Acta Polytechnica **64**(3):182–193, 2024
https://doi.org/10.14311/AP.2024.64.0182

Published by the Czech Technical University in Prague

THE DECIMALISATION OF REPUBLICAN TIME. THE FRENCH REVOLUTION WHICH FAILED (1793–1795)

Michael Dudzik

Charles University, Faculty of Arts, Institute of Economic and Social History, nám. Jana Palacha, 116 38 Prague, Czech Republic

correspondence: dudzikm@ff.cuni.cz

Abstract. The French Revolution is rightly regarded as a major milestone in human history. Its most famous ideas of equality and freedom have endured up to the present day, but these were not the only ideas promoted during this turbulent time. In order to establish a new social order, the revolutionaries proposed, among other things, the use of decimal time which was part of the so-called Republican calendar. This chapter will focus on the circumstances of the creation, application, and the use of the decimal (time) system, analyse the reaction of society, and explain the reasons for the early demise of this revolutionary undertaking.

Keywords: History of Technology, France, French Revolution, Republican Time, Republican calendar, Decimal (time) system, Ancien regime, 18th century, 19th century.

1. Introduction

The Enlightenment of the 18th century contributed to the destruction of the prevailing worldviews, promoting new ways of thinking about man and human rights. The pressure to make all the three estates equal led the old regime of the French monarchy to collapse and to the establishment of a new, liberal government seeking to implement all the benefits of Enlightenment philosophy. The radicalisation of the political landscape due to external and internal events went hand in hand with novel ways severing all ties with the previous regime and binding citizens to the new one.

Nevertheless, democratic ideas soon gave way to a pro-government ideology whose main principle was to eliminate all inequalities in the society. Once the people were equal, it was the turn of the many units of measurements and weights used across the kingdom, which were a major impediment to trade. It wasn't easy to find a solution, but in the end, a decimal system was adopted due to its simplicity and ease of conversion. For this reason, the parliamentarians decided to apply a decimal system to other areas that were integral to civic life – months, weeks, days, and the time.

The topic of this chapter, the introduction of decimal time derived from traditional time, was part of a package of changes introduced in the autumn of 1793. The centuries-old tradition of recording calendar months, weeks and days did not escape the process of unification. They were all given their own names, the number of days in each month and each week was changed, and the annual cycle was completely reinterpreted so that it bore no resemblance to the now obsolete Gregorian calendar. It was a thorny path to the adoption of this Republican calendar (so-named because it was adopted during the French Republic), which was lined with lengthy speeches and terms that were carefully constructed so as to celebrate the country's agricultural tradition as much as possible.

Many papers have been written on the calendar, some of merit, some less so. Most of these focus on the same thing, and as such this chapter only looks at the most up-to-date and well-considered works, which shed a new light on the matter. Sanja Perovic [1] and Matthew Shaw [2], for example, note the history of calendars and the formation of the final version of the Republican one, something that a paper by Jan Orel [3] also provides information of note on, despite its brevity. Nor should we overlook the debates of the time that led to the approval of the calendar [4, tome 74]. In order to understand the new format, dates had to be converted from the Republican [5] to the Gregorian calendar; the same approach was used for the conversion of currencies, such as the old livre [6] and the new franc [7].

The calendar included a change in the recording of time as evidence of a definitive end to the old ways. The previous duodecimal system was to be replaced by a decimal system, which now prevailed in other areas of human life. The process of decimalisation, its introduction, the response of citizens, and post-revolutionary returns to the idea are no longer frequent topics in papers today. While decimal time was an important addition to the Republican calendar, few authors have emphasised it, let alone produced works of merit on the issue.

Even so, some authors have undertaken thorough investigations of the matter and produced studies that remain of value today. For example, Richard Carrigan [8], who described the introduction of decimal time, together with Louis Marquet [9], outlined the way in which the government endeavoured to impose

Republican time on the people. Conference proceedings on the perception and recording of time in modern France were equally useful [10]. Time in its decimal form, however, was not just a feature of the French Revolution, as it also appeared in many proposals by scientists and enthusiasts in the second half and at the end of the 19th century, which is summarised by Hector Vera [11]. One well-known proponent [12] of decimal time stands out for his contributions on the subject and must be noted as the last champion for this transformation in recording the passing of the day.

The chapter makes use of deduction, as it illuminates how parliamentary debates led to the establishment of the calendar in the form of a law, while induction and a direct method trace how the government used its articles to implement changes to civic life. A progressive method takes a closer look at the means by which the government sought to bring decimal time into the public domain and why the role of watchmakers was indispensable in the production of timepieces using decimal dials.

The objective of the chapter is to show that the revolution didn't just take place at a political and societal level, but also affected the social and cultural sphere in order to erase everything that was old, replacing it with a new order that did not resemble the previous one in even the slightest way. The result of decimalisation, however, was not always met favourably by the people. The reason why neither the Republican time nor its calendar succeeded stems from the latent connection between the society and the tradition and the fragile nature of both these projects, which could not withstand the onset of the new regime.

2. Establishing a new social order

The end of the 18th century heralded the end of an era whose political, economic, and social climate exposed the weaknesses of the ossified *ancien régime*.[1] In the heady atmosphere of the revolution, the new government of the people abolished the privileges of the first and second estates, declared French subjects to be equal citizens before the law and set up a new administrative division for the country comprising 83 departments. As part of the ongoing standardisation process, the ruling class and the greatest scholars of the time decided to completely transform France's traditional way of life and its established order.

The revolution unfolded at three levels: commercial, economic and in terms of time. The creation of the French departments did not prevent the use of a huge variety of different units of weights and measures, yet this usage did not fit in with the new regime's policy, which sought to substantially reduce their number. What was behind this decision? First of all, it was based on the demand that *"the upper class no longer utilise their own measures based on their estates and that an unchanging measure should be established"* [14, p. 82]. The use of different units was a disruption to both international and domestic trade and as such, the government promised that it *"will continue to endeavour to improve this system so as to expedite, simplify, and favour its use"* [3, p. 17].

One of the first proposals was that a duodecimal system should be used for all conversions between units, something that market vendors in particular would have no problem with when dividing goods into halves, thirds and quarters [15, p. 102]. The calendar also used a duodecimal system, as did clocks and the financial sector, where one livre equalled 20 sous, or 240 deniers. Nevertheless, on 8 May 1790, the Academy of Sciences was charged with the task of finding a more suitable method of division and, on 27 October, its commission announced that it had decided to use a decimal system [9, p. 51].

