

THE HEAVENS AND TIMEKEEPING, SYMBOLISM AND EXPEDIENCY

Paul Gabor*

Timekeeping has always followed the heavens for reasons of practicality and symbolism. These two motivations can have conflicting implications for the concrete implementation of timekeeping mechanisms. Even in this eminently pragmatic age we have little control over the power of temporal symbols. This paper focuses on the deeper dynamics underlying timekeeping, proposing several notions which can serve as tools in examining the past and the present of chronology: continuity, timelessness, inertia, expediency, empirical and calculated schemes, symbolism and reality. We show that the principle of astronomical conformity in timekeeping seems to fulfill its social function even when it is not perfectly observed. In the realm of symbolism, what counts is the general perception, not the fact. Throughout history, expediency dictates a general trend away from empirical timekeeping to calculated schemes. These do not follow the principle of astronomical conformity strictly, rather, they respect it on average, aided by empirical correction mechanisms. In the present case, debating the relative merits of UTC as defined in 1972 and the proposed uniform civil time is very much an instance of this general shift away from empirical timekeeping. Calculated timekeeping does not actually agree with the Heavens at any given moment but this does not seem to jeopardize the general perception of its astronomical conformity. The general perception seems to follow the intention rather than the fact. This paper proposes to examine the dynamics of symbolism and expediency in the long history of timekeeping compromise, and apply these findings to the proposed decoupling of civil time from Earth's rotation.

INTRODUCTION

This conference focuses on issues raised by a proposal submitted to the upcoming Radiocommunication Assembly of 2012. The matter is primarily technical but it also touches upon a principle which has been regarded as inviolate and undisputed for millennia: that civil timekeeping needs to follow astronomical events. Let me state my purpose already at the outset. I will not be calling for an unconditional preservation of the UTC as defined in 1972, nor will I be advocating a concrete proposal for its revision.

What I would like to recall, however, is the depth of meaning that timekeeping represents. I would like to get in touch with the symbolic substrata and other social dynamics of timekeeping. However, I shall also point out that these dynamics exert conflicting influences upon the development of timekeeping schemes throughout history. By consequence the actual schemes are never perfect.

The principle of astronomical conformity possesses great symbolic power. And yet, as I shall try to show, this does not imply that timekeeping schemes ought to follow the Heavens as accurately as possible — just accurately enough. Symbolism can suffer some astronomical inaccuracy. In fact,

*Vatican Observatory, Department of Astronomy, University of Arizona, Tucson AZ, 85721-0065.

my overall message is that of reassurance. I believe that even if a decoupling of civil time from Earth's rotation becomes a reality in the near future, it is unlikely to have lasting consequences.

To outline the contents of this paper briefly, Section 1 examines some of the purposes of timekeeping, in order to show the depths of motivation for the astronomical conformity of timekeeping which is a principle deeply ingrained in its history. Section 2 discusses various aspects of the social dynamics underlying timekeeping, including interplay of astronomical conformity with other forces and principles. The purpose of this Section will be to gather notional tools, (hopefully) useful in approaching the subject at hand, and Section 3 applies them to several concrete cases.

Most (if not all) of the historical examples do not concern the diurnal rhythm but other elements of timekeeping. I believe this is legitimate because the issues are clearly analogous and the history of the definition of the day does not provide sufficient material.

THE HIDDEN DEPTHS OF TIMEKEEPING

Purposes of timekeeping: practical and otherwise

Timekeeping (closely followed by navigation) is doubtless the most ancient mission of astronomy. It is an eminently practical endeavor. Already in 360 BC, Plato mentions this evidence.

The observation of the seasons and of months and years is as essential to the general as it is to the farmer or sailor. (*Republic*, 527c)¹

This is all the more true today when, assisted by omnipresent accurate timepieces, our lives are meted out by the second under the dictate of schedules, agendas, timetables, milestones, and deadlines. We tend to forget that apart from these most prosaic and pedestrian of utilitarian purposes, there is more to timekeeping than practicality, and how ever inane these other purposes may seem, they are much more profound and pervasive.

