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Time balls and standard time in Australia

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Abstract

Australia moved to standard time at midnight on 31 January 1895. Great Britain had begun the idea of the same time across a country, but this idea was unsuitable for countries with a greater spread in longitude. Instead, the United States and Canada introduced zone time to simplify the considerable number of separate times that were in use in North America. The successful introduction there led to an international conference in 1884 that established the meridian of Greenwich Observatory as the origin of all time zones. A number of intercontinental conferences in Australia took up the idea and the governments of the various colonies were advised on the introduction of standard time. A few years after its introduction, the simple scheme of three one-hour time zones across the continent was altered with South Australia moving to a time only half an hour behind the eastern colonies.

Introduction

On 1 February 1895, the time ball on top of Sydney Observatory (Figure 1) dropped five minutes late according to Sydney time. This was not an error necessitating the usual procedure of raising the ball to half-mast for 15 minutes and circulating apologetic notices to newspapers (Anon., 1908). Instead, Sydney, along with the whole of the continent, had switched on that date to standard time, a system in which the country was divided into three zones of longitude, each keeping a time separated from the next zone by one hour. This necessitated clocks in Sydney being put back by the five minutes, explaining the apparent lateness of the time ball.

In the early days of European settlement, there was no need for a uniform system of time, in Australia or anywhere else in the world. Until the end of the 18th century, towns and localities kept their own local time. Only a few people travelled and those who did travelled slowly on foot, by horse-drawn carriage or on sailing ships. This slow travel allowed plenty of opportunity to change the time on the pocket watches or carriage clocks that travellers carried with them.

Figure 1: Sydney Observatory with its time ball in the late 1870s or early 1880s. Collection Nick Lomb.

In the following century, the advent of faster travel on trains and faster communication through the electric telegraph led to a major change in the situation. Separate times at each station on the train line became a nuisance, not just for the railway

companies, but also for their passengers. Although the changes in time were also disturbing for telegraph operators, it was the telegraph that led to the solution. Using the telegraph lines, astronomical observatories, such as Sydney Observatory, could distribute accurate time over a wide region.

In this paper, I look at how standard time came to be introduced in Australia. First, though, I examine its beginnings in the United Kingdom and, a little later, in North America. Then, before discussing the experience in Australia, I consider the important 1884 conference held in Washington, DC, that decided on the Greenwich Observatory as providing the Prime Meridian, the origin for all time systems internationally.

The beginnings of standard time

The first country to move towards a standard, uniform time was Great Britain. There, public passenger trains began running in 1825, while the electric telegraph began operating in 1843 (Howse, 1980). The railway companies simplified matters for themselves by switching to London time even before the availability of the telegraph, using clocks carried on the trains to set the times on station clocks.

Figure 2: Greenwich Observatory with its red time ball in 2005. Photo Nick Lomb.

Greenwich Observatory (Figure 2) started distributing time from 1833 through its time ball that was dropped down a post at 1 pm each day. Obviously, the time ball could only be seen from a limited area surrounding the Observatory, so three years later an Observatory employee, John Henry Belville, began calling on London chronometer makers, who often displayed time in their shop windows, with a watch set to Greenwich Mean Time (GMT). Famously, this service was continued after Belville's death by his widow, and later by his daughter until the 1930s.

Railway companies wanted Greenwich Observatory to supply them with time signals. To do this, in 1852, the Astronomer Royal, George Airy (1801–1892), ordered an electric clock from the clockmaker Charles Shepherd. This clock was to control a number of slave clocks throughout the Observatory and a large clock at the gate, trigger the dropping of the time ball at 1 pm, as well as sending an hourly time signal to various railway companies. Soon many towns had also switched from local time: by 1855, 98 per cent of public clocks in Great Britain were set to GMT. However, it was only in August 1880 that GMT was legislated as the legal time in the country.

The United States and Canada both faced similar challenges to Britain with the development of trains and telegraphic communication. However, in North America, the situation was complicated by the much greater longitude spread of the two countries; whichever town's or observatory's time was chosen as the standard, there would many places far away (east or west) that would need unacceptable adjustments of several hours from local time.

From 1834, US railways adopted a single time for each line; that was the time indicated by the station clocks. This adopted time was that of a major city serviced by the line (Bartky, 1989). There were a number of suggestions of introducing a zone system so that the time would be the same within each zone with a one-hour jump between zones. The railway companies initially dismissed these suggestions as unnecessary for timetable and safety considerations.

