea that the metric system is "French," and because of some ill-defined Anglo-Franco hostility, it is a system that should not be embraced for that reason alone. Historically, the success of the metric system began to take-off when the French turned the metric system over to international governance, but this is unknown by the vast majority of Americans and would have little impact.

In 2007 Naughtin discovered that the original proposal for the metric system had been published by an Englishman, John Wilkins, in 1668. This was many years before the French would adopt the same weights and measures, that is, the liter, meter and Kilogram, but with decimalization.

While historians might treat this information as a historical curiosity, and ponder if the information was used during the formulation of the metric system in France, Naughtin realized it was of great cultural relevance. The fact that the metric system was proposed by an Englishman, may have exactly zero relevance to the length of a millimeter, the mass of a gram, or the volume of a milliliter, but it could potentially attenuate, and possibly overcome the perception of metric units as foreign, by the English speaking world. On July 13, 2007 (2007-07-13) Naughtin appeared on the BBC and publicised this fact. In a TEDxMelbourne talk in Melbourne Australia on March, 13 2010, (2010-03-13) he incorporated this new knowledge about the British origin of the metric system into his lecture.

Naughtin also realized that Australia may have the metric system, but many people use it in a rather cavalier manner, that does not pro-

vide clarity and transparently transfer information. Naughtin championed the simplest manner of expressing quantities, and spoke against creating "mixed metaphors" of measurement units in place of direct measurement comparisons. The metric system, when properly used, allows for an instant understanding of the magnitude of quantities under comparison. In his 2010 TEDxMelbourne talk, Naughtin illustrated the problem of using mixed units and prefixes. Pat presented a slide in which he compares energy use data he has organized for clarity, and compares it with the data as originally presented by the Australian Bureau of Statistics. The information from this slide is reproduced in 14.1.

Energy statistics

From Australian Bureau of Statistics
'Non-Renewable fuels used to generate electricity include black coal (53.576 **kt**), brown coal (65.075 **kt**), and natural gas (291,372 **TJ**). Hydro-Electricity was the main renewable source of electricity, and in 2001-02, 15,567 **GWh** of hydro-electricity were produced. . .'

. . . Non-renewable fuels used to generate electricity include:

1. 1600 petajoules from black coal,
2. 1000 petajoules from brown coal,
3. 290 petajoules from natural gas, and
4. 56 petajoules of hydro-electricity

Figure 14.1: Australian energy statistics slide – after Naughtin

The slide shows the original quotation from the Australian Bureau of Statistics. All the representations are not directly in terms energy, but worse yet, they have been written in a manner with units and values which obscure comparison. The tonne is accepted as a metric "nickname" for the pre-metric unit called the ton, which has two varieties. The acceptance of this intrusion of a pre-metric nickname in the metric system encourages poor measurement expression. The kt represents a

kilotonne mass measurement. The tonne is correctly called the Megagram so it actually represents a KiloMegagram, which is a kilokilokilogram, which are both unacceptable uses of prefixes. The value would be more correctly called a Gigagram.

The mass values offered for coal are not direct energy values, but proxies. When discussing energy, the only metric unit for energy is the joule. The use of GWh (GigaWatt-hour) is a metaphorical way to represent energy. Watts are in energy per second, and would not be properly multiplied by hours. One would have to convert the hours to seconds and multiply to get the total amount of energy in joules. Below the quotation from the Australian Bureau of Statistics, Naughtin has converted the information entirely to joules, and used an appropriate metric prefix, Peta, so they may all be compared as integer numbers. This demonstrates that when properly used, the metric system encourages numeracy.

Naughtin pointed out in his lectures and writings over and over, that without a measurement policy, there will be measurement anarchy. He cites NASA's metrication policy as currently being: become metric if you want to, and choose millimeters or centimeters, if you want to. Indeed, the very idea of a measurement policy is not discussed among engineers or scientists in the US. There is almost a view that it is not important, or worse yet "you're over-thinking your job." Quite reasonably, Naughtin asserts that probably about 10% of the USA's Gross Domestic Product is waste because it has no measurement policy.

Naughtin also examined the amount of waste paper generated because programmers in the United States determine the default margin for paper. When using Microsoft Word with A4 paper, the margins are set 25.4 mm (1 inch) on the top and bottom and 31.7 mm (1 1/4 inch) on each edge. The total image area is 146.6 mm x 246.2 mm for an area of 36 093 square millimeters. When the margins are rounded to metric values of 25 mm top and bottom, and with 30 mm on the sides, the page looks fine (possibly better) aesthetically, and your working area has increased to 37 050 square millimeters (150 mm x 247 mm). If this image area is used, as is generally done for common reports, the paper savings is about 957 square millimeters or about 2.65% of your previous costs. Naughtin points out:

> Saving about 2.7% of the 490 000 000 tonnes of paper used each year for business forms in offices in the USA, would

> reduce annual office costs nationwide by about $3 500 000 000 000 each year – and this estimate does not include any savings from reduced printing, photocopying, paper handling, and storage costs.

Naughtin also argued that editors should avoid the prefix cluster around unity:

> Avoid unit names that use the prefixes centi (c), deci (d), deca (da), or hecto (h). Instead use unit prefixes that are multiples and sub - multiples based on thousands. Examples of preferred prefixes are micro (μ), milli (m), kilo (k), and mega (M).

but strangely he found kilotonne (kt) acceptable.

Naughtin sent letters to every member of the US Congress about the importance of Metric System adoption in 2011. In his newsletter *Metrication matters* - Number 95 - 2011-04-10, Pat states: "The result: nil, nix, nothing, zero, zilch. Not even a courteous, "We thank you for your letter..."

Pat Naughtin died on 2011-07-16 (July, 16, 2011). His last two newsletters arrived to his readers posthumously, for a grand total of 100.

References

[1] 1975 Metric Hearings pg 59