I believe that the practical purposes of timekeeping will receive quite extensive attention from many of the speakers at this conference. What I feel needs mentioning, however, are its purposes which may not seem all that practical. That is why I will leave the former to others and concentrate on the latter.

The purpose of this conference is to ponder the consequences of "decoupling civil timekeeping from Earth's rotation". If our deliberations are to proceed with clarity and balance, I believe we need to remember that timekeeping is not just a practicality. It touches upon some of the basic, and indeed, most primitive aspects of civilization and culture. What I will try to bring forward in this Section are the results of reflections of anthropologists and historians of religion, and I have to ask your indulgence, because I am no expert in either of these fields.

Regeneration of Time

Timekeeping satisfies a considerable number of social needs, and apart from the obvious practical ones, there are many of a different sort: the need to come together to celebrate or to deal with the past, to mark a new beginning or to help bring about closure and healing, to feast and to fast. I will limit myself to an example of a social ritual we all know and participate in: the New Year's Eve.

Why do we celebrate a randomly chosen moment of the civil year? I am sure you have asked yourselves this question before. To my utter horror and consternation, I find that many undergraduates today have an answer ready. They tell me, "It is a convention," and consider the matter closed. If

pressed, they explain that since it is a convention, it is just a random accident of historical evolution which could have gone another way easily. Therefore, the subject is of no deeper relevance. (This does not stop them from wholeheartedly indulging in the celebration of this “mere convention”).

The precise moment of this social ritual is indeed a convention. But the ritual itself? Is it a celebration of a convention? Is it simply that the transition from one calendar year to the next is a good pretext to indulge in some merrymaking? Or is there a more profound meaning behind it?

Mircea Eliade identifies the fundamental motivation behind the New Year’s celebrations with a very archaic operation which he calls the Regeneration of Time.² How ancient is this procedure? Since it is clearly present in the culture of Australian Aboriginals, as well as in the cultures of the Fertile Crescent, we can derive a lower limit on the age of the Regeneration of Time by looking into the DNA chronology of prehistoric migrations (unless this is a case of “convergent evolution” which is unlikely). A recently published result allows us to deduce a lower limit of about 60,000 years!³

The exact purpose of these rites may be debated but it is clear that they are related. According to Eliade, the Regeneration of Time is a way of dealing with the past and establishing a new beginning. This is achieved by a ritual cosmogony, a ritual re-creation of the world, which is preceded (and perhaps symbolically provoked) by a return to the primordial Chaos through another set of rituals. There are numerous variations in these but mostly they try to effect this abolition of time and return to a chaotic timelessness by suspending social and moral codes, e.g., slaves and their masters exchanging roles for the day, the whole community drinking to excess. Generally speaking, the more confusion the better.

Some elements of these rituals remain with us to this day as somewhat puzzling customs devoid of their symbolic power: the public and generalized ebriety of the New Year’s Eve or the custom still alive in some schools of the youngest student becoming the headmaster for a day. It is worth remarking that these remnants of ancient rituals are not practiced only on the New Year’s Eve but can be found in conjunction with other important dates public and private: the carnival before Lent, the bachelor party before the wedding, etc.

I believe we need to realize how far-reaching Eliade’s insight really is. What he is saying is that human societies need a periodic abolition of “time” itself during an immersion into primordial Chaos so that Cosmos, the ordered world, may arise anew. And this implies that those who are in charge of timekeeping are in fact in charge of ritual cosmogony!

Timekeeping schemes: artifacts with symbolic power

Timekeeping schemes (calendars, UTC, the seven-day week...) are artifacts devised by individuals and societies. Once they become symbols they gain a life of their own. Regardless of their authors and their intentions, timekeeping schemes come to possess symbolic powers. They have the ability to evoke mysteries and depths which hold a powerful subliminal sway over us. They draw us in and produce diverse emotional responses. The seven-day week has a link to Creation and thus to the Creator. It is a symbol of the Creator Himself. And, according to Paul Tillich, a symbol “participates in the power of that which it symbolizes”.⁴ The lunar month (which has been effectively left out by Julius Cesar’s calendar reform) has a clear link to the feminine with all the richness and depth of meanings this signifies. A few decades ago the Platonic year’s link to the nearly forgotten idea of secular change and the ages of world has been brought forth from the collective subconscious as the supposed advent of the “Age of Aquarius” excited many minds and hearts.

