"Time Sticks":
How Islam and Other Cultures Have Measured Time

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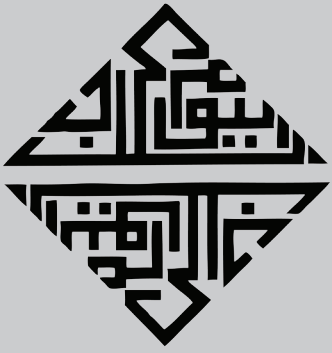

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Introduction

Time is essential to the very structure of Muslim communal life. Times of ritual and worship of Muslim obligation are regulated according to celestial events, both lunar and solar, meaning that they are always place-specific and are seasonally adjusted on a daily basis. The sun measures the day with its four daylight prayers and—by the length of its absence—also controls the fifth, the night prayer. The moon measures the months and so also the year with its seasons of ritual celebrations. The Islamic calendar is an essential but oft-forgotten institution that has held the Islamic world together over wide geographic distances and for well-nigh a millennium and a half. One of its greatest advantages may have been that it was so low maintenance. By adopting a strictly lunar calendaric system, the beginnings (and thereby the ends) of the twelve months of the year, and therefore the year as a whole, could be determined empirically, anywhere, by way of sighting of the new moon that signaled a new month's beginning.

In this paper, I look at the five daily prayers of Sunni Islam in order to explore how the "day" and the "hour" are structured in Islamic tradition, in Islamic science, and how they are being reconfigured in our new age of globalization.

Times of the Day

The Islamic day (like the Judaic and the Christian day) begins at sunset. The convention to use the arrival of night as dateline fits well with the preeminence of the lunar cycle in the Islamic calendar as a whole. To begin the new day at sunset had probably been a pre-Islamic custom.[1] In ancient Egypt, the new day began at dawn. To the Babylonians, it began at dusk. The Romans had two systems: their *natural* day began at sunrise, and their *civil* day began at midnight, which is the reckoning that underlay the Julian calendar and now by extension the Gregorian calendar. Since 1925, astronomers have universally counted the day from the midnight hour. When in 1972 radio stations across the world began to broadcast their time in terms of "Coordinated Universal Time" (UTC) predicated on "Greenwich Mean Time" (GMT), it became global practice to start the "official" day at midnight.[2]

"Seasonal" Time of the Five Daily Prayers

The five Islamic ritual prayers endow the day with a specific pulse that remains a vital sign of time perception in Muslim societies. In a world of global time zones, atomic clocks, and affordable wrist watches, where day and night are measured in 24 hours of equal 60-minute length, the times of these five ritual prayers are pegged

to the much older system of seasonal time and unequal hours. Even where this fact may merely imprint itself on the subconscious of all who dwell within earshot of a mosque's *adhan* (call to prayer), it fosters a groundedness in the seasonal progression from shorter to longer units of daylight and then back again. Societies have lived by this system of time reckoning and time management through most of human history. For millennia, human labor took its cues from local, astronomical time. The day's stretch between dawn and dusk determined the patterns of working, eating, resting, and praying. An hour was a one-twelfth fraction of the day or night whose length changed with the seasons, not an absolute or constant entity in its own right. Other than in the regions on or close to the equator, the hours of the day would be shorter in the winter months and longer during the summer. Seasonal time is sometimes referred to as "organic" time, while the clock-measured time of 60 minutes per hour is said to have created "abstract" time.[3]

The Technology of Time Sticks

Folk astronomy and simple timekeeping devices that used shadow lengths by day and lunar mansions by night were part of religious knowledge and devotional practice in all pre-modern Muslim societies. (Lunar mansions—stations of the Moon on the ecliptic—represent the Moon's average daily motion.) The *shakhis* or *shakhs* (time stick) is a gnomon, or indicator, that marks the sun's apparent progression by changes in the length and direction of its shadow. Most cultures at one time or another have used gnomons to measure daylight hours. Many pre-Islamic cultures, including the ancient Egyptian, Babylonian, and Chinese as well as the Greek and Roman, used the concept of the time stick to develop shadow clocks and sundials.[4] In the Arab world, very few of these simple time sticks have been preserved. From the literature it appears that they were most often vertical devices, crafted in various sizes and of various materials such as wood or stone, which stood upright in a mosque's courtyard enclosure. In a splendid 1983 account in *San'a': An Arabian Islamic City*, R.B. Serjeant, David A. King, and Isma'il al-Akwa report that an example of a traditional *shakhis* has survived in the main mosque of al-Janad north of Ta'izz in Yemen:

> ...a stone gnomon about the height of a man, with which the time of day could be reckoned using simple rules originally adopted from Indian astronomy, and the time of the midday and afternoon prayers, both defined in terms of shadow lengths, could also be regulated. In medieval Yemeni almanacs simple tables were sometimes given for reckoning time of night by lunar mansions.[5]

