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Indigenous Clockmakers, Schedules, and Quantitative Time in the Spanish Colonies (16th Century)

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Abstract

During the 16th century, the term “Cemilhuitlapohualtepoztlī” meant “clock” to the indigenous peoples of Mexico. They had formed this neologism out of three words from the Nahuatl language: “cemilhui” (the passing of a day); “tlapoaliztlī” (to count); and “tepoztlī” (bell or iron). This linguistic evidence, in conjunction with other documents found in Spanish and Latin American archives, show that autochthonous people came into early contact with these mechanisms and promptly assimilated quantified time. Historiography often claims that the Catholic Church imposed this kind of time among indigenous societies, however, this paper demonstrates that indigenous peoples appropriated a more precise and quantified time in the offices of the colonial administration, either by working as clockmakers or by producing “timetables” and calendars. This process allowed, on the one hand, the global synchrony between the Old and the New World, and on the other hand, the coordination of collective temporalities and local calendars.

Keywords

history and anthropology of time – history of technology – written culture – administrative history – history of the Spanish Empire

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1 Introduction

In most Latin American cities and towns, especially those founded by Spaniards, it is common to find a clock in the churches of each central square. Many of these clocks do not work today, they have either deteriorated or stopped, the mechanisms do not work, and the hours do not chime. An observer might conclude that Latin Americans are indifferent to quantitative time and that these clocks were relics installed by the Catholic Church. Indeed, when people talk about clocks, timetables and punctuality, the last society they think of is Latin Americans. Usually the first ones are German, Swiss, English, or Japanese. However, beginning in the 16th century, with the expansion of the Spanish Empire in the New World, Latin American cities were actually the first to install clocks and adopt the Christian calendar outside the European continent. Contrary to what is often claimed, this process did not take place in churches and monasteries, but within administrative centres, Royal Audiences, and town councils (“cabildos”).

By the time the Japanese first became acquainted with a mechanical clock, and decades before the Chinese became interested in these machines, the indigenous peoples of the New World, particularly those of New Spain (Mexico), were already buying clocks and working as clockmakers. In 1550, when the Spanish Jesuit Francisco Xavier offered a clock to the daimio of Yamaguchi in Japan, and in 1583, when the Chinese authorities of Zhaoqing received a clock as a gift from the Italian Jesuits Michele Ruggieri and Matteo Ricci, the indigenous peoples of Mexico City and the towns of Tlaxcala and Tlatelolco had already incorporated into their language and techniques every aspect of clockmaking and punctual timekeeping (Cipolla 1967; Cabezas García 2012, 78–79 and 116–17; Frumer 2018, 34–58). Like many other clockmakers in the New World, these indigenous peoples worked for the offices maintaining the clocks, but there were also indigenous interpreters and scholars who collaborated in the translation of calendars.

Whether as officials or civilians, these indigenous peoples helped to configure office schedules and quickly incorporated quantitative time into their daily lives. In this context, this population was a key gear in the bureaucratic system that contemporaries began to compare to the mechanism of a clock, as the administration of the Spanish Empire has been known ever since (López-Cordón Cortezo 1996; García Santo Tomás 2015, 48–49). Despite the endless accumulation of claims about the slowness and inefficiency of this bureaucratic system, the reality is that the network of royal offices was governed by very strict regulations that determined official procedure down to the smallest detail. It is not without basis that these spaces have been understood

by historiography as true theatres of justice and government, since the daily tasks seemed to follow a script and to stage repetitive rites (Cárdenas Gutiérrez 2006; Brendecke and Martín Romero 2017).

The following pages will explain how this process was shaped by the indigenous peoples of the New World, starting with the identification of the first clocks and clockmakers, continuing with the adoption of the Christian calendar among the indigenous peoples, and ending with the use of quantitative time in the exercise of administration. The case study will be certain indigenous groups in central Mexico, generally known as Nahua because they share Nahuatl as their common language. The phenomenon studied here occurred earliest and fastest in this area and in these societies. However, these cases were replicated throughout the rest of the New World during the 16th century.

2 Indigenous Clockmakers without the Wheel

The Nahua ignored the wheel for applied uses, yet part of their population quickly understood the function of mechanical clocks. Anthropologists and historians have pointed out that pre-Hispanic societies used wheels for writing and making toys, but not for locomotion, much less for the transmission of energy through the conjunction of gears (Caso et al. 1946; López Valdés 1966; Urcid 2017). Even though they were not familiar with mechanics, let alone machines with automatic movements, many indigenous peoples quickly adapted to certain jobs that did not exist in the New World before the arrival of the Spaniards. That is why it is not an isolated occurrence to find specialised indigenous peoples working in mills, printing presses, looms, blacksmiths' shops, and mechanical trades in general (Paniagua Pérez 2010; Ricard 1966, 212–16).¹ However, historiography has paid little attention to indigenous clockmakers who, although relatively few in number compared to other jobs, were among the first clockmakers to exist outside Europe.

The oldest known image of a mechanical clock in the New World was not painted by Spaniards, Portuguese, or Italians, but by indigenous peoples in the “Codex of Tlatelolco” (Fig. 1). This manuscript was written around 1562

1 In one of the earliest known manuscripts on the history and customs of the indigenous peoples of central Mexico, Fray Toribio de Benavente, known as “Motolinía”, draws attention to the fact that these people quickly and easily learned the mechanical arts from the Spaniards. In a few paragraphs of the text entitled “Historia de los indios de Nueva España” [History of the Indians of New Spain] (c. 1536), he highlights their ability to make ironwork and bells with a good sound, adding that this craft was one of the first they learned after the arrival of the Spaniards. (Benavente “Motolinía” 2014, 224–30).

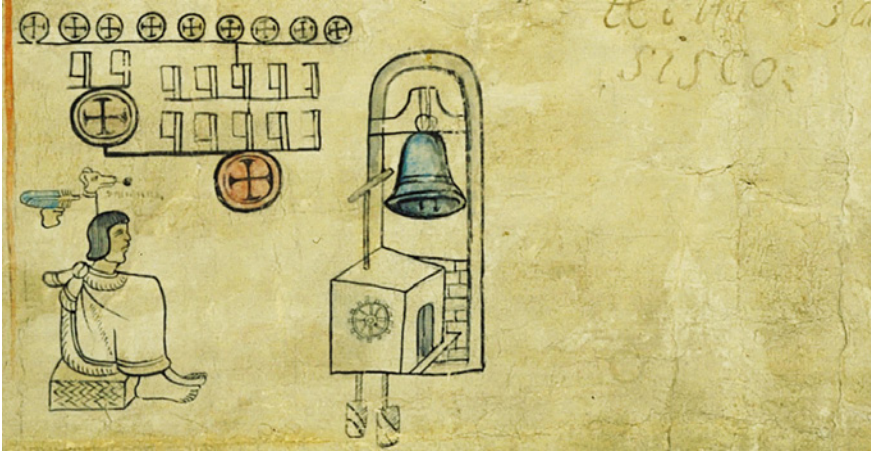


FIGURE 1 Clock of the Codex Tlatelolco (1558). Indigenous nobleman counting in front of a chiming clock
SOURCE: BIBLIOTECA NACIONAL DE ANTROPOLOGÍA E HISTORIA (MEXICO), SIG. 35-39, SHEET 9

and its contents record what happened in Tlatelolco between 1542 and 1560. It is possible that the document was commissioned to benefit the indigenous, reminding the Spanish authorities that they were their allies in the conquest of new territories. Don Diego de Mendoza Imauhyantzin, cacique of Tlatelolco, most probably used it as a historical document and political instrument to demonstrate the validity of his rule, document military alliances with the Spanish, and highlight the constructions that had been made to improve the city (Valle 1994).² Among the most noteworthy items in this text, the last section includes an indigenous person seated in front of a mechanical clock with a bell, after recapitulating important events for the Tlatelolcos such as the conquest of northern Mexico, the appointment of caciques, viceroys and judges, the funeral honouring of Emperor Charles V, and the exaltation of King Philip II's oath to the throne.