I would like to stress that *even those institutions which have the authority to modify timekeeping schemes themselves, have little control over the symbolic significance of what they regulate. Even though the results are mostly out of the hands of individuals and institutions, it is nonetheless infinitely preferable to meddle in such matters with at least some idea of the underlying dynamics.*

UNDERLYING DYNAMICS AND ASTRONOMICAL CONFORMITY

Principle of Astronomical Conformity

The issue under consideration at this conference is an instance of the astronomical conformity of timekeeping schemes. How does astronomical conformity impact the symbolic power of timekeeping schemes? One might argue that for symbolic and ritual purposes, astronomical conformity is of no import. Eliade's Time Regeneration festivals could be declared at any point of the year. Let us examine the historical record. On the one hand, we must acknowledge that not only they can be declared without regard to Earth's rotation or orbital position, but also that sometimes this indeed was the case. On the other hand, however, we can point out that *although astronomical accuracy was often lacking in fact, what is universally present is the principle that feasts should be celebrated in conformity with natural rhythms in general, and astronomical phenomena in particular.*

In the 1st Century BC, Geminus examining the history of the Greek calendar expresses this quite clearly as the general opinion of Antiquity:

“Accuracy in observing feasts pleases the Gods.” (*Isagoge*, VIII, 6-9)⁵

The Chinese Empire was very distant from the cultures of the Fertile Crescent and the Mediterranean basin, and yet even there the principle of calendar accuracy was an undisputed goal. Between 104 BC and AD 1644 the Chinese government reformed the calendar about 50 (fifty!) times precisely because they wanted the calendar to conform to the heavens.⁶ This principle was expressed in the official astronomical canons for the calendar:

“The verification of the principles of ancient astronomical canons has to be sought in the Heavens.” (*Hanshu*, j. 21A)⁶

“It is good to conform to the Heavens in order to bring about the accords [between observation and calculation].” (*Jinshu*, j. 18)⁶

Coupling timekeeping schemes with celestial phenomena has been, for the most part, a very practical arrangement. Although I do not have an exhaustive data set I venture to claim that the evidence at hand suggests that the astronomical conformity was universally accepted as a principle, although it was not always adhered to in fact.

How can something be *universally accepted but not respected in fact*? Certain moral principles are violated by many or most people, and yet they represent a foundation of very important social institutions. The institution of marriage, for instance, is founded upon a number of principles, one of which is fidelity. This principle is a part of what defines marriage as an institution in our society. It may seem strange but the principle of fidelity “works”, i.e., provides the society with an idea of what marriage is, even when some people, sometimes, are not faithful. This example shows that a principle can fulfill its function even when its observance is not perfect.

Similarly, *the principle of astronomical conformity in timekeeping seems to fulfill its social function even when it is not perfectly observed.*

This discrepancy was sometimes caused by simple lack of astronomical knowledge (e.g., in the above-mentioned Chinese case), but more often by a conflict with other principles.

Continuity and Timelessness

Continuity is a very practical aspect of any timekeeping scheme, and it can gain a special symbolic significance. A continuity since “time immemorial” lends the timekeeping scheme a certain air of timelessness which makes it sacrosanct and thus immune to change. Social institutions enjoying an air of timelessness are often accepted as sacred rather than profane, as *contemporary with the foundation myths* of the given civilization.