The French proposal to use a decimal system was not the first one in Europe, however. Dutch military engineer Simon Stevin (1548–1620), who came up with the concept of decimal fractions in 1585, is considered a pioneer in the field. There were then proposals to introduce a decimal system for weights in the Duchy of Bavaria (1578), for measures, volume, and currency in the Kingdom of England (1661), and for length in the French monarchy (1670) [16, pp. 3–6]. The justification for preferring this system was that it could be *"considered a kind of natural scale since human beings have ten fingers"* [15, p. 101].

This is also why the decimal system prevailed in the minds of scholars in terms of the organisation of the world at the time: after the metre became the default unit in March 1791, the Decree for Uniform Weights and Measures was passed[2] on the basis that *"it is most important for the progress of art and the human spirit that the variety, inconsistency, and imprecision of weights and measures, which continuously hinders industry and trade, be removed"* [4, tome 74, p. 550]. Although the same month saw the abolition of all the academies in the country, the project's gravity was also realised by the radical Montagnards, who ensured its continuity so that finally, on 7 April 1795, an act establishing the new decimal metric system could be passed, with the standard laid down in December 1799 and the order that it be used coming into effect on 23 September 1801 [16, pp. 13–20 and 24–29], [18, pp. 425–442 and 426–429], [3, pp. 19–30], [2, pp. 37–39].

The revolutionaries also applied a decimal system in their monetary reforms: on 24 August 1793, the livre now comprised ten *décimes* and a hundred *centimes* [17, tome 8, pp. 161–162], and on 15 August 1795 the livre was replaced by the franc [17, tome 8,

[1] The Revolution was born from *"the fragility and weakness of the royal power, the complex manifestations of social tension, material and economic difficulties and the anxieties of the lower social classes"* [13, p. 20].

[2] *"A new system of weights and measures based on the measurement of the Earth's meridian and decimal division will be uniformly used across the Republic."* [17, tome 6, p. 81]

pp. 267–268] with the same value, determined by an act [17, tome 8, pp. 176–177] of 28 March 1803.[3] The final area which remained to be freed from old regime's last vestiges was the perception of the seasons, weeks, days and even time itself. To this day, the calendar of 1793 remains the most well-known rearrangement of the annual cycle, but it was not the first to appear at the end of the 18$^{\text{th}}$ century. The French may have encountered two earlier calendars, each of which was issued under a different regime.

The first of these was proposed by essayist Sylvain Maréchal (1750–1803) in 1788. Although his calendar did contain twelve months, each of its months comprised three weeks of ten days; with five additional days added on the 31$^{\text{st}}$ of March, May, August, December, and January. The year began in March, the months were numbered consecutively, and the days randomly celebrated monarchs, scholars, ancient and modern philosophers, writers, artists, or sailors. The calendar was rejected mainly by the Church for whom *"the names of the saints were replaced with the names of the most renowned men of antiquity and modernity,* [and it therefore demanded] *that this scandalous and blasphemous work be condemned to the flames and the author branded a godless heathen".*[4]

The second, so-called Calendar of the French People (*Le Calendrier du peuple franc*), was created in 1793 by the Philanthropic Society and was dated from 1789, which it considered the beginning of the era of liberty. The year in this calendar was identical to that of the Gregorian calendar: it began in January and had the same number of days in each month as today's calendar. These were not in ascending order but were given their own name according to an event associated with them: January, for example, was renamed the month of Frost, May was the month of Greenery and December was the month of Trial, since it was during this month that the trial of King Louis XVI (1754–1793) was held. The authors justified the naming of individual days thus: *"The names of religious heroes must be rejected as dangerous, or at least unnecessary. We have deliberately excluded from our philosophical key those kings* [...] *whose virtues have been destroyed by the corruption surrounding their thrones."* [21, pp. 9–10. Months with descriptions of days are introduced on pages 25–37; they are followed by an index of listed names with a short description]. The calendar ended on 21 September 1792 with the abolition of the monarchy and the establishment of the republic, that marked the need for a new (celebratory) recording of the days.

Parliamentarian of the National Convention, Charles-Gilbert Romme (1750–1795), undertook the difficult task when he presented a report on his own calendar to Convention colleagues on 20 September 1793.[5] His project intended to mark the definitive end of the old regime and the severing of ties with the history of kings replaced by the revolution and alongside it the renewal of society. This culminated on 22 September 1792 *"at nine o'clock, eighteen minutes and thirty seconds in the morning when the sun reached the true autumn equinox and entered the sign of Libra"* [17, tome 8, p. 366]. It was on this day that the First French Republic was proclaimed, which with the equality of day and night also established *"civil and moral equality"* [22, p. 294].

These events were to be recorded in Romme's calendar, whose final form was adopted by Convention members on 24 November 1793 as the *Decree on the New Era, the beginning, and the organisation of the year and on the names of the days and months.* Although the calendar was approved fourteen months after the establishment of the Republic, it was decided that it would be backdated to 22 September 1792, the first day of the Republic. The seventh and eighth articles of the founding decree laid out the most important aspects:

"The year is divided into twelve equal months of thirty days each. The twelve months are followed by five days that complete the ordinary year and these are not part of any month. Each month is divided into three equal parts of ten days, which are called decades." [17, tome 8, p. 364; for the full text see tome 8, pp. 364–372].

The Republican calendar, as we call it nowadays, adopted some elements from both of its predecessors. The year always began on 22 September and had twelve months, thirty-six weeks, three hundred and sixty days, plus five additional days at its end (17–21 September); the leap year contained one extra day. Maréchal's division of the months into three weeks was accompanied by the poetic naming of the months and days taken from the *Calendar of the French People*, with each day referring to plants or minerals, the fifth day to animals and the tenth day to agricultural tools [22, pp. 296–297], [3, p. 6 and 11].

This imaginative nomenclature was developed under the supervision of Romme, Chairman of the Committee of Public Education (*Comité d'instruction publique*), in collaboration with various experts in the field: mathematicians Gaspard Monge (1746–1818) and Joseph-Louis Lagrange (1736–1813) helped with decimalisation, while astronomer Alexandre Pingré (1711–1796) offered his calculation of the equinoxes, chemist Bernard Guyton de Morveau (1737–1816), botanist André Thouin (1747–1824) and two poets André Chénier (1762–1794) and Fabre d'Eglantine (1750–1794) came up with names. The involvement

[3] For more about the French currency, see [19].

[4] The names of the months from March to February: princeps, alter, ter, quartile, quintile, sextile, septembre, octobre, novembre, décembre, undécembre and duodécembre. In addition to Elizabeth I (September 8), Charlemagne (January 18), René de Réaumur (October 18), Marcus Tullius Cicero (December 6), Voltaire (May 30), Francesco Petrarca (July 18), Michelangelo Buonarroti (March 6), or James Cook (February 14) also appeared on certain days [20, pp. 4–5].