² Such documents, drawn up by the indigenous peoples themselves, became common from the mid-16th century onwards in order to claim the privileges they had won by allying themselves with the Spanish. Recent historiography has shown that an important part of the process of conquest and expansion of the Spanish Empire in the New World was the product of pacts made between indigenous peoples and local Spanish authorities. Moreover, many of these caciques maintained their power and dominion for decades and sometimes generations, though on certain occasions they did have to justify their ancestry and jurisdictions with this type of documentation, and even sometimes travel to Spain to appeal directly to the king (Mira Caballos 2023; Díaz Ceballos 2020; Puente 2018).

The clock painting is headed by a glyph indicating the year 1558. Judging by the quality of the blanket covering the figure of the indigenous person and the bench on which he is seated, this personage was a member of the local nobility. His name is unknown, although from the pictorial and alphabetical inscriptions it is possible to infer some features of his trade and identity. Just above his head there is a dog glyph, a rubber ball, and the words “tentli e yhuatl” (which means lip and coloured feather). According to this, it is possible that this indigenous person may have worked as a scribe or accountant, since in addition to these inscriptions, a series of Spanish coins and Nahua numerals were drawn on the upper part, totalling 249 *reales de a ocho* (universal currency of the Spanish Empire). Those who have deciphered this document suggest that this money represents the purchase value of the clock, although when compared with the figures on other clocks of the same period built in the New World, it is more likely that it is an account of the repair or adaptation of the mechanism (Valle 1994, 83–84; 2008).

In any case, this fragment of the codex is a unique document in the history of watchmaking, not only because of the date and the place where it was produced, but also because of the set of meanings it brings together in a single painting. Firstly, the drawing is at the same time a figurative representation of the clock, an account of watchmaking expenses and a direct identification between a character and the use of the mechanism. In Europe this type of documentation was produced separately, sometimes illustrating clocks as an allegory of *temperantia* (moderation) and *sapientia* (wisdom), but also as plans and sketches of the machinery, or as invoices for the purchase, construction, or repair of a clock. In this case, the indigenous peoples of Tlatelolco documented in their own way the existence of the machinery so as to leave no doubt about the technical, economic, and quantitative relationship they had with the clock. The weights, the bell and the clapper connected to the mechanism are graphic testimonies of its applied use. But above all, the intention to draw a gear outside the case complements the objective they were pursuing: for them there was no mystery in the inner workings of the clock, the use they were making of it was practical and not simply symbolic.

However, this is not the earliest record of a clock in the New World. There is documentation of the demand for clocks as soon as the Spaniards began founding towns. In 1521, the Spanish Crown approved a request made by the authorities of Santa María la Antigua del Darién to build a clock (today's border between Colombia and Panama). This Royal Decree indicated that they were authorised to take money from the royal coffers and obtain the materials for its construction themselves. The order never materialised because it arrived too late, by which time the Spaniards had abandoned the city due to

problems of location, siege by the indigenous peoples and conflicts between the conquistadors.³ Nevertheless, this request is indicative of the way in which the mechanical clock was introduced in the New World, because contrary to what is usually thought, the initiative did not come from the king or the Catholic Church, but from the need to coordinate schedules in newly founded cities as their administration processes became more complex. This process, as we shall see below, did not happen unilaterally from the Empire to its colonies, but evolved at the local level and with a certain degree of autonomy.

The founding of these settlements, first in the Caribbean and then in Tierra Firme (the Isthmus of Panama), led to the accumulation of experiences on the ground that would later be useful for the legal organisation of large cities (Díaz Ceballos 2020, 23–98). Indeed, in 1528 Emperor Charles V signed an “Ordinance” for Mexico City, still called by the Nahuatl name “Tenochtitlan”, in which he decreed, among several administrative codes, the need to install a “Clock in a convenient place so that they can hear him” in the building of the Royal Audience (Puga 1563, 89–90). In this case the order was obeyed and executed almost immediately, as in 1533 the Royal Audience of Mexico had already sent 400 pesos of gold to Spain for the purchase of a clock. Meanwhile, the *Casa de Contratación* of Seville, the institution in charge of administering travel and business with the New World, had contributed another 500 pesos for the casting of the bell. The documentation indicates that the mechanism was made to resemble the Seville Cathedral clock and that it was sent following the order to the letter to have a chiming mechanism to strike the schedules.⁴

Now, it may seem logical to assume that this order was inspired by previous laws enacted in Spain, but there are actually no traces of the compulsory use of clocks inside Royal Audiences. Judging by “La nueva recopilación de leyes” of 1567, the legislative corpus that organised and unified regulations for the Spanish kingdoms in the Iberian Peninsula, the installation of a clock in the judges’ chambers dates back to several similar laws enacted independently by Charles V and Queen Juana I of Castile (1581, 1: F. 1, Ley III, Tit. V, 57v). The first was in Segovia in 1532, then in Valladolid in 1537, Granada in 1542, and the same year in Medina del Campo. In other words, all of them came after the Mexico City ordinance of 1528. This does not mean that clocks were first installed in the

3 Archivo General de Indias (AGI), *Panamá*, 233, L. 1, ff. 295v–296r. AGI, *Panamá*, 235, L. 7, ff. 120r–121v. Santa María la Antigua del Darién was founded by María Fernández de Enciso and Vasco Núñez de Balboa in 1510 and was finally vacated in 1524.

4 AGI, *Indiferente*, 1961, L. 3, ff. 17v–18r. AGI, *Indiferente*, 1092, N.º 45, s/f. Some authors claim that this clock was a gift from Emperor Charles V and others that it was brought to Mexico City by conquistador Hernán Cortés. Nevertheless, they offer no documentary evidence (Sánchez Flores 1980, 77; Boils Morales 2015, 95–96).

administrative halls of Mexico and then in Spain, as clocks have been present in the Spanish court since the 15th century (Pérez Álvarez 2013; Vielliard 1978). The purpose of these dates is to highlight the simultaneous development of such regulations as an obligatory line of command between Spain and the New World, first at the local level, in accordance with the bureaucratic needs of having a clock, and then at the imperial level, with the adoption of a law as a universal rule.