An Abandoned Mosque with a Time Stick in the Najd

I have seen a remnant of a horizontal *shakhis* in a now-deserted mosque in an abandoned hamlet of mud-brick buildings near the provincial town of Zilfie in the Najd (north-central Arabia). The mosque and its surrounding settlement had been built during the 1920s when regional villagers temporarily relocated there to escape Wahhabi Ikhwan attacks on their original dwellings. It was a mosque right out of the Hadith, a reproduction of the Prophet's mosque in Medina. This one faced due West toward Mecca, so the horizontal *shakhis*, attached to the Eastern edge of the roof, began to cast its shadow onto the open courtyard as soon as the sun declined from an overhead position.

Prayer Times in the Holy Qur'an

Ritual prayer and its five daily appointed times (the *mawaqit*) evolved on the basis of Qur'anic revelation and Prophetic and communal practice. There are many exhortations to prayer and devotions in the Holy Qur'an. In several instances, they include some general directives as to times of day and night for these forms of worship.[6] But the Qur'an does not specify five daily prayers or five set prayer times. When the early jurists began to explicate the Qur'an as basis of the law in the seventh and eighth centuries, they were arguing from within a ritual order through which the five daily prayers had been institutionalized, so that (as is quite often the case) existing practice was fitted into revealed ordinance. Most prominent in their discussions were nine Qur'anic verses that contain some indications of time of day or night for prayer, found in Suras 20 and 17 (dated into the Middle Meccan period of the revelations), Suras 30, 11, and 40 (Late Meccan), and Suras 2, 4, and 24 (revealed at Medina).

A very important text for many interpreters is Sura 17:78 (Middle Meccan): "Perform the prayer at the inclination of the sun (*li-duluk al-shams*) until the darkness of night (*ila ghasaq al-layl*). And the recitation of dawn (*qur'an al-fajr*), it is attended [or, it is witnessed]." Here the exegesis hinged on the phrase "at the sun's inclination," *li-duluk al-shams*; by identifying the "sun's incline" with the time immediately following the sun's zenith position at high noon, the interpreters established that the period "until the darkness of night," *ila ghasaq al-layl*, encompassed the noon (*zuhr*), afternoon (*'asr*), sunset (*maghrib*), and night (*'isha*) prayers, while the "recitation of the dawn," *qur'an al-fajr*, signified the dawn prayer (*fajr*). On other verses, there was—and is—no consensus, such as 2:238 (Medinan): "Observe the prayers, and the middle prayer, and stand before God devoutly." The eleventh-century astronomer Abu al-Rayhan al-Biruni, in his book *The Exhaustive Treatise on Shadows* (Ifrad al-Maqal fi Amr al-Zilal)—hereafter *Shadows*—says that there is not a single prayer that has not been proposed as "the middle prayer:"

"[T]hey disagree concerning it, and they explain it in so many ways, some of them attain the limit of the ridiculous...." To his mind there is no doubt that the "middle prayer" is the afternoon prayer, because it falls between the two daylight prayers (dawn and noon) and the two darkness prayers (sunset and night).[7]

Prayer Times in the Hadith

In the classical Hadith, the historical and the normative are intertwined. After the jurist al-Shafi'i (d. 820) had recast the concept of *sunna* (law based on inherited tradition) as the Prophet's *Sunna* (law based on the Prophet's actions), the historical part of the Hadith was all but swallowed up in the normative. We can perceive stages of this process in the several "layers" of information assembled by al-Bukhari (d. 870). These describe the Prophet's prayer practice in Medina and ascertain that the five daily prayers were, in a sense, "negotiated" (or "bargained over") with God during the Prophet's night-journey into the heavens; they also report that the times of prayer were taught to the Prophet by the angel Gabriel.[8]

The Prophet prayed the noon prayer (*zuhr*) when the sun had passed its highest point in the sky (i.e., crossed the meridian), but he also said that in times of severe heat, the noon prayer should be offered later; the Prophet prayed the afternoon prayer (*'asr*) when the sun was shining into his wife 'Aisha's room without casting a shadow and while sufficient time remained to walk to the outskirts (of Medina) in broad daylight; the Prophet finished the sunset prayer (*maghrib*) at a time when one could still discern places an arrow's shot away; he sometimes postponed the evening prayer (*'isha*) until a late hour, when a third of the night had passed; and he performed the dawn prayer (*fajr*) when in the waxing light a man could recognize his close neighbor while the women, who were farther away, would not be recognized on their way home (from the mosque).[9] The Prophet forbade prayer at the exact moments of the rising, culmination, and setting of the sun.[10] Prayers offered at these times are said to occur *bayna qarnay al-shaytan*, "between the horns of Satan," since it is then that the *mushrikun* (polytheists) offer their own. In *Shadows*, al-Biruni specifically mentions the Harranians, Hindus, and Magians among worshippers of astral bodies who adopt such times for worship and prostration.[11]