[5] For the entire speech see [4, tome 74, pp. 549–557].

Autumn	Vendémiaire 22/9–21/10	Grape harvest	Brumaire 22/10–20/11	Mist	Frimaire 21/11–20/12	Frost
Winter	Nivôse 21/12–19/1	Snowy	Pluviôse 20/1–18/2	Rainy	Ventôse 19/2–20/3	Windy
Spring	Germinal 21/3–19/4	Germination	Floréal 20/4–19/5	Flower	Prairial 20/5–18/6	Meadow
Summer	Messidor 19/6–18/7	Harvest	Thermidor 19/7–17/8	Summer heat	Fructidor 18/7–16/9	Fruit

TABLE 1. The months in the Republican revolutionary calendar, alongside their dates and English translation [3, p. 12], [17, tome 6, pp. 364–365], [23, pp. 7–8].

of so many renowned figures only confirms the importance of the project and how much significance the revolutionaries attached to it.[6]

Romme's calendar aspired to be an agricultural calendar and the author of the nomenclature, d'Eglantine, explained why: *"Our first idea was to dedicate the calendar to agriculture so that the nation would return to it.* [...] *With the Republic, the time has come for the peasant farmer to be more esteemed than all the kings of the world."* [23, p. 6 and 13]. Even so, the revolutionary work did not come about without its difficulties: the greatest problems arose with the precise determination of the length of the year[7] and with the naming of the months, weeks and days: while advocates promoted names based on revolutionary events, their opponents wanted objective names so that the whole of Europe could adopt them.[8] The compromise that was reached was to name the days differently, with the years, months and weeks numbered in ascending order.

Although the calendar (Table 1) was adopted and actively used for several years, there was undeniable resistance. The rural population in particular objected most to the de facto abolition of the Christian Sunday as a day of rest that moved to the tenth day. The confusion of the population was reflected in mocking caricatures whose main figures were Mrs Sunday and Citizen Décadi (the tenth day) [2, pp. 83–85], but in the end, the rest period was doubled, and Republican and Christian holidays were celebrated at the same time. The main negative, however, remained dominant – the work ethic was collapsing because the people could not tolerate working nine days in a row [2, pp. 48–49 and 56], [26, pp. 247–248, 250, 252–253 and 255–257].

It wasn't too long before there was more criticism of the calendar: not only was it disrupting the prevailing way of life in line with the liturgical year, but it was also isolating France from neighbouring countries. Moreover, it could be claimed that *"it was not only non-religious, but also anti-Christian"* [3, p. 15]. A year after the fall of the Jacobins, supporters and opponents of the calendar clashed with each other once again in the Convention. The calendar was beginning to be regarded as a relic, especially after 15 July 1801 when the First Consul concluded a concordat with the Pope.[9] Mathematician and physicist Pierre-Simon Laplace (1749–1827) gave his last speech on the calendar on 9 September 1805:

"The greatest disadvantage of the calendar is in the confusion it causes to our neighbours, and our isolation in the middle of Europe [...] *The Gregorian calendar undoubtedly does have some serious flaws,* [...] *but it fulfils the main purpose of the calendar well in that it can easily be divided into days.* [...] *One might fear that the return of the old calendar would be followed by the reintroduction of the old measures,* [...] *but the government* [...] *is a long way from restoring the huge number of different measures which ranged across the territory of France and hindered her internal trade."*[10]

The Senate, which was debating the return to the Gregorian calendar, listened carefully to Laplace's speech and agreed that the empire would resume the

[6] Mathematician and astronomer Charles-Francois Dupuis (1742–1809) and professor of military engineering Claude-Joseph Ferry (1756–1845) also sat in the commission. The painter Jacques-Louis David (1748–1825) provided a graphic representation of each of the months [2, p. 41], [3, p. 8], [24, p. 304], [25, pp. 65–66 and 70–71].

[7] The calculations indicated that the year had 365.24 days, which did not exactly fit into the decimal system, or rather half of it [3, p. 4], [24, p. 314].

[8] The original names of the months were Republic, Unity, Brotherhood, Freedom, Justice, Equality, Revival, Session, Real tennis, Bastille, People, and Mountain (political grouping); in a similar patriotic way, the days of Equality, Cap, Cockade, Pike, Plow, Compasses, Sheaf, Cannon, Oak and Freedom was created [17, tome 8, p. 364], [23, pp. 9–10].

[9] After saying that no one in the countryside wanted to use the calendar and that the peasants could not work ten days in a row, the opponents were called ignorant. On the debate, see [25, pp. 83–85].

[10] For the entire speech, see [27].

use of the old calendar from 1 January 1806. The Republican dream of a patriotic method of recording the date never took hold again, and not even the brief period of the Paris Commune in 1871 was strong enough to bring back the calendar. Nevertheless, this audacious project still represents a fascinating contribution to French cultural and patriotic history to this day.

3. Decimalisation of time

The decimal system took hold wherever people wanted to use it – in markets and places associated with trade. The revolutionary calendar instead represented a major departure from the existing order of things: the abolition of Christian holidays, the introduction of additional (work)days and the rearrangement of the days and weeks in the month met with disfavour, yet most legislative acts and journals were dated using the new format. In the eyes of the increasingly radical Jacobins, there remained only one area of human life that was yet unaffected, and this was the one which was most unlikely to succumb to change – time itself.

There were two kinds of time: sexagesimal (base 60) and duodecimal (base 12), the use of which had been devised by the Babylonians and then the Egyptians.[11] As with the calendar, the introduction of the new time was a complex process, because people operated based on the sexagesimal clock.[12] A crack in the credibility of conventional time was created by French astronomer Jean Picard (1620–1682), who suggested, in 1671, that the swing of the seconds pendulum might not be the same everywhere on Earth. And when it was discovered that indeed *"the pendulum was not immutable, it lost its value as a universal time standard"* [16, p. 6] and society had to accept that *"there is no such thing as universal time"* [30].