From this moment on, the presence of clocks multiplied in several cities of the continent, mainly in the buildings of the Royal Audiences and town councils (Fig. 2). In general, they followed the same procedure: first, the need for a clock arose during administrative exercises to organise the high demand of obligations. Second, the local authorities agreed to raise the money by adding the economic resources from the city with funds from public collections in which residents participated. Third, they entered into an agreement with a “clockmaker” to make the clock, although on several occasions this clockmaker was actually a blacksmith, gunsmith or miller who knew how to forge shafts and gears, and who could have been European, Indian, mestizo or black. Fourth, once installed, the mechanisms exhibited constant imperfections and therefore had to be kept “concerted” and “current”, two terms that are commonly found in the documentation and which are picked up as complaints expressed by the inhabitants of the cities. Fifth, population growth and the increase of bureaucratic operations resulted in increased pressure on administrative authorities to build new mechanisms with bigger bells.⁵

A good example of this process, and perhaps the first agreement for the purchase of a clock by the Nahua, can be found in the minutes of the cabildo of the city of Tlaxcala, a town inhabited and run by indigenous peoples. In the session of March 3rd, 1550, the need to have a clock for the “honour of the emperor and to make Tlaxcala look good” was discussed. As in the “Codex of Tlatelolco”, the Tlaxcalans intended to use this work to exalt the importance of their community by attracting the attention of the authorities and

5 None of these clocks remain today. They all disappeared as they were repaired or adapted, but also because of the renovation and demolition of the buildings in which they were installed. The oldest known examples are in Mexico and were part of the Cathedral of Cuernavaca and the convent of Huejotzingo, both belonging to the Franciscan order. However, neither their date nor their authorship can be determined at present. An observation by an expert clockmaker determined that they were probably built before 1660, but there is no documentation to assure their existence in the 16th century (Spencer 1977). Likewise, there has been speculation about the installation of clocks in the towers of the churches of Cholula and Tepeaca in the mid-16th century, but neither provide sources to validate these comments (Sánchez Flores 1980, 77; Boils Morales 2015, 95–96).



FIGURE 2 Comparative map of the first clock cities between America and the Far East. The map shows the first mention of a clock in the documentation. SOURCE: MAP DRAWN UP BY THE AUTHOR FROM VARIOUS SOURCES

thus obtaining a privileged place among the hierarchy of the Empire. In fact, they decided to write to the viceroy in Mexico City to ask for his authorisation, which was immediately granted. Some opposed the purchase, arguing that the *cabildo* was poor, but others responded by saying that they could not fail to “do something so necessary” and that together they had enough inhabitants to raise the money (Celestino Solís, Valencia, and Medina Lima 1985, 100–101 and 295–96).

Based on their pre-Hispanic tribute system, the Tlaxcalans contributed according to hierarchy (Martínez Baracs 2008, 149–60). The heads of the manor houses contributed in greater proportion precisely to reaffirm their nobility, although the public collection was itself a procedure that ensured the collective ownership of the clock. According to later testimonies written by indigenous peoples, the clock was not installed until a decade later, in 1560, and it was made by a clockmaker called “Juan Perdo Geminiano”, whose surname could indicate an Italian origin (Townsend 2010, 164–67; Zapata y Mendoza 1995, 160–61; Lockhart, Berdan, and Anderson 1986, 69). Despite this delay, the same records show that the indigenous peoples were previously familiar with the functioning and use of the clock, as the Nahuatl word they use describes the function of the mechanism very well: “Tlapohualtepoztlí”. In other documents they would add the prefix “Cemilhui” to form a neologism meaning: “Cemilhui” (the passing of a day), “Tlapoaliztlí” (to count), and “Tepoztlí” (bell or iron). As was common in the orthography of the time, the word did not follow a unified spelling, but it was still preserved in the everyday speech and writing of indigenous peoples until the 17th century, alternating with the Castilian word “Relox” and the mestizo word “Reros” (Dibble 1963, 87 y 122; Zapata y Mendoza 1995, 160–61 and 564–65; Castillo 2001, 151–52; Chimalpáhin Cuauhtlehuanitzin 2001, 270–71; Townsend 2010, 164 and 170).

It is clear that in the mid-16th century, the Nahuatl understood that a clock was an iron instrument that counted the length of the day by ringing a bell. A technical and quantitative relationship not unlike the need to install clocks in the Royal Audiencias and town councils to see and hear the hours regularly. Moreover, indigenous peoples were involved in administrative work from the beginning, both keeping and drawing up schedules, as is recorded in the minutes of the town council of Tlaxcala. In fact, the invention of words about the clock did not stop at its description. Fray Alonso de Molina (1513–1579), a Franciscan linguist and Spanish migrant who arrived in the New World at a very young age and learned to speak Nahuatl with the native children, collected in his “Vocabulario en lengua castellana y mexicana” [Vocabulary in Spanish and Mexican language] (1571) other expressions related to the use of the clock that point to a quantitative and punctual time: “Niquilochtia yn

tonalpoualoni” which means “to stop or slow down the clock that is ahead”, and “Tototza nic” which means “to advance or speed up the clock”. (Molina 1571, 44r and 152v).

All this information is confirmed by the presence of indigenous peoples who worked mainly for the administrative buildings. Between 1553 and 1560 there are two indigenous peoples in charge of maintaining the clock installed in the tower of the Cathedral of Puebla on behalf of the city council and with public money (Carrión 1896, 449–59). In the account books of the Colegio de Tlatelolco, an educational institution for the indigenous elite, in 1570 the payment of indigenous clockmakers is reported (García Icazbalceta 1892, 252). A certain “Luis Yndio” maintained the clock at the University of Mexico between 1580 and 1587.⁶ In 1580, Martín Damián, Pedro Joaquín, Pedro San Miguel and Martín Jacobo, all indigenous, were in charge of the clocks in the Viceroyal Palace (Castro Morales 2003, 74). It is very possible that they even participated in the observation of the lunar eclipse of November 17th, 1584 to determine the longitude of Mexico City, one of the most accurate astronomical exercises of the time, which took place on the roof of the Royal Audience (Rodríguez Sala 1999). Thanks to a clock that the viceroy Pedro Moya de Contreras ordered to be set with extreme precision, it is known that the phenomenon ended at 7 hours and 27 minutes, a quantitative, technical, and scientific time measurement realized by this group of indigenous peoples.

3 The Reproduction of Quantitative Time in Indigenous Hands

The indigenous peoples of Mesoamerica adopted the Christian dating system more quickly and spontaneously than the complicated calendrical conversion diagrams suggest. Within a few years of the arrival of Hernán Cortés (1519) and the conquest of México-Tenochtitlan (1521), certain *tlacuilos* and *tlaman-tinis* (scribes and literate indigenous) began to use the Christian Era to date censuses, histories and chronologies. A Nahuatl manuscript from 1528 uses alphanumeric writing to recapitulate the events of ancient Mexicans, recall the genealogy of the rulers who preceded the conquest, and record contemporary news. The structure of this text resembles the European annals that noted year after year the events and news that took place in a given city, and for this reason it is currently referred to as the “Annals of Tlatelolco” (Berlin and Barlow 1980).

6 Archivo General de la Nación de México (AGNM), *Instituciones coloniales*, Universidad, Vol. 5, Exp. 105, ff. 113–115. AGNM, *Instituciones coloniales*, Universidad, Vol. 6, Exp. 145, f. 107r.

