Chapter 13

A Momentary Flash of Metric Lighting

There were a few behind the scenes metric skirmishes in the 1980s and 1990s.

In 1982, the state of Florida decided to add metric units to its highway signs. The rational behind this change was that over five million tourists visited Florida, and many of them were unfamiliar with US measurement units. They also believed it would encourage Americans to become more familiar with metric units. Florida was going to use its own funds to implement this change. There was only one thing they needed, the approval of the Federal Highway Administration (FHWA). It came as a surprise when, despite the 1866 federal law which does not allow the prohibition of metric units in the US, the FHWA refused to allow the metric signs. They argued that Congress had passed a law which prohibited the installation of solely metric highway signs using Federal funds, unless Congress approved. The installation of these signs would violate neither of those conditions.[1] The FHWA would later reverse itself without providing reasons for the attempted ban, or why it changed its stand. Like most tales of metric in the US, a later Florida Governor would refuse to allow the signs to be installed.[1] [2]

During the momentary faux-interest in metrication during the late 1970s, Interstate 19 in Arizona was constructed using metric signs for distances. I-19 is just over 101 Km in length and thus far exists as a living fossil from 1978. The signs have distances in meters, or Kilometers, but speed limits in miles per hour. There was a push by the Arizona DOT

[1] President George H.W. Bush argued that more time was needed to figure out how to change over highway signs. President Bill Clinton backed away from a program to convert highway signs to metric in 1994.

to change the signs over the US medieval units, but in 2010 this plan stalled.

On September 23, 1999 after two decades of quiescence, there was a momentary flash of interest in the metric system by the media. It was on that day that the first known US space mission failure was caused from the lack of the US adopting the metric system. The Mars Climate Orbiter is assumed to have crashed into the surface of Mars. Because pound-force was used instead of newtons (metric) in navigational computations, it doomed the spacecraft. The thrust instruction software expected values in newtons, but was instead given pound-force. There is pound force and pound mass in US units. In the metric system there is newtons and Kilograms. It is hard to confuse those two designations. Total cost of the Mars Climate Orbiter to the American taxpayer was $327.6 million.

This "metric mishap" did not deter NASA from continuing to embrace US units in a metric world. Michael Milstein in *Air & Space* magazine pointed out in 2001 that:[3]

> . . .the U.S. portion of the International Space Station is built in Imperial Units while the rest of the super-expensive structure has been constructed in metric. About 10 years ago NASA gave serious thought to the idea of building the whole thing in metric, but decided that would drive the cost way up. All the NASA contractors were tooled to build parts in inches and pounds; converting to metric would have required revised designs and new machines. So instead they developed an elaborate and costly computer-modeling and cross-checking procedure to make sure that metric and Imperial parts fit together and work properly.

Yet again, NASA would rather continue to tempt fate, and absorb the cost inefficiencies of using US units, simply so its ossified contractors could continue to use them, which in turn makes their designs incompatible with all other space agencies in the world. NASA continues this mixed course, even as they insist they are striving for "international cooperation in space." Rather than insisting NASA contractors switch to metric, NASA continues to employ the worst of both worlds.

In 2005, the DART (Demonstration for Autonomous Rendezvous Technology) satellite crashed into another satellite, called MUBLCOM,

with which it was to rendezvous. This would be referred to as a "Premature Retirement." The full report of the mishap by The Mishap Investigation board has not been released. In 2006, NASA announced that they would not release the investigation's report, citing that the report includes details protected by the International Traffic in Arms Regulations.

An abbreviated and opaque summary of the report was released. What it tells us is that DART has a GPS system on board to compute its position, and used other sensors to determine its position. The discrepancy between the positions reported by the sensors, and the GPS, were so large that the software continued to reset, over and over, in the expectation the oversized error would vanish. This used up considerable amounts of fuel at a high rate of consumption, which eventually ran out. The report offers this explanation concerning the measurement discrepancy:

> If the measured velocity had been sufficiently accurate, the calculations would have converged and resulted in correct navigational solutions. However, DARTs primary GPS receiver consistently produced a measured velocity that was offset or 'biased' about 0.6 meters per second from what it should have been.