The authority in resolving this issue was the French Academy of Sciences, to which *"many scientists turned in order to resolve this thorny problem,"*[13] and the Paris Observatory, which had supervised the correction of time by the stars and movement of the planets since the 1730s using a double-row grid to stabilise the pendulum [29, p. 116]. Due to their privilege of keeping track of time and determining its length, the astronomers became promoters of the decimal system for recording the time. The inclination towards decimalisation can be linked to the emergence of military and civilian engineering schools, whose curricula consisted largely of exact science and adherence to the use of mathematics, as well as to the dissemination of these ideas to the public through the renowned *Encyclopédie*, whose entry on *"decimal"* reads:

"It shall be highly desirable that all divisions, for example, of livre, sou, fathom, day, hours and so on be 10 to 10; this division will greatly simplify and facilitate calculation and shall be much more convenient than the arbitrary division of the livre into 20 sous, the sou into 12 deniers, the day into 24 hours, the hour into 60 minutes, and so on." [31, tome 4, pp. 669–670].

Towards the end of the *ancien régime*, voices calling for the decimalisation of time became increasingly frequent. Lawyer Claude Boniface Collignon (?–1819), for example, proposed in 1788 that *"day and night time should no longer be divided into 24 hours, but into 10 hours, and 1000 minutes, respectively, with each hour equal to 100 minutes, each minute to 1000 seconds and each second to 1000 thirds"* [32, p. 39; an overview of the calculations can be viewed on p. 159]. But it was almost impossible to propose decimal time before the revolution, since the clergy and nobility had had unlimited power over it: the priests adjusted the calendar, the church bells determined the daily rhythm, and the noblemen had the privilege of setting their own weights and measures on their own estates [11, p. 32].

The marginalisation of the first and second estate untied the hands of decimal time advocates, who, with the implementation of a decimal system for weights, measures, currency, and the calendar, saw its application to time as a logical progression. Mathematician Jean-Charles de Borda (1733–1799) presented his own solution to the variable second on 25 November 1792: instead of a 360-degree circle, he proposed using a circle of 400 degrees and introduced a pendulum able to make a hundred thousand oscillations per day in a semi-circle [9, pp. 51–52 and 55], [29, p. 157]. All that remained was to justify the confusion of the duodecimal division of the day, which Romme did in florid style on 20 September 1793:

"The arts and history, for which time is a necessary instrument, ask of you new measures of duration which will also be freed from the errors that credulity and superstitious routine have transmitted to us from through centuries of ignorance. [...] *The day was divided into twelve parts that were only equal to those of the night at the equinoxes. The 24 parts were then made equal, but the beginning of the day wasn't the same everywhere.* [...] *Their perfecting will be complete when time is subjected to the simple and general rule of decimal division."* [4, tome 74, pp. 550–552].

The speech favouring the decimalisation of the years, months, weeks, days, and time was met with a positive response: Gilbert Romme's commission, which included mathematicians and astronomers, heralded success and guaranteed the prestige of the project at the same time. Despite the Jacobins' hostility towards the academics, in the end, Romme got his way and Article 11 of the above *Decree on the New Era* of 24 November stipulated the following:

[11] The least common multiple of the first six consecutive numbers gave the Babylonians the number 60. The Egyptians observed 12 lunar cycles in one year, 12 stars in the night sky, or counted three links on the remaining four fingers with their thumb [28].

[12] The first mechanical clocks appeared in the 13th century [29].

[13] Along with the Gregorian calendar, time was also to be subjected to astronomical laws [30, p. 97].

"The day, from midnight to midnight, is divided into ten parts, or hours, every part into ten others, and so on until the smallest measurable duration. The hundredth part of the hour is called the decimal minute; the hundredth part of the minute is called the decimal second." [17, tome 8, p. 365].

The decree was set to take effect on 22 September 1794 so that citizens had time to get used to the change. In the meantime, the National Convention was endeavouring to find a way to make decimal time as familiar as possible to the people. The French people were to encounter it every day and ideally, always have it within sight, and as such the Convention decided to organise a competition between 9 February and 19 June 1794 to find the best way, or method, of converting the dials of clocks and watches to the decimal system [8, pp. 307–308], [10, p. 110], since the *"success of decimalisation of the day rested largely on the watchmakers who, by producing watches and pendulums could bring the new calculation of time into the daily lives of the French"* [34, p. 60]. One such decimal watch would then cost 15 sous (€ 7.75) [2, p. 79].

Competitors had to fit ten hours, one hundred minutes and one hundred seconds into the dial and apply this change to both new and redesigned timepieces. Once the competition ended, its committee of seven scholars and watchmakers and four alternates presented their report, stating that fourteen of the two hundred responses were worthy of note, and four contestants had won a financial reward, but none of them had received the prize because the committee members *"had found no design meeting the prescribed conditions"* [34, p. 60].[14]

The 4 December assessment offered a few conclusions for the successful implementation of decimal time in society: that five o'clock should be located in the upper half of the dial, corresponding to noon, when the sun is in the sky,[15] that each watch and clock should display just one time system so as to avoid confusion, that changing the mechanism would be easier than just changing the dial, and that it would be better to produce new timepieces rather than redesign current ones [9, p. 53]. The first decimal watches and clocks were produced according to these rules, but their manufacture was not easy at all.

First of all, the watchmakers had to adjust the appearance of the dials to decimal time, determine how many teeth the cogs needed in order that the timepiece movements resulted in exactly a hundred thousand oscillations (seconds) per day; they also had to use a pendulum that was 0.741887 metres long [9, p. 54–55]. Only artists using *"the simplest, most skilful, most accurate and most economical method"* [17, tome 8, p. 371] were able to meet all these criteria. New timepieces were gradually produced, with their number growing and their design differing since some had a dial with duodecimal time surrounded by a dial with decimal time, with the second hand either on the same dial as the hour and minute hand, or each on a separate dial.

Only a handful of watchmakers became known for the precision and decorativeness of their products, such as Pierre-Basile Lepaute (1750–1843), Robert Robin (1742–1809), Antide Janvier (1751–1835), and Louis Berthoud (1754–1813) [35]. The list of watchmakers involved is much larger [36] thanks to the fact that the government's one year old decision to mass-produce watches and clocks already bore fruit: on 11 November 1793, the Convention set up the so-called National Watch Factory (*Manufacture horlogère national*) in Besançon and appointed the Swiss Laurent Mégevand (1754–1814) director. The factory prospered (Figure 1), with the number of watchmakers increasing, and between 480 and 600 watch movements[16] being made during one ten-day decade [33].

All the measures taken by the French government, from the shift towards decimal time and the establishment of a clock and watch factory to the launch of the competition to introduce the new way of recording the day were to no avail, however, for *"the people were not familiar with the change to decimal time and there were also very few practical reasons to use it"* [33]. Mathematician Lagrange delivered another negative argument on 28 March 1794, half a year before the new time was due to come into force:

"In the measurement of time, the decimal system is much less important to the necessities of life than all other measurements, because, with the exception of astronomers, no one ever has to make large calculations for hours, minutes, and seconds. [...] *It may thus be said that the introduction of the decimal scale for measuring time is based more on convenience, simplicity and uniformity than on the basis of general utility."* [34, p. 60].