The authorship of this list of dates and events has not been determined with certainty, although it is probably the work of Pablo Nazareo, lord of Xaltocan (Baudot 1983, 70–72). In any case, this would be an indigenous nobleman who was educated by the first Franciscan missionaries from a very early age, and long before the official establishment of schools for indigenous peoples. This suggests that the first generation following the arrival of the Spaniards, immediately bridged the chronologies of the two societies. These young indigenous peoples, usually members of the local nobility and connoisseurs of pre-Hispanic documents, served as interpreters and scribes in those moments of contact. For this reason, it is not unusual to find traces of their handwriting in documents and situations in which it was essential to write exact dates to achieve a certain degree of understanding and synchrony.

This is confirmed by a census ordered by the Spanish Crown in the area of the Marquesado del Valle, a group of lands that belonged to Hernán Cortés and his heirs (Madajczak et al. 2021). The aim was to obtain a record of the number of people and the type of tribute they paid, so the scribes recorded in detail the names of the family members living on each plot. The census was begun sometime in the 1530s and was written in Nahuatl by seven different hands using the Latin alphabet. The document may have been produced by combining pre-Hispanic manuscripts with oral interviews, but it definitely introduced new forms of dating. Beyond the use of figures for dates and quantities, the scribes recorded only the years of the younger children, while ignoring the age of the adults. A routine act of writing that not only proves the level of assimilation of the Christian Era among the younger strata, but shows how a new generation was automatically enrolled in an administrative dating system.

The use of alphanumeric writing, registration documents and lists by indigenous societies is often interpreted as a form of imposed submission to Spanish power (Mignolo 1995). However, the logographic and symbolic system of Mesoamerican indigenous peoples was not only used in combination with alphabetic writing until the 17th century, but many of the recording needs corresponded to both indigenous and European writing. The Nahua had prior knowledge of certain types of paper and inks, but more importantly they had a corps of officials sufficiently educated to compose, collect and archive records. Thus, the administrative requests of the Spaniards did not take them by surprise. In fact, in their literacy practices they closely linked enumeration with chronicles. The Nahuatl word “Pohua” had the double meaning of “to tell” and “to relate” (Lockhart 1992, 326–73).

As for the relationship between the numerical and calendrical writing system, there were similarities that possibly united the differences between the accounts of the two societies. In Nahua accounting, for the recording of dates

and ephemeris, the numeral system used was so precise and regularised that the numbers did not require additional interpretation or oral amplification. In that sense, the Nahua system resembled the Western numeral system in which each digit represents a specific number. It is true that in the Nahua world, numerals were present in all areas of ritual and civil life, and that depending on the context or object, different numerals were used (Dehouve 2014, 39–76). This coexistence of various modes of enunciation and notation in the same society, far from being an obstacle to the learning of the European numeral system, made it possible for a new system to be incorporated with some ease to existing ways of counting. In other words, the Nahua possessed the ability to handle several numerations and, under this logic, it was not difficult for them to incorporate Arabic and Roman numerals as just another system that served to count certain quantities, especially dates.

However, this does not mean that Nahua and European numerals were devoid of qualitative interpretations. Both systems qualified numbers according to their context. For the devout Christian, for example, dates and divisions of the day were sacralised according to the corresponding saint and ritualised according to the Canonical Hours (Moutin 2020). This was in addition to the esotericism, numerology and Judaic astrology that was so present in the minds of European scholars and mystics (Yates 1991). On the other hand, for the Nahua certain numbers, quantities or dates could be auspicious or nefarious, so they made an effort to choose some and avoid others when constructing buildings, making predictions, offering tributes, celebrating rites, participating in games of chance and many other activities pertaining to all social spheres (Dehouve 2014, 191–216 and 235–77). Thus, the qualification of numbers was shared by both cultures, albeit corresponding to different rites and purposes, and therefore, in the aspects of religious life of both Europeans and Nahua, a fully quantitative use of numbers was not cultivated.

The perfect correlation of the two calendars presented even more complex problems. This exercise, which combined computation with historiography, was known as the “art of hemerology” among a select group of European scholars (Glareanus 2014; Grafton 1975). Its purpose was to fit into a universal chronology and account for the history of all known human groups, an art that was cultivated until at least the 17th century in both Europe and America. Faced with the novelty of contact with societies inhabiting previously unknown lands, a historiographical project was launched to systematically incorporate the past and present of the indigenous peoples. Franciscan missionaries were part of this tradition of scholarship and took it upon themselves to introduce it to the New World in order to gather information that would be useful to this goal. They quickly realised that the Nahua devoted all their knowledge to

establishing the calendrical system and that they recorded in detail both astronomical observations and social events (Gruzinski 2021, 64–116).

The Franciscans tried to supplement their existing knowledge with information provided by the indigenous people's authorities, while also consulting the ancient manuscripts they still preserved. Despite the rigorousness and the efforts of several missionaries, a perfect synchrony between the Julian calendar and the Nahua calendars was never achieved as there were several insurmountable problems. On the one hand, the information they received from indigenous peoples was contradictory and one testimony did not coincide with another, either because some of the informants were reluctant to reveal the workings of their calendar system or because they were sincerely ignorant of how the computations worked. Additionally, the missionaries were never able to discover when the indigenous calendar year started or how they solved the discrepancy between the tropical year and the annual calendar. All of this indicates that correlation between the two calendars is impossible even for modern mathematicians, and that it is also probable there was no unified use of the calendar at least in the area of central Mexico. In fact, it is thought that several indigenous calendars coexisted, requiring periodic adjustments according to the mismatch between natural and social cycles. (Díaz 2019; Boone 2016; Prem 2008; Motolinía and Dyer 1996; Tena 1987; Kubler and Gibson 1951).

Although it may seem paradoxical, it should not be forgotten that at the time the situation with the Christian calendar was not very different, since its use was not widespread either and its calculation was also imperfect. Suffice it to recall that, by the 16th century, the Julian calendar had accumulated ten days of discrepancy with respect to the date of Easter and other mandatory feasts. As a result, not all populations celebrated sacred rites on the same day, and for this reason Catholics were ridiculed by other religious groups. This "scandalous" and "intolerable error", in the words of the ecclesiastical authorities, was only corrected after 1582 with the implementation of the calendar reform (or Gregorian calendar) in the Catholic kingdoms of Europe, and between 1583 and 1584 in the American and Asian colonies of Spain and Portugal (North 1983; Carabias Torres 2012; Nothaft 2018; Uribe 2022). In other words, both the Christian calendar and the indigenous calendars were imperfect and under construction at the time the two worlds came into contact, so their synchrony was relative and ultimately impossible to achieve despite all the efforts of the scholars of both societies.

One of the most renowned and eye-catching results of these shared studies are the so-called "Calendrical Wheels". These circular diagrams, created in the second half of the 16th century, were drawn with the purpose of graphing

indigenous calendars, even though it was known that existing information was partial and imprecise. Fray Diego Valadés, the first indigenous mestizo to publish in Europe, left for posterity one of the earliest attempts to correlate the Julian and Nahuatl calendars in his work “Rethorica Christiana” (Fig. 3), printed in Perugia, Italy in 1579 (Ramírez Vidal 2016, 272–319). Today we know that none of these calendrical wheels had any practical use, neither as calendars nor as date conversion tables. However, since their creation, the opposite has been believed to be true. The idea that circular time was an exclusive concept of indigenous societies has prevailed ever since, even though several studies have shown, on the one hand, that there is no evidence of pre-Hispanic calendar wheels, and on the other hand, that they actually belong to a Greco-Roman and medieval tradition known as “diagrams of wisdom or mnemonics” (Boone 2008; Spitler 2005; Taylor 1987).