In a "second layer of traditions," the Hadith also specifies the first and last limits of prayer periods.[12] In the books of *fiqh* (jurisprudence), time limits for daylight prayers were early on expressed in terms of shadow length. The system as a whole was ascribed to the example of the angel Gabriel who had taught it to the Prophet at the beginning of his mission. This is how the authenticated Hadith quotes the Prophet's words:

> Verily Gabriel came to me twice at the door of the Ka'ba and we prayed the noon [prayer] when the shadow is like the rope of a trap [i.e., very thin], then the afternoon prayer when the shadow of anything is the equal of it[self]; then the

> sunset prayer when the sun falls and the fast is broken, then the prayer of nightfall when the twilight disappears; then the morning prayer when dawn arises and food is forbidden for the one who fasts. On the second day he [i.e., Gabriel] prayed with me the noon [prayer] when the shadow of each thing was like unto it[self], like the time of the day preceding for the afternoon prayer; then the afternoon prayer when the shadow of anything is twice itself, then the sunset prayer at its [same] time as the other day; then the last, the nightfall prayer when [i.e., up to] a third of the night had passed; and the morning [prayer] when it dawns. And he said: The prayertime falls in between.[13]

Prayer Times and the Problem of Geographical Latitude

The classical Hadith shows that it was composed or recorded by people who were not familiar with astronomy. Since the limits of prayer periods are defined in terms of the apparent position of the sun relative to the local horizon, Islamic prayer times depend on terrestrial latitude.[14] This requires that prayer times be defined in terms of shadow increases, not shadow lengths that vary according to degree of latitude, so that the Prophet's Hadith-recorded formula of shadow lengths in Mecca and Medina would be quite inadequate to determine prayer times in other latitudes.

Latitudes are imaginary lines connecting places that share the same angle of the sun above the horizon at any given time. Solar altitude, always latitude-specific, determines the length of shadows. It also determines the length of days; therefore, the latitude where we live marks our seasons and weather reports, and used to mark, perhaps more than it does now, our economies and lifestyles. The parallel lines of latitude wrap the globe from the equator to the poles in a pattern of shrinking concentric rings, which to the ancient scientists were markers of the seasonal journeys and positions of the seven planets that moved from east to west across their sky. Since it is at the equator that the seven planets pass almost directly overhead, scientists early on chose the equator as their zero-degree line of latitude. Then they divided the hemispheres above and below the equator into 90 degrees each, and calculated and drew the parallels of the Tropic of Cancer and the Tropic of Capricorn that marked the sun's passing through the summer and winter solstice, which they understood to be the northern and southern boundaries of the sun's motion over the course of the year.[15]

The Rise of Islamic Science

By way of early conquest and expansion, the Islamic realm fell heir to several much older civilizations that had long traditions of scholarship in the theoretical and applied sciences. From an early date, the science tradition was integrated into the Islamic worldview. The translation movement of the eighth through

eleventh centuries, from Indian, Persian, Greek, and Syriac sources into Arabic, was a consequence of, rather than a reason for, this integrative intellectual climate. Pursued at first in the existing capitals of classical learning such as Jundishapur, Damascus, and Alexandria, and later also in newly created Islamic urban centers like Baghdad and Cairo, the translation movement eventually Arabicized centuries' and even millennia's worth of major works in natural science, philosophy, literature, and even religion. In certain cases, this linguistic transformation and the research that initiated it, and later built on it, were so fundamental that they produced a conceptual transformation of entire disciplines. The early generation of scientist-translators was soon followed by schools of editors and exegetes who glossed and polished the new texts. In cosmology as in metaphysics, the premises of older, pagan cultures were incorporated into the Islamic scientific tradition, often by way of a radical recasting that made them responsive to the doctrines of Islamic monotheism. By the late tenth and early eleventh centuries, when the Arabic translations of Indian, Babylonian, Persian, and Greek mathematics and astronomy passed to al-Biruni in Central Asia, and the Arabic translations of Greek philosophy and medicine passed to Ibn Sina in Iran, those classical and Hellenistic texts had been Arabicized to a degree that they appeared to their new protagonists as "Arabic science."