Regime change came into play again, with the post-Thermidorian regime endeavouring to get rid of its predecessor's accomplishments, including the changes to timekeeping. The final nail in the project's coffin came in a speech on 1 March 1795 given by one of the members of the Convention, Claude-Antoine Prieur-Duvernois de la Côte d'Or (1763–1832):

(1.) *"Since* [decimal] *division offers almost the whole nation no marked advantage, it would cast a bad light on the new system of measurement and the decimal system which are, in contrast, useful.*

(2.) *Because the counting of hours is not a purpose of trade nor subject to police regulations, the use of*

[14] More about the competition in [9, p. 53].

[15] *"The fifth hour should be at the top of the face and correspond to noon, and the tenth hour should be at the bottom of the face and should correspond to midnight."* [10, p. 110]

[16] Both men and women earned two livres (€ 20.77) a day and young men were exempt from military service [37, pp. 559–557]. From 80 watchmakers (August), the number rose to 400 (November 1793), 930 (March 1794) and 1629 (autumn 1794) [38, pp. 68–69].

Figure 1. Different kinds of decimal watches and clocks. French Revolutionary (Decimal) Time [33].

the former time would be restored by immense force of habit.

(3.) *This habit would be further strengthened by fear of ambiguity. In order to prevent this, we would need to adopt new names which have not yet been introduced and which would be very difficult to implement into everyday language, especially for people who do not write, never make calculations, and do not estimate time by any way other than common opinion.*

(4.) *The cost of replacing clocks would be huge.*

(5.) *And finally, citizens and watchmakers would have tremendous resistance to the time, because the former would have to have their watches replaced and the latter would lose the ability to sell those which are already made."* [39, p. 27].

Like Lagrange, he did not consider decimal time suitable for use by ordinary people, but rather for a closed group of scholars, astronomers and mathematicians and for their calculations. By the time de la Côte d'Or was summarising his findings, the Republican calendar was no longer the only enforced way of tracking the year and people were gradually reverting back to the Gregorian calendar and Christian holidays. The same loosening occurred with decimal time, whose proponents were either executed or had to go into hiding during the White Terror. The definitive end was the law of 7 April 1795, which established the decimal system for weights, measures, and currency, while paradoxically abolishing the one area where the system had originally been introduced but never practised:

"The provisions of the Act of 4 Frimaire, Year 2 [24 November 1793]*, which oblige the use of the decimal division of the day and its parts, is postponed indefinitely."* [17, tome 8, p. 91].

Decimal time existed (but was not applied) for exactly five hundred days, or a hundred and ninety-eight days since its intended introduction on 22 September 1794. The greatest pressure came from the burgeoning watchmaking industry facing a surplus of unsold sexagesimal timepieces. Another concern was the *"impossibility of replacing the millions of watches and clocks with the old division of time currently in use,"* [34, pp. 60–61] that would have involved exorbitant costs considering that the daily wage of a clockmaker in 1793 ranged between 2 and 18 livres (€ 20.77–€ 189.95) [37, p. 561], not to mention the modification of public clocks, the cost of which would have reached, for example, 300 francs (€ 1 627) per clock.[17]

Figure 2. A demonstration of clocks with decimal time (top), traditional time (bottom) and a Republican Day in the thirty-day month (middle left) [16, p. 23].

Clocks with a decimal or even a duodecimal system on one dial were still used even after the fall of the Jacobins (Figure 2). Toulouse City Council took an opposing path, still using the duodecimal time on

[17]The modification of the dial in 1799 concerned the clock in Toulouse [9, p. 56].

Part of the day	1/8	2/8	3/8	4/8	5/8	6/8	7/8	8/8
Hours	3	6	9	12	15	18	21	24
Dec. time [*cé*]	12.5	25	37.5	50	62.5	75	87.5	100

TABLE 2. Basic conversion to hundredths of a day, *cé*, to the segments or hours of our time, according to Rey-Pailhade.[18]

public clocks at the end of 1794 and replacing it with the decimal system at the beginning of 1795, only to change it back to the duodecimal system after three months of poor operation. It was then decided, in September 1798, that clocks would display both times, with the change ratified before the end of the millennium [9, p. 56]. In 1801, there were still decimal clocks at the Tuileries Palace in Paris, but it can generally be said that *"decimal time was otherwise ignored"* [29, p. 157].

4. Attempts at re-establishing decimal time in the 19th century

All the ideas of introducing decimal time in the 18th century came to nothing, but that did not mean that they were forgotten forever. Human society returned to the idea of easily calculable time six decades later when, in 1856, the Liverpool watchmaker Richard Dover Statter objected to the dual 12-hour format by which the ignorant would complicatedly determine the morning or afternoon hour, and proposed dividing the day into ten hours, one thousand minutes and one hundred thousand seconds and perform the adequate calculations instead.[19] Although Richard Goodridge also took a similar position, the greatest weakness of the decimal system, in his view, was the limited number of divisors, and hence *"decimal notation is a mistake and can be modified, and the sooner the better"*.[20]

Advocates of decimal time increased in number in the second half of the 19th century especially, when *"railways and the telegraph condensed time and space, creating the need for a uniform time standard"* [11, p. 38]. At first, it was thought that each state would follow the time used in its capital city, but this risked *"each state having a different standard, because the time of the second pendulum would depend on the strength of gravity"* [40, pp. 18–19] according to the nation's location. This problem was looked at by academics in France (1870), the United States (1879 and 1884) and in Italy (1883) [35], [11, p. 37 and 39–40]. The most interesting debate, however, took place at the Sixth International Geographical Conference in 1895.

[18]For an overview and method of converting traditional time to decimal and back see [12, pp. 20–23].

[19]Statter argues that it is easy to get confused when converting one new hour to 144 old minutes, a new minute to 1.44 old minutes and a new second to 0.864 old seconds. For more see [40, pp. 5–25].

[20]While ten is divisible only by two and five, twelve is divisible by two, three, four and six [41].