Since their creation, these circular diagrams were used to generate universal schemas about different aspects of human knowledge, including related conceptions of time (Yates 2014; Gómez de Liaño 2018; Rosenberg and Grafton 2013; Eastwood and Grasshoff 2004). They were never intended as true calendars for consultation, but rather as synoptic outlines of time cycles. Despite their complexity and aesthetics, calendrical wheels are useless for the consultation of exact dates and extremely cumbersome to adjust periodically, in that sense they are more static and less movable than their circular form suggests. To some extent the Franciscan missionaries were aware of the symbolic limitations of the calendrical wheels, so they accompanied the diagrams with lists, conversion tables, and narrative explanations. Some of these drawings survived outside their context of production through reproductions and reinterpretations that then ended up distorting both pre-Hispanic conceptions of time, as well as the schematic function they originally served (Díaz 2019, 183–340; Natalino dos Santos 2007). From there, the myth of circular time for indigenous peoples and linear time for westerners was created.

Scholars then, and to a large extent scholars now, also forget that these exercises in hemerology were matters of exclusive concern to the literate elites, be they European or indigenous. The popular sectors of society did not have access to such information or simply did not find it useful for their daily existence. In fact, a scholar on the other side of the world was more likely to know this material. Some of this information came, for example, to the desk of the Frenchman Joseph Scaliger (1540–1609), one of the most ambitious historians and chronologists of the time. As soon as he heard about the history of the ancient Nahua, Scaliger was quick to incorporate it into his universal chronicle, citing the works of the Dominican friar Diego Durán and the chronicler Francisco López de Gómora (Grafton 2005, 59, 335 and 361–62) In contrast to

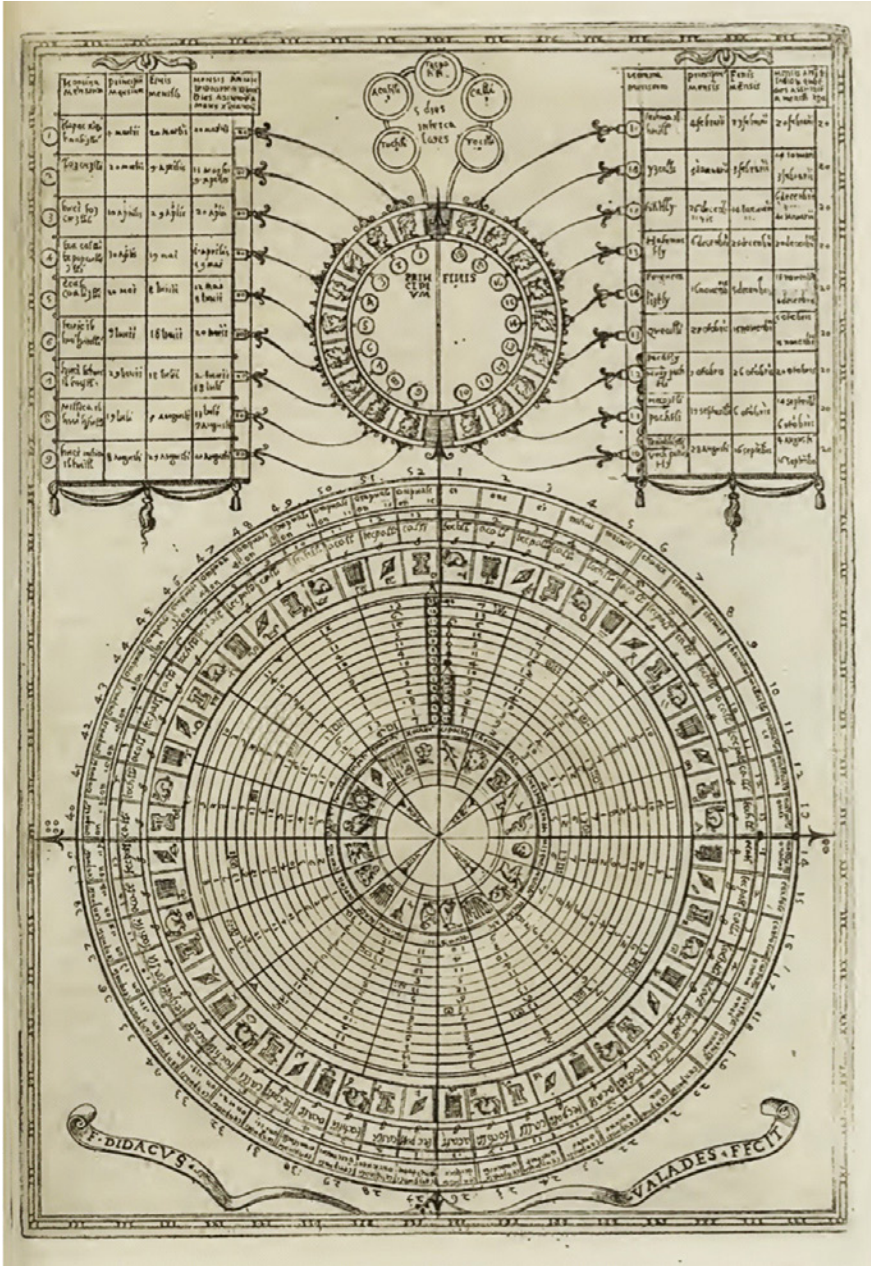


FIGURE 3 The alleged conversion between the Nahuatl and Julian calendars (1579). Below, a wheel with the “indigenous” calendar. Above, the “correlation” with the Christian calendar

SOURCE: FRAY DIEGO VALADÉS, *RETHORICA CHRISTIANA*, CHAP. XXVIII

these scholarly preoccupations, it can be said that in the field of practical life everything flowed more simply and spontaneously, without the need to establish definitive correlations between calendars and without the pretension of elaborating complex diagrams. Specifically speaking, the clearest manifestations of the use of quantitative time can be found in administrative practices and the drawing up of official documents, insofar as the figures express the date exactly, without reference to symbolic or qualitative interpretations.

The documents in Nahuatl mentioned above are the first links in a long chain of writings produced by indigenous peoples using Christian dates in alphanumeric writing. One can take as an example the “Tlaxcala town council minutes” which are recorded from 1547 onwards (Celestino Solís, Valencia, and Medina Lima 1985), dozens of letters gathered under the title “Nuestro pesar nuestra aflicción” [Our grief our sorrow] written in 1572 by indigenous peoples from the valley of Guatemala to complain to Philip II about grievances committed by some Spaniards (Dakin and Lutz 1996), the so-called “Codex Aubin” written by several scribes between 1576–1608 (Dibble 1963), and many other “diaries”, chronicles and annals among which those of Fernando de Alva Ixtlilxochitl and Diego Chimalpahin stand out (Ixtlilxochitl 1891; Chimalpahin Cuauhtlehuanitzin 1997; Chimalpáhin Cuauhtlehuanitzin 2001; Townsend 2010). It should be noted that there was no unified nomenclature for writing the date, as the authors of these manuscripts intermingled Arabic numerals, Roman numerals, and Nahuatl alphabetic numerals in the same document. However, something similar also occurred in documents written in Spanish, it is only at the end of the 16th century that a formalisation of Arabic numerals can be observed (García Larragueta 1998).