In the end, it was a scientific event and a scientist that helped to establish the zone time system in the US. The event was a bright Aurora Borealis on 7 April 1874 and the scientist was Cleveland Abbe (1838–1916), who was chief meteorologist at the US Signal Service (Willis and Hooke, 2006). Abbe received observations of the aurora but the times of observations were discordant, as the observers used their local railway times (Bartky, 1989). This led Abbe to an interest in standard time. In 1879, as chairman of American Metrological Society's (AMS's) committee on standard time, Abbe published a report on the subject. In this he pointed out that there were 75 separate times being used by the railroads and suggested that these should be simplified to no more than five time zones. These were to be known as "Railway and Telegraph time."

In the same year, 1879, the Canadian railway engineer Sandford Fleming (1827–1915) also wrote a report on standard time (Creet, 1998). That report was submitted to the Canadian governor-general, who forwarded it to the Colonial Office in London. As the two reports were similar — not just recommending the adoption of standard time in North America but throughout the whole globe — the two authors joined forces. While Abbe worked through the AMS, Fleming was involved with the American Society of Civil Engineers, for which, in 1881, he became chairman of its standing committee on time (Bartky, 1989).

Progress slowed for a while because the directors of observatories providing time to the railways were not in agreement. Some were in favour of having just one time zone for the whole of the country, while others wanted zones separated by one hour. Consensus was eventually achieved for the second proposal. A remaining question was which meridian to select as the basis of the time zones. Although, as yet, there was no necessity to use the Greenwich meridian, that was selected by the railways, possibly to avoid intercity rivalry. Success then came quickly and most of the railroads switched to standard time on 18 November 1883, with a smooth transition and no accidents.

Over the next few years, railway time was adopted as the official time in a number of US states. However, standard time did not become official in the United States until March 1918, when it was passed by Congress as part of an Act introducing daylight saving (Library of Congress, n.d.).

For Abbe and Fleming, arranging standard time in North America was not enough; they wanted to spread it over the globe. With the support of scientific groups, they appealed to the US Congress to organise an international conference to discuss the location of the prime meridian, the longitude from which all other time was to be measured. This conference was duly held in Washington, DC, in October 1884.

The International Meridian Conference

The International Meridian Conference was held at the Diplomatic Hall of the State Department in Washington, DC, com-

mencing on 1 October 1884 (Various, 1884). There were 27 countries represented, some with multiple delegates, so that there were 42 delegates. Cleveland Abbe was one of the five US delegates, while Sandford Fleming represented Canada but as part of the delegation from Great Britain. The delegates, all male, as to be expected at that period, are shown on Figure 3.

Figure 3: Group photo of the participants in the 1884 Prime Meridian Conference in Washington. Cleveland Abbe is near the top left, partially obscured by white-bearded Lewis Rutherfurd of the United States. Jules Janssen from France strikes a dramatic pose near the front in the middle. Sanford Fleming is not in the photograph. Courtesy Architekturmuseum der TU Berlin. Colourised image.

It was a significant meeting, as it not only set the prime meridian but the basics of the time system that is still followed today. The first and most critical issue was determining the prime longitude, which is the longitude from which all other longitudes were to be measured. Various British and American speakers explained that the prime meridian should be located at an observatory with a transit instrument that could determine accurate time. The observatory also needed to be able to communicate via the telegraph. Other observatories could then determine their accurate longitude by comparing their observed time with the observatory on the prime meridian. Possible choices were given as the "... great observatories of Paris, Berlin, Greenwich, and Washington."

For the sake of economy and convenience, the suggested choice between them was to be based on which one was in most widespread use. That was clearly Greenwich. Figures from Sandford Fleming were quoted that "... more than 70 per cent of all the shipping of the world uses this meridian for purposes of navigation." By using the meridian, it was meant that the ships' navigational charts were based on it. These navigational charts covered the whole globe, and the replacement of the plates used to print them was estimated to cost tens of millions of dollars. Later, Fleming himself elaborated on the statistics for ships. He provided a detailed table indicating the meridians used by ships of all kinds. The table showed that 37,663 ships with a total tonnage of 14,600,972 used the Greenwich meridian, equating to 65% of ships and 72% of tonnage.

These seemed to be convincing arguments in favour of Greenwich. However, the French delegates were unimpressed; they insisted on a "neutral meridian" based on an island or other geographical feature. In particular, they mentioned the island archipelago of the Azores, in the North Atlantic Ocean. One of the French delegates, the famous astronomer and observatory director, Jules Janssen (1824–1907), said that they admitted that the majority of the world's shipping navigated by British charts, but, if it became compulsory to use only those, then

> ... (the common meridian), which by nature is of a purely scientific nature, and to which we would assume a long and certain future, will become the object of

burning competition and jealousy among nations.