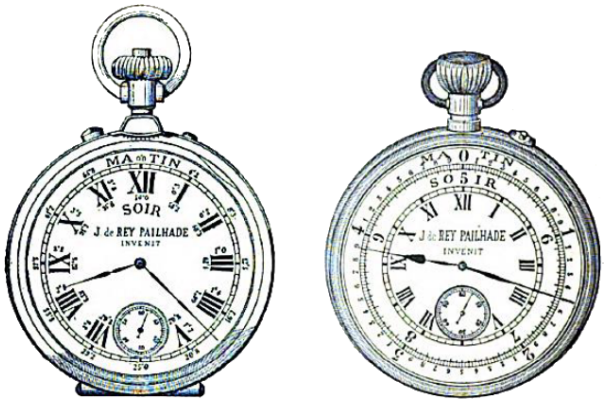

FIGURE 3. Examples of a decimal watch with a duodecimal dial and conversion to decimal minutes (left) and a watch with an inner duodecimal and outer decimal dial with minutes and hours (one for morning, the other for evening), with the hands showing two different times simultaneously [42, p. 24].

The most ardent advocate of decimal time in the 19th century, Joseph-Charles-François de Rey-Pailhade (1850–1934), Chair of the Geographical Society of Toulouse, Committee for the Dissemination of Decimal Methods, and member of other academic societies, gave a speech at the conference [43]. His praiseworthy tirelessness in promoting the decimal system and the number of papers and speeches [44, pp. 429–457] mentioning its advantages with his method for calculating sections of the day are today legendary, not to mention his thorough archival research on the use of decimal time in human history, with a focus on France in 1793 and 1794 [45, pp. 34–37 and 51–56].

Rey-Pailhade's basic unit was the *cé* (short for *centijour*), representing a hundredth of a day, equivalent to 14.4 minutes or 864 seconds of traditional time; the smaller units were called *décicé*, *centicé*, *millicé* and *dimicé* (Table 2). The mining engineer derived the *cé* from the 100-degree circle created during the French Revolution and also presented the method of calculating it. According to him, it was convenient to express in a single number the time of day when, for example, a person got up, eliminating the need to state whether it was morning or afternoon. Despite the engineer's claim that *"the calculation is simple and not subject to errors,"* [42, p. 11] inaccuracies arose in the rather complex conversion of times, this likely being one of the reasons for the failure of the project as a whole.

Henri de Sarrauton (1846–1922), in contrast, proposed maintaining a 24-hour day, but that the hours should be divided into one hundred minutes and these

then into one hundred seconds. A. J. Mettler, advocated the introduction of the so-called scheduling unit standing between the decimal hour and its decimal minute, which divided the day into one hundred parts [42, p. 24], and also a new nomenclature: *chrona* (hour), *decichrona* (scheduling unit), *centichrona* (minute) and *rema* (second). Joaquín de Mendizábal y Tamborel (1852–1926) proposed a more radical project, aiming to introduce a new unit called the *tropo* (star day) with the subunits of *deci-*, *centi-* and *microtropo* used to record time in a completely different manner to anything used before. None of the proposals impressed the audience, however, and thus they were not approved.[21]

The final proposals for the use of decimal time were made in the home of its adoption, France. In 1897, the Commission for the Decimalisation of Time (*Commission de Décimalisation du Temps*) was formed. It sought to set 24 hours in a day, each of which would have 100 minutes and 10 000 seconds. Two years later, members of parliament Paul Gouzy (1833–1919) and Marcel Delaune (1855–1927) introduced a bill along the same lines [9, p. 56], [11, pp. 43–44], [46], but again it did not meet with much support and it also marked the end to a number of interesting, but rather impractical ideas about decimal time. At the same time, it represents the last of the serious attempts to legislate the use of decimal time.

From today's perspective, decimal time seems to symbolise a system used by rather *"the intelligentsia"* [41] in the academies and learned societies, whose principles were applied in astronomical calculations, by sailors in determining their position at sea, and by cartographers in creating maps [40, p. 14], [44, pp. 432–433], [42, p. 10]. Some people have even toyed with the idea *"that there might be two ways of counting: the duodecimal system for the general public, and then the decimal system for astronomers"* [10, p. 111]. Fortunately, this did not catch on, as the use of dual time would have divided society and led to confusion between nations, at least in terms of knowledge transfer. By keeping one time, the French did not isolate themselves from other states and could continue to participate with other nations in shaping and directing human history.

5. Conclusion

The introduction of decimal time, which was a part of the Republican calendar, represented a difficult process that depended on the political situation in France. The tendency to change the recording of the year, months, weeks, and days had appeared just before the Revolution but could not be implemented for certain reasons. The clergy, together with the nobility, had the power to control the lives of their subjects and they rejected any deviation from the established order of things. The change came with the fall of the *ancien régime* and the suppression of the first two estates in favour of a third, which adopted a policy of destroying the old and establishing the new.

The Revolution brought with it the familiar privileges in the political, legislative, and social spheres; but there were still areas where the spirit of the old regime prevailed – a system of units of measurement and weight, which varied from region to region. The abolition of the noble privileges that determined the values of the units used opened the path to their unification according to the revolutionary idea of all-embracing uniformity. The responsibility for finding a new way of converting currency, weights and measures was taken up by scholars from the Academy of Sciences, who proposed the use of a uniform decimal system.

The advantage of reducing the huge number of units of measurement and weight was not only recognised by members of parliament, but also by French citizens, although it took them a little longer to do so. The same procedure was implemented for currency when the livre was decimalised and replaced by the franc at the same conversion rate. The desire to completely remove all vestiges of the old regime, together with the desire to engender the spark of patriotism amongst the people during the political crisis, led the ruling party to decide to change the existing recording of the calendar year, to subordinate it to the annual cycles and to dedicate it to agriculture.

The Republican calendar undoubtedly represents the pinnacle of French revolutionary patriotism. The elaborate naming of the days and months, including the equal distribution of days in each week, was intended to sever the links with the Christian Gregorian calendar. It was a project that was at the interface of astronomy and mathematics, based on reason and exactitude, since many scholars were involved. The passing of the law establishing the calendar represented a victory for the Jacobins, with which they created their own way of recording the whole year down to the smallest part – the hours, minutes and seconds.

Time, that elusive mathematical and physical entity, was the final area which was unaffected by decimalisation. It is not without interest that decimal time was something considered by the French long before the Revolution and it wasn't until the first estate was absent that it could be implemented. Although it was the work of academics, the Jacobins approved and even defended it; that only shows how much they cared about this radical intervention in the lives of citizens. Although the government suspected that decimal time might prove a problem for the citizens (which is why it postponed the time the law would come into force by a year), it was determined to take a number of steps to ensure its successful implementation in society.