In this sense, it can be assumed that the indigenous peoples were as interested in the Christian calendar as the Spanish missionaries were in the indigenous calendars, especially in regard to their practical use. In the last quarter of the 16th century, this phenomenon entered a more concrete stage, beginning specifically with the implementation of the Gregorian calendar in the Americas. The years 1583 and 1584 were the turning point in the process of synchronisation between the inhabitants of the Old and the New World: the correlations that the missionaries and the indigenous peoples tried to establish between the two calendars lost their validity with the new reckoning, but in the meantime, both sides were aligned on the same time axis. Indigenous peoples did not forget their different calendars, as many of these coexisted until the 18th century and some are still in use today. The use of the Gregorian calendar date was simply legitimised as a universal time that would henceforth serve as a link to correlate and coordinate different temporalities.



FIGURE 4 Gregorian calendar updated with Nahuatl signs (October 1583). Below, they delete the day sign corresponding to Julian reckoning and replace it with Gregorian count.

SOURCE: BIBLIOTHÈQUE NATIONALE DE FRANCE, *CODEX MEXICANUS* 23–24, SHEET 6

Again, as in the 1520s, indigenous peoples took a keen interest in the new reckoning and some scribes made the necessary adjustments to their own writing systems. In the “Codex Mexicanus”, for example, there is the imprint of an anonymous *tlacuilo* who, upon learning of the calendar reform on 11 November 1583, turned his pen back to the previous folios to amend the ten-day mismatch and thus adjust the previous dates to the new time regime (Fig. 4). Part of this document consists of a santoral or perpetual calendar, with the celebrations and zodiacal signs. Several Nahuatl hands contributed to this codex at different times, each one correcting, deleting and adding information. Thus, it became a kind of palimpsest whose contents were modified according to the needs of the present. At one point, one of the scribes wanted to emphasise the similarities rather than the differences between the two calendars, and so he added Nahuatl festivals with indigenous people’s symbols. Although the correlation was only apparent, under that purpose he implemented the reform of the calendar, returning to the month of October, erasing the previous sign and drawing the corresponding one with the adjustment of the computation (Castañeda de la Paz and Oudijk 2019, 23–39 and 44–52). Unintentionally, such corrections caused the collapse of the indigenous people’s calculations and simultaneously displaced the use of the Julian calendar, making way for the new Gregorian reckoning.

4 The Schedules Were Not Setup by Default

As with calendars, there was no exact correlation between the schedules of the Nahua and the Christians. Some missionaries tried to find coincidences and take advantage of them for their evangelisation projects, introducing a rite or a feast at the time when the indigenous peoples already celebrated their rituals and offerings (Dehouve 2014, 90–94). Moreover, in certain indigenous language grammar and vocabulary books, missionaries devoted an entire section to the modes that subdivided the hours of the day, thus linked to the observation of the passing of the sun and qualified with activities prescribed by indigenous priests. However, they did not find a complete equivalence. Likewise, within the monasteries, the indigenous peoples adapted to the regime of the Canonical Hours, which, as mentioned, shared with the indigenous people's subdivisions the need to be ritualised. Despite the use of numbers to indicate the rhythms of the day, in the monastic sphere, figures were used to recall the order of religious life and thus sacralise each hour of the day.

The opposite phenomenon occurred in administrative spaces. There, numbers underwent a process of secularisation and were used for two purposes: Firstly, to place the exact moment when an event occurred in a time grid, and secondly, to create schedules that indicated desacralized tasks. The repetitive writing of dates and then times on each document became customary in a spontaneous way, but the establishment of the schedules was a complex matter that required constant updating and negotiation. It is important to note is that there were no predetermined schedules set by the Spaniards and later imposed on the administration of the New World. The indigenous peoples were involved in drawing up these schedules, either as civilians who went to the Royal Audiences or *cabildos*, or as bureaucrats who worked in the administrations of the cities and indigenous towns. From the beginning, indigenous peoples collaborated in administrative practices as scribes and translators, so these officials were a fundamental part in the proper functioning of the juridical-administrative machinery of the Spanish Empire (Cunill and Glave Testino 2019; Cunill 2018; Masters 2018; Guajardo-Fajardo Carmona 1995; Luján Muñoz 1982).

The sources that tell us about these schedules were written in the form of narrative instructions, in other words, they were not in the form of lists, grids or, in modern terms, “timetables”. However, if we take into account that the use of lists was a constant in the Spanish administration, and that in some cases the Spaniards went to the extreme of compiling lists of all the officials and laws of the whole Empire, it is possible that some papers existed that organised schedules in rows and columns (Gaudin 2019, 83–103). However, these

papers were probably destroyed as soon as they lost their validity or the work schedules were reworked, as it is important to remember that these schedules were revised according to eventualities and the very rhythm imposed by society. In fact, not even handwritten or printed wall calendars were spared from this process of destruction, and only a few examples survive from the 16th and 17th centuries (Uribe 2019).

Using a manuscript calendar from 1689 of the Royal Audience of Santafe in the New Kingdom of Granada (today Bogota, Colombia), we can get an idea of the graphic aspect of calendars at that time and their elaboration process (Fig. 5).⁷ First, it is worth noting that the Spanish word used for these types of calendars was “Tabla”, synonymous with list and index, among other meanings (Real Academia Española 1739). In this list, some of the information is crossed out and some was added between the lines. By following the documents that accompany this folio, one discovers that the public holidays were the product of negotiations, as the highest authorities wanted the officials to attend work on as many days as possible, while the officials followed the holy days decreed by the Church to take the day off. In fact, by this time there were already clear rules regarding public holidays and working days, but the same legislation provided room for exceptions such as local saints’ days and saints of personal devotion. From this point on, discrepancies began to emerge, in addition to the advantages that each side wanted to gain over the other according to their titles and privileges. So, where it seemed that it was sufficient to copy the calendars and schedules annually, the truth is that these rules were provisional and were negotiated periodically within the royal offices.

Tabulation as enumeration was not a graphic technique ignored by the Nahua either, as the surviving pre-Hispanic calendars can be thought of as lists and tables. Generally speaking, indigenous reading and writing practices were similar to that achieved with any other table. When certain information is tabulated, general and abstract categories are created with the purpose of generating synthetic schemes. These allow for various types of consultation: vertical, horizontal, linear, diagonal, triangular, random and boustrophedon, almost at the reader’s convenience. The divinatory rites of the indigenous people’s priests have to do with these reading practices when consulting calendars, so the Spanish lists, much simpler in their graphic composition, did not take them by surprise (Mikulska 2015, 259–94; 2014; Boone 2008). In fact, lists as a technology are found in the origins of writing and administrative accounting, so it is neither an exclusivity nor an invention of the Spanish or the