Al-Biruni on Prayer Times and Islamic Science "In the Service of Religion"

By the tenth century, advances in planetary theory, observational data, and instrument-making, as well as the compilation of more accurate star tables, led many Muslim astronomers to critique and correct the ancient sources, including Aristotle and Ptolemy. One of those who "doubted" the theories and data of both, and proceeded to correct them, was the aforementioned al-Biruni, who was born in 973 in Khwarizm (modern Khorazm, in Uzbekistan) and died around 1050 in Ghazna (modern Ghazni, Afghanistan). The Turkish Sultan Mahmud of Ghazna had kidnapped him from his hometown and relocated him in Ghazna to serve as court scientist and court engineer in the Ghaznawid capital. In addition to *Shadows*, al-Biruni wrote a book on the calendars of ancient nations, several cosmologies, and a book on India, among others. In *Shadows*, which he completed in 1022, he lays out some of the areas of "service" that science is rendering to religion, explaining where it benefits the community of the faithful as a whole and every individual believer within it. These include: determination of the proper times and the proper direction of the five daily prayers (which requires knowledge of astronomy and geometry/trigonometry); computations of the beginning and end of the twelve lunar months of the Islamic year to aid in the process of crescent-sighting testimony as legislated in the *shari'a* (for which computation requires knowledge of astronomy

and geometry/trigonometry); and almsgiving, inheritance shares, and buying and selling in the market place (regulations that require knowledge of arithmetic/algebra and even geometry).

Al-Biruni also quotes the Qur'anic and Hadith-based laws on prayer and then discusses how best to implement them: not by following the "guess-work of observation," but by relying on the hard data of higher mathematics. The old "time stick" technology is fine for what it is, he says, but it needs to be "improved" by rigorous, higher training of those who are paid to use it, since he who is ignorant "will make a mistake in the rules of my religion." Every *mu'adhdhin* (one who performs the call to prayer) needs knowledge of astronomy and geometry—including knowledge of conic sections (which, according to al-Biruni, is sometimes called "spiritual geometry").[16]

Important in the calculation of communal prayer times is a precise definition of locale. This means that the local *mu'adhdhin*s must know the ancient authorities—Archimedes, Euclid, Appolonius, and Ptolemy—by heart, and be able to calculate the relation of terrestrial locality (latitude) to solar position (the inclination of the ecliptic) in terms of combinations of trigonomic functions. If the *mu'adhdhin* is interested in deep investigation, then—even though he came as empty as the devil—he goes away as victorious as the prophet Enoch (Idris). But if he refuses to undertake these studies, then he should swiftly relinquish his position and make room for a qualified candidate.[17]

Some *mu'adhdhin*s of al-Biruni's acquaintance were experienced professionals who correctly determined the noon and afternoon prayer periods for their location for each day of the (solar) year. Other *mu'adhdhin*s were of "excessive ignorance." One of them was upset that all available measurement devices and time tables were based on the (solar) "Byzantine year," not the Arab (lunar) year, and "his ignorance made him at the end refuse to accept anything based on the Byzantine months, not allowing it into the mosque, since [those] people are not Muslims. Then I said to him: The Byzantines also eat food and walk around the market. Do not imitate them in these two things [either]?" Then, "when I had confronted him with the fact of his disease [his utter stupidity] for which there is no cure, I left and saw him forsake the reckoning by breaking the instrument."[18]

Al-Biruni reserved his most sarcastic contempt for those who believe that the Earth is flat, "to the extent that some of them are of the opinion that the time of noon is the same in all inhabited places. Thus they base themselves on false premises, which entail as a result that they deviate in prayer away from the true direction."[19]

By the thirteenth century professional astronomers had begun to serve in the capacity of *muwaqqit*s (regulators of prayer times) at prominent mosques in the metropolises of the Islamic world, and there were also astronomers with the epithet of *miqati* who specialized in spherical astronomy and astronomical timekeeping,

but who were not necessarily associated with any religious institution.[20] This large crowd of accomplished scientists left a rich legacy of sophisticated tables for time reckoning and regulation of prayer times that indicate close collaboration between the cadres of Islamic science and religion in pre-modern times.[21]

This fact is of interest in the ongoing debate about the nature of the Islamic *turath* (heritage) in that it contradicts nineteenth- and early twentieth-century Orientalist interpretations of pre-modern Islamic culture, which stipulated an historical clash and cleavage between the Qur'anic ("Islamic") religious sciences and the rationalist and natural ("foreign," largely Hellenism-derived) sciences. The basic premise of this Orientalist critique was that the sciences (borrowed from foreign, pre-Islamic civilizations) were profoundly mistrusted by an ever-stricter "Islamic orthodoxy," so that the sciences existed and survived (until their early demise) not because of Islam, but in spite of it. To this day, similar Eurocentric, Western-Enlightenment-based ideas keep popping up in some contemporary textbooks on the history of science.[22]