Decimal time relied heavily on the watchmaking industry and its products, which led to organising

[21] For details on all post-revolutionary proposals, authors, and feedback, see [8, pp. 305, 309–310], [10, p. 110], [11, pp. 37–44].

a competition aimed to encourage the production of clocks and watches with a decimal face, so that people would more readily accept it. In the end, however, this proved a fiasco, as no prize was awarded, and the commission had to conclude, in December 1794, that the introduction of decimal time would be a very difficult and expensive feat. By this time, however, France was struggling with the consequences of the White Terror and was endeavouring to eradicate everything that had been connected with the previous Jacobin government, in a similar way to what had happened after the outbreak of the Revolution in regard to the remnants of the old regime.

Scant to zero support from the top ranks of politicians condemned all radical projects and proposals to failure – the abolition of the first estate allowed the revolutionaries to establish decimal time and the abolition of the rights of the nobility allowed for the decimalisation of weights and measures, leading on to the introduction of the calendar. But these were two different projects: while unifying the large number of units made them easier to use, the calendar, with its 365 different names for its days and the shift of the start of the year had the opposite effect, specifically to expand the amount of information that people had to deal with.

Tradition also played a role in the matter, deeply rooted in a society that, although it had to resist strong dechristianisation, celebrated Christian festivals alongside republican ones. The same situation was seen in regard to decimal time: although people had about a year to get used to it, the perception of isolation and difference from neighbouring countries was a major obstacle to its acceptance, and this grew into resistance. In the end, Republican decimal time became a theoretical rather than a practical act, which, after the fall of the Jacobins, had no one to defend and enforce it.

Sporadic proposals to return to decimal time in the mid- to late-19$^{\text{th}}$ century were symbolic of a faint glimmer of hope with no significant impact on society; furthermore, these were modifications of the original project, or innovative proposals differing from the revolutionary vision of recording the day. These ideas came largely from scholars, as they did between 1793 and 1795, and so decimal time can be considered a purely academic invention and a form of secret language amongst academics. Nevertheless, it remains true that without supporters amongst high government and political circles, decimal time was doomed to failure.

In conclusion, we can say that the Republican calendar and time were of no use to society at the time and it did not make life any easier for them, unlike the standardisation of weights and measures. Nor could the people get past the fact of the disruption to the annual cycle and traditions, not to mention the stigma of feeling different from the rest of Europe. From today's perspective, the introduction of decimal time may seem like an absurd idea leading to even greater confusion, but the revolutionaries of the time saw it rather as one of many means to bring citizens closer to the state and usher in a new era under the banner of the Republic. But if the third estate had considered the overthrow of absolutism and the establishment of the equality of all people to be absurd, would have we even commemorated any French Revolution today?

References

[1] S. Perovic. *The Calendar in revolutionary France: Perceptions of time in literature, culture, politics.* Cambridge University Press, Cambridge, 2012. https://doi.org/10.1017/CBO9781139198950

[2] M. Shaw. *Time and the French revolution: The Republican calendar, 1789-year XIV.* Boydell Press, Woodbridge, 2011. ISBN 978-0-86193-311-2. https://doi.org/10.1515/9781846158476

[3] J. Orel. *Francouzská (jazyková) revoluce: republikánský kalendář a metrický system [In Czech; French (language) revolution: The Republican calendar and the metric system].* Bachelor's thesis, Charles University, Faculty of Arts, 2012.

[4] J. Mavidal, E. Laurent (eds.). *Archives parlementaires de 1787 a 1860. Premiere série, 1787 a 1799 [In French; Parliamentary archives from 1787 to 1860. First series, 1787 to 1799].* Paul Dupont, Paris, 1909.

[5] Napoleon. The republican calendar. [2024-01-11]. https://www.napoleon.org/en/history-of-the-two-empires/the-republican-calendar/

[6] Convertisseur monnaie. Convertisseur de monnaie d'ancien régime [In French; Old Regime currency converter]. [2024-01-14]. https://convertisseur-monnaie-ancienne.fr/

[7] Historical Statistics. Historical currency converter. [2024-01-14]. https://www.historicalstatistics.org/Currencyconverter.html

[8] R. A. Carrigan. Decimal time: Unlike the metric system of measurements, decimal time did not survive the French Revolution. But is dividing the day by tens a possibility for the future? *American Scientist* **66**(3):305–313, 1978.

[9] L. Marquet. 24 heures ou 10 heures. Une essai de division décimale du jour (1793–1795) [In French; 24 hours or 10 hours. An attempt at decimal division of the day (1793–1795)]. *Bulletin Ancaha* (56):51–57, 1989.

[10] J. Mauerhan. Jour, heure, minute et seconde décimalisés [In French; Day, hour, minute and second decimalized]. In *Pratique et mesure du temps. Actes du 129^{e} Congrès national des sociétés historiques et scientifiques, « Le temps », Besançon, 2004.*, Actes des congrès nationaux des sociétés historiques et scientifiques, pp. 109–114. 2011.

[11] H. Vera. Decimal time: Misadventures of a revolutionary idea, 1793–2008. *KronoScope* **9**(1–2):29–48, 2009. https://doi.org/10.1163/156771509X12638154745382

[12] J. C. F. de Rey-Pailhade. *Le temps décimal. Avantages et Procédés pratiques [In French; Decimal time. Advantages and practical processes].* Gauthier-Villars and Fils, Paris, 1894.

[13] D. Tinková. *Revoluční Francie (1787–1799) [In Czech; Revolutionary France 1787–1789]*. Triton, Praha, 2008. ISBN 978-80-7387-211-3.

[14] M.-H. Froeschlé-Chopard, M. Froeschlé-Chopard. Une double image de la révolution: Le calendrier et le mètre [In French; A double image of the revolution: The calendar and the meter]. *Annales historiques de la Révolution française* (279):74–88, 1990. https://doi.org/10.3406/ahrf.1990.1294

[15] K. Alder. *The Measure of All Things: The Seven-year Odyssey and Hidden Error that Transformed the World*. Free Press, New York, 2002.

[16] C. J. Giunta. *A Brief History of the Metric System*. Springer, Syracuse, 2023. https://doi.org/10.1007/978-3-031-28436-6

[17] J.-B. Duvergier (ed.). *Collection complète des lois, décrets, ordonnances, réglemens, et avis du Conseil-d'État [In French; Complete collection of laws, decrees, ordinances, regulations, and opinions of the Council of State]*. A. Guyot et Scribe, Paris, 1825.

[18] L. Marquet. La création du système métrique décimal et les pharmaciens [In French; The creation of the decimal metric system and the pharmacists]. *Revue d'histoire de la pharmacie* **78**(287):425–442, 1990. https://doi.org/10.3406/pharm.1990.3452

[19] I. Delage. A history of the Franc: The key moments. [2024-01-11]. https://www.napoleon.org/en/history-of-the-two-empires/articles/a-history-of-the-franc-the-key-moments/

[20] S. Maréchal. *Almanach des honnêtes gens [In French; Almanac of honest people]*. Paris, 1788. Calendar design illustrated, but not paged.