When the location of the prime meridian finally came up for a vote, there were 21 nations in favour of Greenwich, two abstentions — Brazil and France — and one against, San Domingo. The Spanish representative was absent from the vote due to illness and subsequently asked for his country to be added to those in favour. Although it is no longer a working research observatory, current visitors to the Royal Observatory, Greenwich, can see the prime meridian line delineated and highlighted, as shown on Figure 4.

Figure 4: The prime meridian line at Greenwich Observatory in late 1975 or 1976. Since then, the brass strip has been replaced by stainless steel and at night there is a green laser shining from inside, marking the meridian in the London night sky. Photo Nick Lomb.

After this clear result in favour of Greenwich as the prime meridian, the next issue to be debated was a seemingly trivial one. Longitudes were to be counted from Greenwich, but should they be counted from 0° to 360° or east or west of Greenwich? Those in favour of the second alternative argued that for a place near Greenwich it is more convenient to say it is a few degrees west than to say it is 350° and some degrees east. More profoundly, it was argued that with counting to 360°, the break in the system would come awkwardly at Greenwich, while counting to plus minus 180° would put the break in the longitudes in the remote (to them) Pacific Ocean. On this issue, Sandford Fleming broke with other members of the British delegation by recommending that longitudes be counted 0° to 360°. He claimed that this would assist with the adoption of a universal day and universal time, which were to be discussed afterwards. Fleming's arguments were rejected.

When the vote was taken, it favoured counting longitudes east and west of Greenwich by 14 for, five noes, and six abstentions, including France. In effect, this decision established the International Date Line, which is well-known to Australians travelling to or from the west coast of the United States. As they cross the line, they gain or lose a day.

Subsequently, the conference accepted resolutions setting up a universal day, starting at midnight on the prime meridian and counted from 0 to 24 hours. Although starting from midnight seems obvious, it was not at the time as astronomers counted time from noon to avoid a change of date during the night. As will be discussed later, establishing a universal day and universal time were far-sighted decisions that are of

crucial importance to our modern times with instant communication around the world.

Adoption of standard time in Australia

By the late 19th century, the Australian colonies generally kept the time of their capital city throughout their own colony. That meant that there were no inconvenient changing times when travelling outside the city. The only people having to change times on their pocket watches were those who moved between colonies. For example, rail travellers from Sydney to Melbourne had to put their watches back by 25 minutes at Albury, on the border between the two colonies. However, this was only a slight inconvenience compared to having to change trains at the same station (Ryan, 2017).

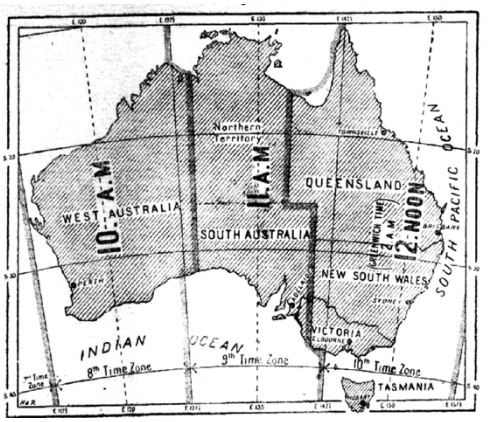

Figure 5: The standard time zones as established in 1895. From the *Daily Telegraph* 31 January 1895, page 5.

The push to move to standard time did not come from the railways but from gatherings of professional men. An early mention was at the Intercontinental Conference of Surveyors at Melbourne in November 1892 (Anon., 1892). There, a simple system was proposed that would see the legal standard of time for NSW, Tasmania, Victoria and Queensland be taken from the time at the longitude of 150° east of Greenwich. Similarly, South Australian time would be based on the 135th meridian and Western Australian time on the 120th. It was felt that "… every traveller would support such a change." Figure 5 shows how the continent was to be divided up into time zones. The South Australian Government Astronomer Charles Todd (1826–1910) dissented and wanted time for the whole of Australia to be based on the 150th meridian. That would have meant that people in Western Australia were two hours out of step with their local time, and was not accepted by the conference.