The pre-modern Islamic texts do not support this critique. Quite to the contrary, Muslim scientists such as al-Biruni argued that it was the very separation of theology and science (in his case, mainly mathematics and astronomy) that had preserved the truthfulness and validity of both, and the great Qur'anic exegetes of the classical age, such as Fakhr al-Din al-Razi (d. 1210) profoundly shared this opinion. In his *Great Exegesis of the Qur'an* (Al-Tafsir al-Kabir), al-Razi discussed scientific subjects (meaning that he was thoroughly familiar with the larger cultural debates of his time),[23] while the scientist al-Biruni often wrote about the value of independent scientific investigation in the human quest to comprehend the cosmos, God's "work." There is now a new, revisionist literature written by contemporary scholars of Islam and science who have demonstrated that religion and science were two great intellectual traditions in the classical period of Islamic history, where in some splendor they operated in mutual independence, autonomy, tolerance, and often in modes of mutual enrichment.[24] (However, as we have just heard, not every village imam or country-bumpkin *mu'adhdhin* shared this opinion.)

Longitudes, Time Zones, Global Time and its Limits

Antiquity knew both equal and unequal hours. But the astronomers needed a more precise system of time definition; in the second century BCE the Hellenistic astronomer Hipparchus (d. ca. 225 BCE) developed the notion of "equinoctial hours," based on the length of the hour at the solar equinox, when the day is as long as the night. This scheme provided the astronomers with 24 subsections of the day that were of equal duration, independent of the seasons. Three hundred years later, Hipparchus's intellectual heir Ptolemy (d. ca. 160 CE) developed the concept further by dividing each equinoctial hour into 60 minutes. The "60" may have come to him

from the sexagesimal system favored by the ancient Babylonians.[25] This system also underlay the many further measurements and calculations of Muslim astronomers and mathematicians. But even though equal hours had been around by then for a millennium or more, the astronomers' hours had little impact on how societies in the Islamic world and in Europe were measuring their time.

The 12 unequal, "temporal," or seasonal hours of day and of night prevailed in Europe even after the mechanical clock had been developed in England in the fourteenth century. Over time, this new technology spread across Europe in the form of public clocks that chimed the hour from churches and civic buildings; these new mechanical timepieces could not keep track of seasonally fluctuating hours and required constant adjustment, so it was by way of the mechanical clock that the astronomers' equinoctial hour eventually came to replace seasonal time. It took the Europeans several centuries to perfect this system's mechanics and several centuries more to coordinate time measurements across regions. While European coach travel in the eighteenth century could still get by on "local" (solar) time, railroad travel and the electrical telegraph in the nineteenth century required regional time coordination. This, in turn, required calculation of longitudes—since two locales longitudinally separated even by a modest distance used different solar time settings—and it also required the definition of time zones within which all the clocks of a pre-determined number of longitudes would show the same time.

Ancient science had developed both notions. Longitudes are imaginary lines that cover the globe in same-size circles, stretching far apart at the equator and converging at the poles. Longitudes are determined by observing and calculating the sun's passing through its zenith (high-noon position) in a north-south, pole-to-pole direction. Each line represents a meridian, an imaginary, vertical, and semicircular disk above the Earth. Even though their cosmology stipulated a stationary earth that neither spun around itself nor rotated around the sun, the meridians of longitude of the ancient scientists were the same as our own. So also was the notion of reckoning the Earth's circumference in terms of 360 degrees, and the stipulation of 24 meridians (each in the middle of a time zone) spread at global intervals of 15 degrees—12 east and 12 west of a "prime meridian" or zero-degree longitude line. But (unlike with latitudes) there were no compelling astronomical reasons to choose a specific longitude for the zero-degree position, since any line drawn from pole to pole could serve as a starting line for reference.

The Hellenistic astronomer Ptolemy, working in Alexandria, Egypt, chose to locate "his" prime meridian close to home by running it through the Fortunate Islands (now called the Canary and Madeira Islands) off the northwestern coast of Africa. Later map-makers moved "theirs" to many other places, which had nothing to do with astronomy and everything to do with politics. The royal astronomer Nevil Meskalyne (d. 1811) informally brought the prime meridian to Greenwich, by making the Greenwich meridian the reference point for his maps of lunar

distances. International treatises concluded in 1883 and 1884 at the International Meridian Conferences made the practice into law (even though the French held out until 1911), and these treatises also ratified the establishment of our international time zones.

Technological progress has meant chronographic and calendrical standardization that eventually took on global validity.[26] The Islamic prayer times are now regionally computed (often by electronic means), and the results are publicized by way of radio, television, newspapers, almanacs, wall and pocket calendars, and the Internet. The computation is usually done by local survey departments or observatories or other agencies approved by the religious authorities,[27] which generally means the Ministry of *Awqaf* (religious endowments) or its equivalent. Prayer times are defined in terms of time zone-specific, standardized time. Religious officials in the provinces usually know how to adjust the time tables issued for their country's major cities to allow for differences in terms of degrees of longitude and/or latitude.