“Calendars are resistant to change. The Kings of Egypt had to swear before they took office that they would not change the calendar...”⁷

The Egyptian calendar was perceived as a divine gift and thus it was unthinkable to change it even though its non-conformity with the seasons soon became apparent (the year was 365 days long with no leap years). Let me stress that *timelessness is not just another name for continuity or inertia.*

Our own timekeeping still contains one “timeless” element: the 7-day week. It has been around literally since “time immemorial” because its early Mesopotamian origins are shrouded in mystery. It is clearly older than the Hebrew Scripture which enshrines it within the Creation narrative of Genesis 1, linking it to the beginning of time itself. In the context of 20th Century debate on the reform of the calendar, the Second Vatican Council maintained that the perennial status of the 7-day week needs to be safeguarded:

“Among the various systems which are being suggested to stabilize a perpetual calendar and to introduce it into civil life, the Church has no objection only in the case of those systems which retain and safeguard a seven-day week with Sunday, without the introduction of any days outside the week, so that the succession of weeks may be left intact, unless there is question of the most serious reasons.” (Constitution *Sacrosanctum Concilium* of the Second Vatican Council, Appendix *Declaration on the Revision of the Calendar*)⁸

This example demonstrates the difference between timelessness and continuity. Whereas continuity is obviously important for practical purposes, it is by no means a sufficient reason for maintaining the highly impractical continuous cycle of 7-day weeks. This particular institution can be explained by its timelessness: It cannot change because it has been in place since “the beginning of time”.

It is important to note that *what counts is the general perception, not the historical fact.* In other words, although most of us know that the cycle of 7-day weeks cannot possibly have its origin at the beginning of time, this fact is overshadowed by *the feeling of timelessness surrounding this particular institution. As long as this feeling remains, the institution remains and retains its symbolic power* of evoking the Creation narrative.

Inertia

Inertia is another property of social institutions which often prevented astronomical conformity. The overdue reform of the Julian calendar is a well-known example. The reasons why the change was so difficult to tackle ranged from simple procrastination to fear caused by previous traumatic experiences. Relevant authorities did not wish to rekindle old conflicts or cause new divisions in Christendom. The long struggle to unify the celebration of Easter (2nd–6rd Century) was still vividly present in historical memory. Indeed, it is there even now.

In the mid-1920's, the League of Nations established a committee to study calendar reform, including fixing the date of Easter (e.g., on the first Sunday in April). The Committee diligently launched a comprehensive inquiry, requesting official positions of governments and other bodies, including ecclesial authorities. What is quite remarkable is that all major Christian Churches responded in the same way: There are no doctrinal objections to such a proposal but we do not want this to cause further division among Christians.⁹

Gregory XIII's reform of the calendar was a courageous move, which did indeed lead to considerable tension which still remains to be resolved with the Orthodox Churches. *Inertia in such sensitive matters as timekeeping can be a force to be reckoned with.*

Expediency: shift from empirical timekeeping to calculated schemes

Last but not least there is a general trend to replace empirical timekeeping with calculated schemes which do not follow the actual astronomical phenomena but mean parameters. As an undesired but inevitable consequence a certain discrepancy between the Heavens and civil timekeeping is introduced.

This tendency has been evident throughout the history of timekeeping. Let me recall the example of Jewish timekeeping which, until AD 70, was strictly empirical. The months were meticulously observed according to the phases of the Moon and solar years were kept according to the Metonic cycle. After the Jewish-Roman wars, however, Hillel II, president of the Sanhedrin (AD c. 320-385), enacted a transition to a calculated calendar scheme. I find this particularly revealing because of the contrast with Judaism's insistence on accurate observance of the ritual rules and regulations: even the Great Sanhedrin capitulated under expediency's inexorable pressure, abandoning the strict, empirical coupling of Jewish feasts and festivals with the Heavens.

What speaks in favor of the calculated schemes is expediency. It is much easier to follow computational rules than to maintain an astronomical vigil over the celestial phenomena relevant for timekeeping. Empirical schemes need protocols and networks in order to announce the observed parameters, making it difficult to follow the empirical time. Calculated schemes can be extrapolated into the future (which empirical ones cannot), and into the past (for which empirical ones require an access to records).

In the present case, debating the relative merits UTC and TAI is very much an instance of this general shift away from empirical timekeeping.