Standard time was next raised at the Postal and Telegraphic Conference held in Brisbane in March 1893 (Anon., 1893). Charles Todd, who was also postmaster-general for South Australia, again proposed one time for the whole of Australia. This time, though, it was for the time to be based on the 135th meridian that passed through South Australia. The consequence would have been that both on the east and west coasts of the continent, local time would differ from standard time by over an hour. Surprisingly, that proposal was accepted by the conference.

The acceptance of Todd's recommendation was reversed at the following Postal and Telegraphic Conference held in Auckland, New Zealand in March 1894 (Anon., 1894). This time, the conference accepted a proposal from the Queensland representative, Walter Horatio Wilson (1893–1902) to use, as had been previously suggested, the 150th, 135th and 120th meridians. For good measure, he also added the 165th meridian for New Zealand.

The idea of standard time was then in the hands of the politicians. Standard time legislation passed through the parliaments of the various Australian colonies with little opposition. The main objections came from the "Only two or three denizens of that home of lost causes the Victorian Legislative Council [who] opposed the Bill" (Davison, 1993, p. 73). There the Solicitor-General, Henry Cuthbert (1829–1907) introduced the Standard Time Bill on 16 January 1895 (Anon., 1895a). He explained that standard time was necessary as part of the move towards federation of the Australian colonies. As well, he referred to the Postal and Telegraphic conferences of 1893 and 1894, stating that the hour zone system was accepted at the latter meeting after much discussion.

One "denizen" claimed that "the Bill was a fad of a few scientific men," who were using the zone system as a temporary measure as they wanted the same time across the country. Further, that the railway timetables would have to be reprinted. Another complained that "people in Melbourne would have to get up 20 minutes earlier every day for the rest of their lives." Yet a third stated that "... the Government should avoid tinkering with what they did not understand." In reply, it was pointed out that railway timetables would remain the same and would not need to be reprinted. Reference was made to the Intercontinental Surveyors' Conference as supporting the zone system as it was of "value to Victoria from both the scientific and the practical point of view." As for the time difference of 20 minutes, time was wrong in all country districts, and it was not noticeable to the residents.

Despite the opposition, the Victorian Legislative Council agreed to the Bill without amendment. Consequently, the Governor gave his assent to the Act on 29 January 1895, just in time for its introduction three days later (Parliament of Victoria, 1895, p. 97).

On the assumption that the Act would be implemented in Melbourne, the government astronomers at Sydney and Melbourne were giving instructions and explanations of the new time system on the days before the change. Henry Chamberlain Russell (1836–1907) said that people in Sydney should put their clocks and watches back five minutes on the evening of Thursday 31 January 1895 (Russell, 1895). He noted that, "To be exact the change should be made at midnight ... but it will answer any purpose if the change is made late in the evening." Russell stressed that it was important to make the change, as all timetables of trains, trams and ferries would be changed by the same amount of time. Robert LJ Ellery (1827–1908) in Melbourne, gave a brief history of the introduction of standard time, referring back to the surveyor's conference of 1892 that he had chaired (Anon., 1895b). He explained that the time is the same for any meridian, so that the time zone of eastern Australia, based on the 150th meridian, also applied in New Guinea and in parts of Russia.[1]

In Melbourne, where the time had to be put forward by 20 minutes, the General Post Office clock was changed at midnight on 1 February 1895 (Anon., 1895c). To mark the occasion, it was illuminated, which it had not been for some time in the interest of economy. The change was also marked

1 Ellery mentioned Kamchatka, but today it is Vladivostok that keeps a time 10 hours ahead of Greenwich, that is, time based on the 150th meridian.

at Williamstown, Melbourne's old seaport, by the dropping of the time ball (Figure 6), not just at the usual 1 pm, but also at 9 am and 5 pm. In association with the time ball drops, a Victorian naval boat fired a gun 30 seconds before each drop. A consequence of the switch to standard time was that the arrival and departure times of intercolonial trains had to be altered in Melbourne. For example, the Sydney express was due to arrive at 12:09 pm instead of 11:34 am.

Figure 6: The Williamstown time ball in 2011. Photo Nick Lomb.

South Australian time shift

Although the adoption of the three standard time zones went smoothly, there were soon rumblings of discontent from South Australia. The Chamber of Commerce started urging a change to the time in the colony from July 1897 (Anon., 1898a). The objection was that by being one hour behind the time of New South Wales and Victoria "... the trading community [has been placed] at a decided disadvantage as against their neighbours ...". It was pointed out that before the change to standard time in 1895, South Australia had only been 35 minutes behind Victorian time. A return to that position was considered to be advantageous to the colony.