Technology has also created the concept of linear time, a relatively recent Western invention that is replacing, or is poised to replace, the multiple, subjective, and situation-specific times of the past.[28] The new form of clock-based time is producing a new global psychology in which time equals punctuality, efficiency, and economic rationality.[29] It is noteworthy that prominent Muslim theologians are now participating in a modernization discourse on the "preciousness" and "utility" of time to advocate greater social order and enhance virtues such as punctuality and regularity, reliability and exactness. An example is a recent publication, *Time in the Life of the Muslim*, by the "Global Mufti," "the Great Media Shaykh," Shaykh Yusuf al-Qaradawi (now 84 years old and based in Qatar), in which he says that time is man's most precious possession. The believer must preserve, save, and spend it with the greatest care. "Killing" time is a form of slow suicide, since he who "kills" time—by, for instance, playing backgammon or chess or cards—is actually killing himself. Like health, leisure is one of God's great gifts to mankind, but leisure is also a danger in that it always "fills up," most often with foolish schemes for men and lustful, sensuous ones for women. Therefore, the righteous forefathers (*al-Salaf al-Salih*) always hated it when someone was idle. Today's Muslim must perform all required and scheduled activities (religious as well as worldly) punctually, efficiently, and according to the proper time frame—not at "any time" but at "the proper time." Time management is part of a righteous Muslim's way of life; this includes rising at dawn (or, at the latest, sunrise), going to bed at an early hour, eating one's big meal in the middle of the day, and eating only a light supper at night.[30]

Al-Qaradawi's model may perhaps appear to parallel the "Protestant work ethic" of the West. But this is not at all what al-Qaradawi has in mind. On the contrary, his model is squarely based on Qur'anic teaching about the nature and use of "human time." In tandem with many others, al-Qaradawi has long envisaged

modernization both as a Qur'an-centric, inner-Islamic affair and also as globally relevant. This "authentic" modernization must take a different course from the West that pursued its own modernity by way of secularization; however, Western-developed technology can, and should, be harnessed to it.

Time (Still) "Sticks"

In the Islamic world today, the Western calendar provides a global point of reference even where the Islamic year reigns supreme. More important to the smooth workings of global enterprise is the now universal adoption of 24 global time zones whose standardized 24-hour increments are measured by clocks that, in each time zone, begin to tick off the new day at midnight.[31] But while this may be "official time," many Yemenis still refer to it as *Rumi* (originally meaning "Roman" or "Byzantine," now used in the sense of "Western") time, and they refer to their own indigenous system as "Arab" time. Since the "Arab day" begins at sundown that in Yemen is seasonally pegged at about 6 p.m. "Western" time, a traditional Yemeni who says "see you Friday evening" means a period commencing at 6 p.m. on Thursday. By this reckoning, the "Western" hour of 6 a.m. on Friday is 12 p.m. "Arab" time, and Friday's 12 noon is 6 p.m. "Arab" time (and then the new day [Saturday] starts again with 12 a.m. "Arab" time at about 6 p.m. on Friday).[32]

In traditional communities in Saudi Arabia, the old system has likewise survived and created a system of double time-keeping. *Tawqit zawali* (meridian timekeeping) stands for time reckoning in which the hours are counted from noon and midnight (like in the West), while in *tawqit ghurubi* (sunset timekeeping), they are counted from the hour closest to sundown.[33] In the Najd sundown is seasonally pegged at 7 p.m. "standard/meridial time." An Egyptian colleague described a visit to the house of a Saudi religious notable in the provincial town of Burayda in the Najd. In the Imam's *majlis* (sitting) room, on the traditional *wijar* (shelf for keeping coffee pots) were two clocks. One measured the time in the new "official" way, by *zawali* (meridian) time, while the other clock was set on *tawqit ghurubi*, where sunset represents 12 o'clock. My colleague noted that their visit began at 5:40 according to one of the clocks, and at 10:40 according to the other. It made perfect sense. Their meeting occurred one hour and twenty minutes before the sunset hour that was pegged at 7 p.m. of "standard/meridian" time.[34]

This imam's clocks followed what had been long-standing practice in many parts of Europe and the Middle East. Prior to the standardization processes in the seventeenth and eighteenth centuries, the French and Germans began their equal hour day at midnight. The English, Italians, Bohemians, and the Welsh also calculated their day in equal hours, but their zero-hour was sunset, and in Siena it was half an hour before sunset. Sunset clocks had to be recalibrated every five to ten days, and each parish or town published a set of tables indicating on which days,

and by how much, the clocks had to be reset.[35]

In many parts of the Islamic world, the practice of using mechanical clocks to measure "Islamic time" was the norm rather than the exception. Throughout the Ottoman Empire, clocks had long been owned and operated in private households and some public spaces, such as mosques. For the Ottomans, the "new day" began every evening at sundown, when they set the clock dial at 12:00; the clock would run until the next sunset, when the dial was reset at 12:00 to mark the next day's beginning. For centuries, this system permitted Ottoman society to combine traditional notions of time with the abstract, mathematical hours of the mechanical clock.[36] The central administration eventually abolished the old system because it had become an obstacle to modernization, but it was only relinquished reluctantly, at least by the public.[37]

Measurement and management of time are cultural constructs. But older notions of time measurement can "stick around" for a long time.