By construction, *calculated schemes do not follow the principle of astronomical conformity strictly, rather, they respect it on average, minimizing long-term drifts.* Since computational rules cannot predict astronomical phenomena with perfect accuracy, *calculated timekeeping needs some correction mechanisms based on observation.* The major drawback is that *often no such mechanism is defined at the outset.* As a matter of course Clavius says (*Romani calendarii... explicatio*, V, 17)¹⁰

that the Gregorian calendar should be tweaked after several millennia by judiciously omitting a leap day to keep it synchronized with the tropical year. Yet there is no mention of such a mechanism in the Papal Bull *Inter gravissimas*:

“Then, lest the equinox recede from XII calends April [March 21st] in the future, we establish every fourth year to be bissextile (as the custom is), except in centennial years ; which always were bissextile until now; we wish that year 1600 is still bissextile; after that, however, those centennial years that follow are not all bissextile, but in each four hundred years, the first three centennial years are not bissextile, and the fourth centennial year, however, is bissextile... and the same rule of intermittent bissextile intercalations in each four hundred year period will be preserved in perpetuity.” (Gregory XIII, *Inter gravissimas*, 1581)¹⁰

Despite this drawback, it is clear that the calculated schemes are highly attractive because of their expediency. They are always mere tools allowing to conform with the Heavens with a minimum of empirical input in day-to-day timekeeping. What is also crucial to note is that *in general, calculated timekeeping at any given moment does not actually agree with the Heavens. This, however, does not seem to jeopardize the general perception of the astronomical conformity of such schemes. The general perception seems to follow the intention rather than the fact.*

Symbols and Reality

Why is astronomical accuracy such a central principle (although poorly observed) not just for the everyday and practical but also for the symbolic and ritual purposes of timekeeping? I believe the fundamental reason has to do with the relationship between symbols and reality. The relationship is rather complicated. Not so long ago, all human societies would have understood that the eternal realm of symbols and myths, values and virtues, Gods and heroes, was the ultimate reality, and our lives were a part of this true world inasmuch we imitated these models, i.e., inasmuch we participated in the timeless and therefore permanent (principally through ritualized behavior). Plato's ontology is a philosophical reflection of this relationship of symbol and reality.

Our society today is somewhat at odds with this view, and a different ontology rules. We say that real is what we see, touch, measure. At the same time, a substratum of our collective consciousness remains faithful to the previous view. I shall refrain from developing this topic any further. The only purpose of these terse remarks was to indicate why I think the relationship between symbols and reality is far from straightforward in our culture.

Be it as it may, *symbols are instinctively perceived as at least grounded in reality if not indeed true and real.* A good timekeeping example being noon and its dark twin, midnight. There is something magical about noon and midnight. Historically, high noon was regarded as the symbolic axis of the day, a stepping stone in the river of time. Similarly midnight represented the essence of darkness. Hours are labeled with respect to noon as hours “ante” and “post meridiem”. Noon was announced (and in many places still is) by the tolling of bells, and in the days of unreliable mechanical clocks, noon was the privileged moment of clock synchronization. This was understandable as the culmination of the Sun was very easy to observe accurately. By a certain effect of inertia, even after a century of time zones people think of 12 o'clock as the moment when the Sun is the highest. *It is the symbolic significance that dominates over factual trivia.*

In the event of decoupling the civil day from Earth's rotation, the inertia of general perception will maintain all the symbolic significance of the diurnal cycle for a long time. *Symbols work as long as they are perceived as grounded in reality: timekeeping symbols work as long as they conform to astronomical phenomena at least in some way that would allow the general perception to persist.*

Perceived astronomical conformity thus lends force to timekeeping symbolism. But this relationship is mutual. *The symbolic value of timekeeping exerts a pressure on timekeeping schemes until they conform to astronomical Heavens.*

APPLICATION

We can now apply the notions outlined above to several instances of timekeeping, primarily those under consideration at this conference.

UTC Scenario 0: No change

In this scenario UTC as defined in 1972 remains the basis of civil timekeeping. The system of how the public is informed about the leap seconds may be improved perhaps.

From the point of view of the underlying dynamics as described in the previous Section, this scenario abides by the principle of astronomical conformity but is contrary to the expedient trend of abandoning empirical timekeeping for calculated schemes. I believe this discrepancy will exercise a pressure on the UTC, sooner or later bringing about a change.