These objections were accepted by the Government, which drew up a Bill to move the time in the colony forward by half a n hour, putting it only half an hour behind the eastern states. There were dissenters. In a letter to the editor of *The Advertiser*, someone signing themselves Horologist (1898) explained that the zone time system was adopted as it simplified calculations. They said, "Alter the clock and you throw away the labor and skill of the scientific men who originated the time zone system ...". Similar arguments were raised in an editorial in *The Advertiser* on the day of the final debate in the House of Assembly (Anon., 1898b). The editorial suggested that the same advantage could be gained by opening places of business and similar establishments half an hour earlier.

At the final reading of the Bill in the House of Assembly, the Bill having already passed through the upper house, there was a vigorous discussion (Anon., 1898c). One spurious advantage mentioned was that as the Melbourne Cup was run at 3:30 pm, which was 2:30 pm in South Australia, the winner would be known there an hour ahead of the race. The speaker who cited the horse race, presumably tongue-in-cheek, said that "The Bill was a hanky-panky attempt to gain some advantage over the other colonies." A

number of speakers expressed resentment that Charles Todd's proposal for one time for Australia based on the 135th meridian passing through South Australia had not eventuated. As already noted, this proposal was made and accepted at the 1893 Postal and Telegraphic Conference, but rejected at the following meeting in 1894. The Bill was passed, and South Australia moved 30 minutes forward.

Discussion

Since 1898, the situation in Australia has been that the eastern states base their time on the 150th meridian, 10 hours ahead of Greenwich; South Australia and the Northern Territory are based on a meridian 142½° east, making them 9½ hours[2] ahead of Greenwich; Western Australian time is based on the 120th meridian, 8 hours ahead of Greenwich. As discussed, the situation was the result of serious and complex discussions and deliberations at a series of conferences, the recommendations of which impacted government policy, internationally and locally. These conferences included the 1884 Prime Meridian conference held in Washington, DC, the surveyor's conference held in Melbourne in 1892, and the two intercolonial postal conferences held in 1893 and 1894.

Today, it is not only the half-an-hour South Australian zone that deviates from the original scheme of three one-hour time zones covering Australia. Daylight saving has been introduced in a number of states, but not in those that extend towards the tropics: Queensland, Northern Territory and Western Australia. Daylight saving was first introduced during World War I and then repeated for three summers during World War II (Communities and Justice, 2022). It was reintroduced in 1971 and seemed to have become popular, since at a 1976 referendum in NSW there was 68 per cent support. With daylight saving, there are five separate time zones in Australia during the summer months.

The scientists and other professionals who introduced standard time to Australia were concerned about intercolonial (now interstate) train trips and telegraphic communication. They would not have dreamt of the number of instantaneous communications in the modern world that would be almost impossible without time zones. These communications include phone conversations, text messages and Zoom conferences, not just between Australian states, but with the entire world. Without zone time, these communications would be difficult or impossible to negotiate and arrange. Interstate travel can now be far quicker with aircraft than with trains as in the late 19th century. Zone time reduces the chance of confusion about timetables and helps reduce the chance of accidents.

Our civic time is based on the Universal Time (UT), decided upon at the Prime Meridian Conference in 1884. Local time is Universal Time plus the integer number of hours (or half hours) equivalent to the appropriate standard meridian. As the Earth's spinning is gradually slowing down, it no longer meets the nanosecond accuracy required by today's navigation, communications and scientific systems. This has led to a more precise definition of UT as Universal

2 The author often has had to calculate time of astronomical events in South Australia and in the Northern Territory for the annual *Australasian Sky Guide*. He can attest that the half hour zone adds an annoying complexity to calculations.

Coordinated Time (UTC) (Astronomical Applications Department, n.d.). UTC is based on time from atomic clocks, but leap seconds are occasionally inserted to ensure that there is no more than 0.9-seconds difference to the time from the Earth's rotation.

Although the present system has been in operation for decades, the operators of critical infrastructure such as global navigation systems, like GPS, find the discontinuity caused by leap seconds to be increasingly problematic. Hence, the international General Conference on Weights and Measures at its 2022 meeting in Versailles decided by the year 2035 to greatly increase the allowed difference between the time from atomic clocks and the time from the Earth's rotation (The General Conference on Weights and Measures, 2022). Thus, the link between our civic time and the spin of the Earth that has existed since the beginning of human history will be greatly lessened in the near future.

Despite the modifications to the time zone system and the changes to the way time is defined and measured, the introduction of standard time by the Australian colonies in 1895 has become increasingly useful and necessary in the 21st century.

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