[21] *Calendrier du peuple franc, pour servir à l'instruction publique [In French; Calendar of the Frankish people, to be used for public education]*. Jahyer et Geslin, Angers, 1793.

[22] C. C. Gillispie. *Science and Polity in France: The End of the Old Regime*. Princeton University Press, Princeton, 2004.

[23] P.-F.-N. Fabre d'Eglantine. *Rapport sur le calendrier républicain [In French; Report on the Republican calendar]*. Imprimerie nationale, Paris, 1793.

[24] M. Froeschlé. À propos du calendrier républicain: Romme et l'astronomie [In French; About the Republican calendar: Romme and astronomy]. *Annales historiques de la Révolution française* **304**(1):303–325, 1996. https://doi.org/10.3406/ahrf.1996.1974

[25] M. Laurencin. *Le calendrier républicain: Un marqueur de la régénération de la société sous la Révolution [In French; The Republican calendar: A marker of the regeneration of society under the Revolution]*, vol. 28 of *Mémoires de l'Académie des Sciences*, pp. 61–85. Arts et Belles-Lettres de Touraine, 2015.

[26] S. Bianchi. La «bataille du calendrier» ou le décadi contre le dimanche. Nouvelles approches pour la réception du calendrier républicain en milieu rural [In French; The "battle of the calendar" or the décadi versus Sunday. New approaches for receiving the Republican calendar in rural areas]. *Annales historiques de la Révolution française* **312**(1):245–264, 1998. https://doi.org/10.3406/ahrf.1998.2176

[27] Brumaire. M. Laplace fait un rapport sur le projet de sénatus-consulte portant rétablissement du calendrier grégorien [In French; Mr. Laplace reports on the senatus-consulte project reestablishing the Gregorian calendar]. [2024-01-12]. http://prairial.free.fr/index.php?lien=cal_senatusconsulte1805

[28] M. A. Lombardi. Why is a minute divided into 60 seconds, an hour into 60 minutes, yet there are only 24 hours in a day? *Scientific American* 2007. [2024-01-12]. https://www.scientificamerican.com/article/experts-time-division-days-hours-minutes/

[29] S. Debarbat. Temps public, temps scientifique [In French; Public time, scientific time]. In *Pratique et mesure du temps. Actes du 129e Congrès national des sociétés historiques et scientifiques, « Le temps », Besançon, 2004.*, Actes des congrès nationaux des sociétés historiques et scientifiques, pp. 115–122. 2011.

[30] F. Bléchet. L'art de mesurer le temps à l'aube des Lumières [In French; The art of measuring time at the dawn of the Enlightenment]. In *Pratique et mesure du temps. Actes du 129e Congrès national des sociétés historiques et scientifiques, « Le temps », Besançon, 2004.*, Actes des congrès nationaux des sociétés historiques et scientifiques, pp. 97–108. 2011.

[31] D. Diderot, J. L. R. d'Alembert. *Encyclopédie, ou Dictionnaire raisonné des sciences, des arts et des métiers, par une Société de gens de lettres [In French; Encyclopedia, or reasoned dictionary of sciences, arts and professions, by a Society of men of letters]*. Briasson, Paris, 1754.

[32] C. B. Collignon. *Découverte d'étalons justes, naturels, invariables et universels [In French; Discovery of fair, natural, invariable and universal standards]*. Les Frères Gay, Strasbourg, 1788.

[33] Svalbard. French revolutionary (decimal) time. [2024-01-02]. https://svalbard.watch/pages/about_decimal_time.html

[34] P. Quesnel. *Sublimer le temps et les hommes: nouvelles approches pour l'étude du calendrier républicain en Loire-Inférieure [In French; Sublimating time and people: new approaches for the study of the Republican calendar in Loire-Inférieure]*. Master's thesis, Université Laval in Québec, 2005.

[35] C. Roulet. Decimal time: The revolution that never was. *Watches & Culture* 2010. [2024-02-01]. https://www.watchesandculture.org/forum/en/decimal-time-the-revolution-that-never-was/

[36] Richard Redding Antiques. Artists. [2024-01-15]. https://www.richardreddingantiques.com/artists/

[37] Association française pour l'avancement des sciences [In French; French association for the advancement of science. Besançon and Franche-Comté: Historical, scientific and economic notices]. *Besançon et la Franche-Comté: notices historiques, scientifiques et économiques*. Session. J. Dodivers, Besançon, 1893.

[38] L. Trincano. Les Maîtres-Horlogers Comtois du XVIII siècle [In French; The Comtois Master Watchmakers of the 18th century]. *Annales Francaises de Chronometrie* **13**:57–74, 1943.

[39] C.-A. Prieur. *Note instructive sur les poids et mesures [In French; Instructive note on weights and measures]*. Imprimerie nationale, Paris, 1795.

[40] R. D. Statter. *The Decimal System as a Whole, in Its Relation to Time, Measure, Weight, Capacity, and Money, in Unison with Each Other*. Groombridge & Sons, London, 1856.

[41] R. E. W. Goodridge. On the proposed change of time marking to a decimal system: A plea that the duodecimal system be retained, 1886. [2024-01-17]. `https://www.mhs.mb.ca/docs/transactions/1/timechange.shtml`

[42] J.-C.-F. Rey-Pailhade Joseph. *Application simultanée et parallèle du système décimal à la mesure des angles et du temps [In French; Simultaneous and parallel application of the decimal system to the measurement of angles and time]*. Société de géographie de Toulouse, Toulouse, 1895.

[43] J.-C.-F. Rey-Pailhade Joseph. Comité des travaux historiques et scientifiques [In French; Historical and scientifical works committee]. [2024-01-17]. `https://cths.fr/an/savant.php?id=100854`

[44] J.-C.-F. Rey-Pailhade Joseph. Étude historique sur l'emploi du calendrier républicain [In French; Historical study on the use of the Republican calendar]. *Bulletin de la Société de Géographie de Toulouse* (4), 1908.

[45] J.-C.-F. Rey-Pailhade Joseph. La montre décimale de Laplace [In French; Laplace's decimal watch]. *Revue chronométrique* (688), 1914.

[46] C. Higgins. Decimal time: How the French made a 10-hour day, 2013. [2024-01-02]. `https://www.mentalfloss.com/article/32127/decimal-time-how-french-made-10-hour-day`