Later in the report is this statement:

> Correction of the *units conversion error* [emphasis mine] in the simulation math model described earlier led to a lowering of the gains setting to improve the expected proximity operations performance based on mission simulations.

This is a very, very, roundabout admission that a unit conversion error was central to the failure. The error is "about" 0.6 meters according to the report. This is 600 mm. The simplest apparent explanation for the bias is that the software had a conversion error between feet and meters. The GPS system is meter based. Its software would expect meters. A meter is 1000 mm, and a foot is 304.8 mm with a difference of 695.2 mm or "about" 0.6 meters. The release of the full report would shed light on the possibility that a second space mission was terminated because of the lack of the metric system in the US.

The UK publication *New Scientist* stated on June 22, 2009, without reservation, that a foot to meter conversion was responsible for the DART mission failure:

> Before DARTs launch, NASA found that GPS data on its position was mistakenly being read by its computer in feet. Ironically, correcting this to metres in a simulator resulted in an incorrect change to another parameter that was programmed into the spacecraft – a problem that led to the collision.

It would appear that the embarrassment of the Mars Climate Orbiter fiasco had taught NASA to obscure any further metric muddles which related to spacecraft mission failure. Rather than face the lack-of-metric problem and reform their agency, NASA instead chose the status quo, obfuscation, and denial.

In light of the Mars Climate Orbiter and DART mission failures, it is quite ironic that the navigation system used by the Apollo spacecraft was all in metric.[4] The data internal to the computer was entirely metric. Only at the end of the navigational computation was another possible error introduced, and precious computer memory wasted, by converting the metric values to pre-metric medieval units for display.[2]

The same year that the Mars Climate Orbiter incident occurred, a metric Olde English conversion confusion cost eight people their lives. In April of 1999, about four months before the Mars Climate Orbiter debacle, Korean Airlines KE6316 crashed over a confusion between meters and feet. The cargo flight was to take off from Shanghai China for Seoul South Korea. The Chinese controllers told the aircraft to initially climb to 900 meters after take-off. During their ascent, the first officer contacted Shanghai Departure and received clearance to climb to 1500 meters. Internationally feet are generally used to designate altitude, and the first officer became confused and convinced himself that the plane had been authorized to fly at 1500 feet. The pilot requested confirmation, and twice the first officer stated the plane should be at 1500 feet, and was 3000 feet too high.

The pilot then quickly sent the plane into a steep decent. Both the pilot and first officer tried to pull the plane out of the dive it was now

[2]This practice continues to this day in the US. The GPS System is entirely metric. The metric values are converted to miles and yards for display to the American Public.

in, but failed. The airplane crashed into an industrial development zone 10 Kilometers southwest of the airport. Three crew members, and five people on the ground, died from the impact; 40 more were injured. The Mars Climate Orbiter failure was widely reported at the time. Despite the fact that people died, and were injured in the KE6316 crash, and only hardware was destroyed in the Mars Climate Orbiter crash, the loss of KE6316 is generally lost to metric history.

Metric system discourse disappeared into blackness during the 1980s and 1990s. However, for a single brief moment, the lightning bolt of the Mars Climate Orbiter crash publicly illuminated the metric problem in the US, which had been there in the darkness all along. Like a blinding flash of lightning, it illuminated the toxic measurement landscape momentarily, and then blackness engulfed the terrain once again. Metric discourse in the US media then receded back into non-existence.

References

[1] *USMA Newsletter* Vol. 17 No. 4 pp. 1-2

[2] *The Toledo Blade* "A Few Meters Shy" July 29, 1994 page 10

[3] Milstein, Michael, ' *Air & Space* 'Commentary: Metric Mayhem," March, 2001 http://www.airspacemag.com/flight-today/mayhem.html

[4] *Metric Today*"'Apollo's Metric Moon Landings." Vol. 44 No. 3 May–June 2009 page 2