UTC Scenario 1: A new calculated rule

In this case, the empirical mechanism included in the 1972 definition of UTC would be replaced by a new calculated rule which would allow the UTC to conform with Earth's rotation to within half a second.

Such a rule would satisfy all the underlying social dynamics of timekeeping. The problem is that, at this point in history, it is unrealistic. We do not possess a sufficiently long series of observations to be able to formulate such a rule.

UTC Scenario 2: Decoupled "forever"

The second option is the adoption of a uniform time (TAI) as the sole basis of civil timekeeping. For specialists, navigators, astronomers, etc., UT1 might become available in some form or another. The general public, however, will use TAI exclusively. At the moment of transition to this system, there will be no mention of ever re-coupling civil timekeeping to Earth's rotation.

Whereas such a reform maximizes expediency, it also destabilizes the diurnal symbolism, creating a growing discrepancy between the symbolic significance and the reality upon which it is perceived to be grounded. I would estimate that this instability will be very small in the beginning. It will not take too long (maybe a century), however, before the principle of astronomical conformity reasserts itself.

UTC Scenario 3: To be re-coupled

From the point of view of the underlying dynamics, the main problem with the previous scenario is that it pretends to decouple timekeeping from Earth's rotation once and for all. First of all, I do not believe that is possible because in the long run astronomical conformity will prevail. And secondly,

it is just the pretense of Scenario 1 which makes it incompatible with the powerful principle of astronomical conformity; the actual measures themselves do not have to alter the general perception of timekeeping and its symbolism.

I would suggest, therefore, that if Scenario 2 is to be adopted, it would be wise to include provisions for eventual re-coupling of civil time to Earth's rotation. Such re-coupling, however, should not be a return to the existing empirical protocol, rather it should be a rule for leap seconds in conjunction with periodic reviews of the rule (Scenario 1).

Maintaining the diurnal rhythm in Space

Finally, let us apply our notions of the social dynamics underlying timekeeping to the problem of timekeeping in Space. Obviously, maintaining the diurnal rhythm will be a physiological necessity.* It is also quite clear that in the era of Space exploration, the most reasonable scheme will simply follow Earth time. But when colonies are established on other bodies, following the Earth may be impractical and it may even become a political issue. The principle of astronomical conformity will assert itself, and may prevail in the long run, although it would be struggling against the confusion of time conversions between the Earth and the various colonies. The colonies on Mars will thus adopt the Martian diurnal rhythm (with the Martian solar day of 24h 40 min); assuming that the human body will be adapt, adjusting its internal clock. Similarly the colonies on the Moon or on Ganymede might choose their diurnal rhythms as a simple fraction (1/27 or 1/7, respectively) of their orbital periods (leading to a day respectively of 24 h 17 min and 24 h 32 min).

CONCLUSION

To conclude, let me summarize my position. The principle of astronomical conformity is crucial in civil timekeeping for reasons that go far beyond the purely practical. However, precisely because this principle is so deeply ingrained in our society, a departure from it is unlikely to last.

The drawback of the 1972 protocol is that it is empirical, depending upon observations, whereas the evolution of timekeeping in general has been moving away from empirical protocols to calculated schemes. Several decades of observations should allow to predict the average spin-down rate of Earth's axial rotation with sufficient accuracy so that leap seconds could be introduced according to a simple predefined rule (with an occasional empirical tweak).

Although timekeeping enjoys the mysterious air of timelessness, its history demonstrates a surprising level of flexibility if the underlying symbolism can be maintained. Symbolism depends upon general perception, and is somewhat vague in its relationship to exact measurement.

I would prefer that civil timekeeping remains coupled to Earth's rotation. Yet, if it is to be decoupled, I suggest that the solution most in line with the long-term social dynamics described in this paper, will simply make it clear from the outset that the decoupling is temporary, and that there is a clear intention to introduce, in a few decades, a new and improved coupled scheme, based on a computational rule rather than directly on observation.

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*In the 1997 movie "Men in Black", the eponymous agency maintains Centaurian time with 37-hour days. As the character Zed says, "Give it a few months. You'll get used to it... or you'll have a psychotic episode."

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