"What then is time? I know what it is if no one asks me what it is; but if I want to explain it to someone who has asked me, I find that I do not know."[38] These words were written by St. Augustine, Bishop of Hippo, North Africa (d. 430) when he was exploring the mystery of God's creation of time out of eternity and his own mystery as a reflection of the mystery of God. According to St. Augustine's theology, time could be measured but existed independently of celestial motions since, in fact, it was time that measured solar motion. One can find a similar theology in the Qur'an.

The Qur'an's vision of time is God-centered. Time is God's creation. There can be no abstract time because God, ruler of the universe who is beyond time, is lord over time from the beginning to the end of creation. While time is a function of God's omnipotence, so is its measurement a divine gift that God created for the benefit of mankind. The Qur'an presents richly designed concrete and practical examples that establish God's authorship of all celestial movements and their usefulness to the human race as devices to measure time. Night and day and even the 12 lunar months of the year are appointed times for the believing people. Reading the sky for the five prayers of the day and for the 12 months of the year is a constant reminder of divine power and providence. Despite the acts of the International Meridian Conference of 1884, time itself cannot be zoned.

ENDNOTES

1. Sebastian Günther, "Tag und Tageszeiten im Qur'an," *Erlesenes: Hallesche Beitrage zur Orientwissenschaft*, vol. 25, no. 98 (1998): 47. The pre-Islamic month was lunar, while the pre-Islamic year was lunisolar. During his Farewell Pilgrimage, performed shortly before his death in June 632, the Prophet abolished the lunisolar calendar of pre-Islamic Arabia and decreed the new Islamic lunar year. No revelation instructed him to do so, but Qur'an 9:36-37, revealed the year before, had entailed censorship of the Arabian pagan method of "intercalation" (*nasy*) that periodically wedged an additional month between the two sacred months of Dhu l-Hijja and Muharram, interrupted the sequence of the three sacred spring months of the lunisolar year, and could wreak havoc on the trucial laws of Arabian tradition. Also see Rudi Paret, *Der Koran: Kommentar und Konkordanz*, 2nd ed. (Stuttgart: W. Kohlhammer, 1970), 202.
2. E. G. Richards, *Mapping Time* (Oxford: Oxford University Press, 1998), 63.
3. Gerhard Dohrn-van Rossum, *History of the Hour* (translated by Thomas Dunlap) (Chicago: University of Chicago Press, 1996), 283.
4. Rossum, *History of the Hour*, op. cit., 20-21.
5. R.B. Serjeant, David A. King, and Isma'il al-Akwa, "Calendars, the Time of Day and Mathematical Astronomy," in R.B. Serjeant and Ronald Lewcock (eds.), *San'a': An Arabian Islamic City* (London: The World of Islam Festival Trust, 1983), 34-35.
6. For a thorough analysis of *salat* see P. J. Bearman et al. (eds.), *The Encyclopedia of Islam, New Edition* (Leiden: E.J. Brill, 1995), vol. 8, 925-934. See also Günther, "Tag und Tageszeiten," op. cit., 56-59.
7. E.S. Kennedy, *The Exhaustive Treatise on Shadows by Abu al-Rayhan Muhammad ibn Ahmad al-Biruni, Translation and Commentary* (Aleppo: Institute for the History of Arabic Science, 1976), vol. 1, 210.
8. Sahih al-Bukhari, *The Translation of the Meanings of Sahih al-Bukhari, Arabic-English* (translated by Dr. Muhammad Muhsin Khan) (Riyadh: Darussalam, 1997), vol. 1, *Kitab al-salat*, *bab* 1, and *Kitab mawaqit al-salat*, *bab* 1.
9. Al-Bukhari, *The Translation of the Meanings of Sahih al-Bukhari*, op. cit., vol. 7, *Kitab mawaqit al-salat, abwab* 1, 5, 9, 11, 13, 14, 18, 21, 25, 27. See also "Mikat" in *Encyclopedia of Islam, New Edition*, P. J. Bearman et al. (eds.), op. cit., 27.
10. Al-Bukhari, *The Translation of the Meanings of Sahih al-Bukhari*, op. cit., vol. 7, *Kitab mawaqit al-salat*, *abwab* 30-31.
11. Kennedy, *The Exhaustive Treatise on Shadows by Abu al-Rayhan Muhammad ibn Ahmad al-Biruni*, op. cit., vol. I, 210. In Mecca, prayer is allowed at all times. See al-Bukhari, *The Translation of the Meanings of Sahih al-Bukhari*, op. cit., vol. 1, *Kitab al-hajj*, *bab* 42.