7 Archivo General de la Nación de Colombia (AGNC), *Sección Colonia, Fondo Historia Eclesiástica* 20, 2, Doc. 56.

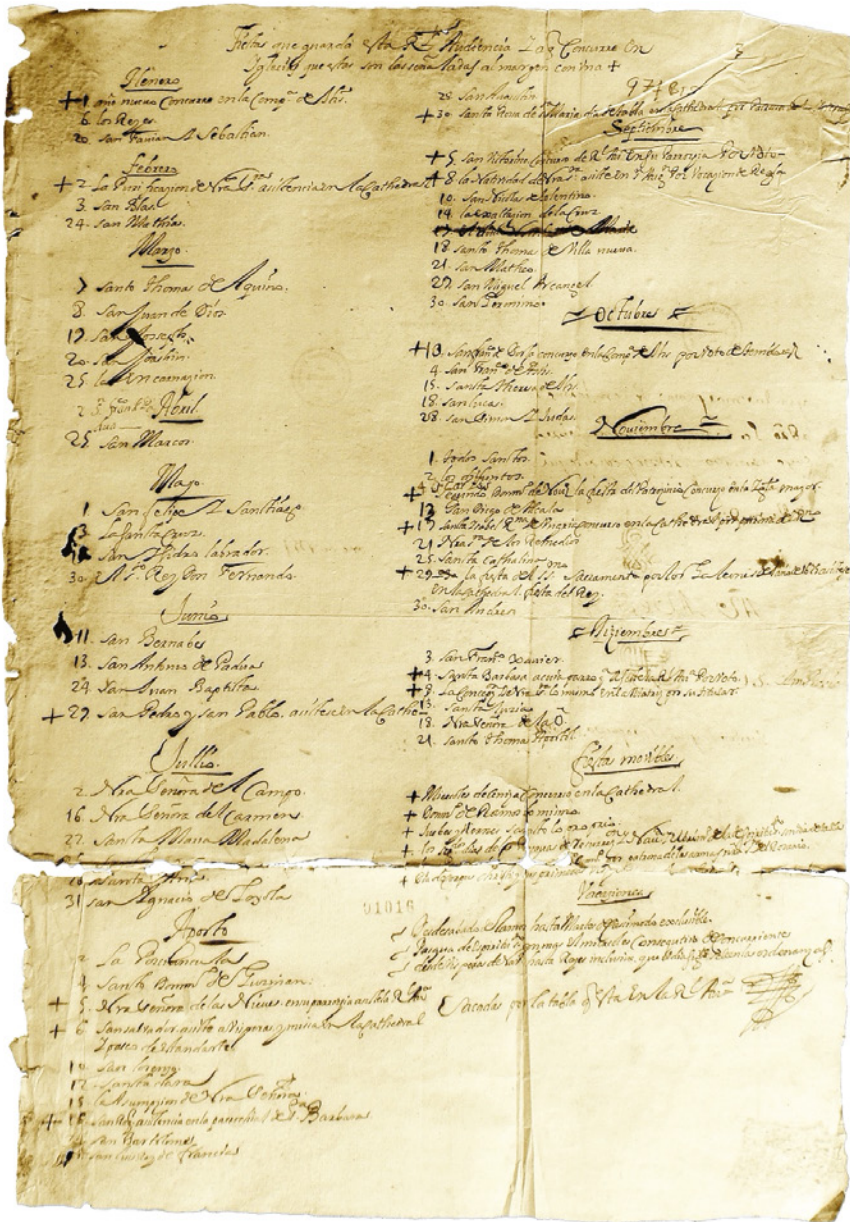


FIGURE 5 Manuscript calendar of the Royal Audience of Santa Fe (1689). Timetables and calendars were tentative and negotiated periodically.
 SOURCE: AGNC, SECCIÓN COLONIA, FONDO HISTORIA ECLESIASTICA 20, 2, DOC. 56



FIGURE 6 Calendar from the printer of María de Sansoric in Tlatelolco (1598). Tabulation of the months by three trilingual indigenous and a Dutch printer
SOURCE: BIBLIOTECA NACIONAL DE MÉXICO (BNM), W, GI-MC

indigenous (Goody 1977, 52–111; Eco 2009). An example of the confluence of tabular systems between different cultures can be seen in a calendar from 1598, the oldest surviving printed wall calendar for the Spanish Empire (Fig. 6). The print came out of the printing press of the Colegio de Tlatelolco whose director was María de Sansoric, a woman of Spanish origin who had as printer the Dutchman Cornelio Adrián César and as typesetters three indigenous persons who knew Nahuatl, Latin and Spanish (Mathes 1995; Garone Gravier 2007).⁸

In short, although no tabulated timetables survive, it is clear that lists and grids were the most suitable and versatile means of writing and amending the subdivisions of the working day. This leads us to infer that calendar wheels were visually attractive, but ultimately too complicated to correct each time the social time changed. Each change involved drawing a new diagram, a

8 It should be added that the printing presses of the New World quickly included the indigenous peoples as operators alongside their languages, printing books in vernacular languages and creating special characters to suit the indigenous calligraphy (Garone Gravier 2020).

process that must have been very time-consuming, whereas lists naturally left some scope for adding or subtracting information. If a new item was required, the lists could be remade relatively quickly by any scribe or printer, so their production and reproduction was convenient for both writing and printing. It should be noted, however, that this process did not happen all at once, but was evolutionary, as it followed the growing pace of administrative centres that progressively took on more functions and were thus occupied by the demands of more people.

The illusion of rigid times, without mutations and directly transplanted from Spain, is produced if one only consults the “Recopilación de leyes de los reynos de las Indias” (1681), a set of books that brings together the laws decreed for the New World. It contains the ordinances that established the schedules in the Royal Audiences within the reign of Philip II, specifically on 17 April 1581 (León Pinelo and Solórzano Pereira 1681a, T. 1, Lib. II, Tít. XV, Ley XXI, 192). Nevertheless, there are several previous reports and ordinances that allow us to keep track of the growing need to specify schedules, as well as revealing that the pace within the offices was more frenetic than the law stipulated. In broad terms, the “Recopilación” indicates that the presidents and judges of the Royal Audiences had to be at their desks from Monday to Saturday to hear reports for at least three hours, if it was not a public holiday. The winter schedule was from October to March from 8 to 11 a.m., and in summer from April to September from 7 to 10 AM. This day was simply called “in the morning”, as can be found in all kinds of documents of the time. On Tuesdays and Fridays, they had to work an extra hour to “hacer audiencia” (hear the litigants) and publish the sentences. “In the afternoon”, which in winter meant from 3 PM onwards and in summer from 4 PM onwards, they were only to be there on Mondays and Thursdays to dispatch judgments.

When these schedules are contrasted with the aforementioned Ordinance of 1528 signed by Emperor Charles V, which decreed for the first time the installation of clocks in the Royal Audience of Mexico City, there are differences between the levels of specificity. In this one, the three morning hours are simply indicated according to the winter and summer schedules, without specific work or afternoon workdays (Puga 1563, 89–90). This difference becomes more evident when compared to the first provisions for the establishment of the *Casa de Contratación* in Seville. As for the schedules, the 1503 ordinances for this institution simply state that the officials were to meet “every day at the hours that were necessary”. In 1510, the hours began to be specified, and in 1531 the schedules were closer to what was finally recorded in the “Recopilación”.⁹

9 1503: AGI, *Patronato*, L. 251, Ramo 1, ff. 1–4. 1510: AGI, *Patronato*, L. 251, Ramo 1, ff. 5–10. 1531: AGI, *Justicia*, L. 944. Todas ellas compiladas y trascritas por: (Morales Padrón 1979).

At this point it should be noted that laxity of the hours was not shared among the Spanish institutions, according to what had seemed customary since then, already by 1480 the Catholic Monarchs had signed a law ordering the “morning” and “afternoon” schedules, stipulated numerically for the Council and the audiences of Castile and reproduced successively in subsequent laws (López de Alcocer, López de Arrieta, and Atienza 1581, 1:T, 1, Lib. II, Tit. III, Ley III, 49r–50). Therefore, the need to number the schedules and to subdivide the working day into ever more precise intervals does not obey a cultural question or an official norm, but rather emerges from a concentration of tasks and interpersonal relations at the same point. In other words, the greater the number of people in the same space (institution or workplace), the greater the need for increasingly strict, and in some cases severe, schedules.

However, when comparing the schedules dictated by law with the rhythm of work in the Royal Audience of New Spain, it is possible to visualise how the schedules were adapted according to the needs of society. A report on the activities of Luis de Velasco y Alarcón, second viceroy of New Spain between 1550 and 1564, indicates that both he and the royal officials worked more hours than stipulated by law and that the activities carried out required a more complicated day-to-day schedule than a general schedule can tell us.¹⁰ In the first instance, it should be noted that every day was scheduled with activities, both morning and afternoon, and that these duties were made more complex by the very social composition of the city. Far from simply hearing relations “in the morning” and making agreements “in the afternoon” as ordered by the “Recopilación”, the days were subdivided into more precise activities and specific schedules, often exceeding the regulated hours, all because of the endless number of people who crossed the threshold of the offices to go to court.

So for example, the viceroy wrote in a complaining tone that on Mondays he had to start making agreements from two o'clock onwards, but that these usually took until seven in the evening, “many times later and rarely earlier”. He claimed that the settlements were prolonged because a good part of them were spent on the affairs of the indigenous peoples, where he had to listen to them one by one to understand the disputes and lawsuits they had among themselves, consulting at the same time the records of reports and valuations of their villages. On Tuesdays, he says that all the officials were busy listening to the “small, infinite and unimportant lawsuits” between the indigenous peoples themselves, and between them and the Spaniards, mulattos, and mestizos. With each of these audiences, the indigenous translators and scribes drew up documents for each of the parties to sign in agreement. Day-to-day

¹⁰ AGI, *Indiferente*, 856.

life continued with the constant presence of the indigenous peoples, whose very existence determined to a large extent the regulation of the schedules.

Indigenous interpreters were also not exempt from laws for the fulfilment of their duties. An ordinance of 1563 stipulated that these translators had to be present at agreements and prison visits every day except holidays. Likewise, they had to go to the Royal Audience at nine in the morning every day and in the afternoons to the offices of the president and the oidores. In case of non-compliance, they had to pay a fine of two pesos for each day, money that went to the city's poor (Solano 1991, 62–63). It should be added that some indigenous peoples were porters of the Royal Audiences and city councils, and according to the “Recopilación” the porters not only had to be punctual in the opening of the offices, but were also in charge of setting the clock in case there was no clockmaker (León Pinelo and Solórzano Pereira 1681b, T. 1, Lib. IX, Tit. 1, Ley III, 131). The chimes of the schedules ended up leaving a deep impression among the indigenous peoples and their sound can be “heard” in several of the cited codices, diaries, or annals. From the last quarter of the 16th century onwards, the writing of the hours became frequent in these manuscripts indicating the number in Arabic or Nahuatl, followed by words such as “hora”, “ora” and “Tzilini” which means: to ring a bell or metal. All these horary expressions can be translated as “o'clock”, and equated with the notions of punctuality and quantitative time that can be found in contemporary European diaries (Baggerman, Dekker, and Mascuch 2011; Sherman 1996).¹¹

5 Conclusions

Historiography confirms that the Spanish Empire was under construction during the 16th century. Cities, communication routes, legal instruments, administrative institutions, ways of recording, and the collecting and processing of information had to adapt to the exponential multiplication of population and territory (Fernández Albaladejo 1993; Bernal 2007; Brendecke 2016). Iberian expansion around the world, particularly on the American continent, imposed a need to govern over distances incommensurable to any bureaucratic apparatus existing at the time. As part of these challenges, it became essential to know what was happening on the other side of the world under a concrete time that was recorded in writing. Mechanical clocks, alphanumeric

11 For example, in the “Codex Aubin” they note that in the year “12 Tochtili” in Nahuatl, a girl named Sebastiana was born “today, Tuesday XXIII January of the year 1582, a day 6 Aquarius, 10 Golden number, 6 hours” (Dibble 1963, 88).

recording and tabulated schedules were the key to connecting cultures and individuals with diverse temporalities on the same time axis.

As the Spanish Empire took on planetary dimensions, a global time structure was constructed. However, as seen in the preceding pages, this phenomenon was not the result of imposing forces that transplanted pre-set schedules from Spain to the New World. The indigenous peoples, particularly the Nahua, discovered the need to install clocks in their cabildos to enhance their cities and, of course, to coordinate administrative operations. Like the Royal Audiences and city councils run by Spaniards and mestizos, the indigenous peoples undertook public collections to build these machines, following their pre-Hispanic system of taxation thereby making the clocks not only public property but also a community asset. The emperor and viceroys adapted to these demands, in some cases contributing money from the royal coffers and eventually adopting by law the need to have clocks with bells so that they could be seen and heard in all the administrative buildings of the Empire.

Regarding the quantitative recording of dates, indigenous peoples and Spaniards showed mutual interest in their calendars. Both sides collaborated to adjust the counting systems, although with disparate and contradictory results. The missionaries tried to adapt the indigenous people's cycles to the ancient mnemonic diagrams and in turn to the Julian calendar, while the Nahua simply incorporated alphabetic writing and Arabic and Roman numerals into their ancient means of chronology. The Spaniards produced a series of calendar wheels that were attractive, but of little use in everyday life. The indigenous peoples began to use Christian dating to write their own historiography and without any pretensions to studies of universal hemerology. Their ability to handle several numerical systems allowed them to provide practical answers for practical life, without the need to displace their other forms of accounting. And while the indigenous and Julian calendars coexisted for decades, both fell into disuse with the new Gregorian calendar reckoning.

Clocks, calendars, and schedules converged in administrative offices and it is here where one can explicitly find the use of quantitative time, with numbers stripped of qualitative meanings or symbolic interpretations. Precise dates and hours served to classify events in a temporal structure, arranging the documentation in a synthetic chronology. Whether as clockmakers, interpreters, scribes, gatekeepers, litigants or simple civilians, indigenous peoples participated in the drawing up of the schedules implemented. The greater the number of processes, lawsuits, claims and consultations, the greater the need to subdivide the office schedules. All of which was subject to permanent negotiations and the periodic reworking of tabulated schedules. In the last quarter of the 16th century, quantitative time was at a higher level of assimilation, both

among indigenous peoples and society at large, all articulated by the Royal Audiencias and town councils. These were the origins of the concept of global synchrony, which today would be impossible to think of without quantitative time adapted and expanded in the New World among the indigenous, mulattoes, mestizos, Spaniards, and Europeans in general.

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