12. P. J. Bearman et al. (eds.), *Encyclopedia of Islam, New Edition*, op. cit., vol. 1, 27.
13. Al-Shafi'i, *Kitab al-umm* (Beirut: Dar al-Ma'rifa, 1973), vol. 1, 71. See also Kennedy, *The Exhaustive Treatise on Shadows by Abu al-Rayhan Muhammad ibn Ahmad al-Biruni*, op. cit., vol. I, 211-212.
14. When reckoned in terms of a meridian other than the local meridian, the times of prayer are also dependent upon terrestrial longitude; see P. J. Bearman et al. (eds.), *Encyclopedia of Islam, New Edition*, op. cit., vol. 7, 27.
15. Dava Sobel, *Longitude: The True Story of a Lone Genius who Solved the Greatest Scientific Problem of His Time* (New York: Penguin Books, 1995), 2-4.
16. Kennedy, *The Exhaustive Treatise of Shadows*, op. cit., vol. I, 228-229.
17. Kennedy, *The Exhaustive Treatise of Shadows*, op. cit., vol. I, 228.
18. Kennedy, *The Exhaustive Treatise of Shadows*, op. cit., vol. I, 76.
19. Kennedy, *The Exhaustive Treatise of Shadows*, op. cit., vol. I, 280.
20. See "Mikat" in P. J. Bearman et al. (eds.), *Encyclopedia of Islam, New Edition*, op. cit., vol. 7, 29.
21. David A. King, *Islamic Mathematical Astronomy* (London: Variorum Reprints, 1986), esp. chapters 2-4 and 9-12.
22. For example, David C. Lindberg, *The Beginnings of Western Science* (Chicago: University of Chicago Press, 1992).
23. Al-Razi, *Great Exegesis of the Qur'an* (Parts 13-14) (Cairo: Al-Matba'a al-Bahiyya al-Misriyya, 1938 (first printing)), 96-126.
24. For example, Dimitri Gutas, *Greek Thought, Arabic Culture* (New York: Routledge, 1998) and Muzaffer Iqbal, *Islam and Science* (Burlington, VT: Ashgate, 2002).
25. George Sarton, *Ancient Science and Modern Civilization* (Lincoln, NE: University of Nebraska Press, 1954), 37-73.
26. Rossum, *History of the Hour*, op. cit., 125-172, 271-287, 323-350.
27. See "Mikat" in P. J. Bearman et al. (eds.), *Encyclopedia of Islam, New Edition*, op. cit., vol. 7, 30.
28. Eugen Weber, *Apocalypses* (Cambridge, MA: Harvard University Press, 1999), 7-8.
29. Sharif S. Elmusa, "Faust Without the Devil? The Interplay of Technology and Culture in Saudi Arabia," *The Middle East Journal* vol. 51, no. 3 (1997): 345-357.
30. Shaykh Yusuf al-Qaradawi, *Time in the Life of the Muslim* (Cairo: Wahba, 4th printing, 2004).
31. Richards, *Mapping Time*, op. cit., 62-63 and Rossum, *History of the Hour*, op. cit., 349-350.
32. Serjeant, King, and al-Akwa, *San'a': An Arabian Islamic City*, op. cit., 33.
33. Hans Wehr, *A Dictionary of Modern Arabic* (J. Milton Cowan (ed.)) (Wiesbaden: Otto Harrassowitz, 1979), 450.
34. Communication from Mamoun Fandy, formerly at Georgetown University and

now at SOAS in London, 1990s.

35. Kristen Lippincott et al. (eds.), *The Story of Time* (London: Merrell Holberton, n.d.), 128.
36. Mehmet Bengu Uluengin, "Secularizing Anatolia Tick by Tick: Clock Towers in the Ottoman Empire and the Turkish Republic," *International Journal of Middle East Studies* vol. 42, no. 1 (2010): 18; here quoting Ugur Tanyeli, "The Emergence of Modern Time-Consciousness in the Islamic World and the Problematics of Spatial Perception," in Cynthia C. Davidson (ed.), *Anytime* (Cambridge, MA: MIT Press, 1999), 162.
37. Ibid.
38. *The Confessions of St. Augustine* (translated by Rex Warner) (New York: The New American Library of World Literature, Inc., 1963), 267.

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