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A Mechanical Clock in Kashan in the Early 17th Century

Abstract

This paper introduces the existence of a sophisticated automaton clock that was set up in the square (*maidan*) in Kashan in the reign of Shah ‘Abbas (1587–1629). Operated by a series of levers and weights, the clock struck the hours of day and night, accompanied by the movement of various figures constructed out of cardboard. The clock was shown as a curiosity to the refugee Uzbek Khan, Vali Muhammad, on his way to the court in Isfahan in 1611 to seek Shah ‘Abbas’s support against his rebellious nephews in Transoxiana. The clock was constructed by a certain illiterate, Maulana ‘Inayat, and was still in operation in the reign of ‘Abbas II (d. 1666). The discussion locates the invention of the clock within the context of the history of clock-making in Iran up to and during the Safavid period.

Keywords: mechanical clock, Kashan, Uzbek embassy, Shah ‘Abbas

In 1020/1611 Vali Muhammad Khan, the Tuqay-Timurid ruler of Transoxania (r. 1605–1611), sought refuge with his Safavid counterpart, Shah ‘Abbas (r. 1587–1629), following the insubordination of his nephews and especially Imam-Quli Khan, governor of Samarqand. Safavid sources pay considerable attention to this visit, which presented ‘Abbas with a great propaganda coup and an opportunity to extend his influence, in a similar way to how Shah Tahmasp took advantage of the Mughal ruler Humayun’s request for assistance in 1544. Despite his warm reception, Vali Muhammad only stayed a month in Isfahan, from mid-June to mid-July, and returned with a small Iranian force in support, having resisted ‘Abbas’s offer to lead an army into Khurasan in person the following year. After an initial success, Vali Muhammad was defeated and executed in September 1611.¹

This paper presents one small episode in the course of the visit of the Uzbek Khan to Iran, namely the account of a remarkable mechanical clock that his

¹ For these events, see A. Burton, *The Bukharans. A Dynastic, Diplomatic and Commercial History. 1550–1702*, Richmond 1997, pp. 128–134; T. Welsford, *Four Types of Loyalty in Early Modern Central Asia. The Tūqāy-Tīmūrīd Takeover of Greater Mā warā al-nahr; 1598–1605*, Leiden 2013, esp. pp. 246–251. I have a paper in preparation on this episode.

party was shown in Kashan on their way to Isfahan. This is one of several nuggets of fresh information found in the previously unused account in Fazli Beg's *Afzal al-tawarikh*,² which furnishes rich details of the mission's itinerary, nicely complementing the record of Munajjim Yazdi, who was heavily involved in the arrangements for the visit and whose chronicle ends this year (1020/1611),³ and the long account by Iskandar Beg.⁴ I have seen almost no other references to this clock, which is one more scarce example of the Persians' development of such devices since the 15th century. In this brief tribute to our esteemed colleague and her wide-ranging interests in Iranian culture, I shall give the passage in Fazli Beg's chronicle in full, before setting the description in its context; I leave it to those with more mechanical and technical minds to ponder how the clock actually worked.

The Chinggisid visitors proceeded by way of the Khurasan high road as far as Siyah Kuh, before heading down towards Isfahan. Once the Shah had heard news of the Khan's arrival in Simnan, he ordered 'Ali-Quli Khan, the *amir-i divan* and *ishik-aqasi-bashi* (chief of the ushers, or head chamberlain) to go to Kashan ("the best of the *mamalik* of Iran") and in cooperation with Muhammad Zaman Beg the vizier and *kalantar* (mayor) and the notables to prepare to decorate the town with lights [and also to prepare] the mechanical hour clock (*vaqt-sa'at*) of Maulana 'Inayat which had been set up in the *Maidan*.

The twelve hours of the day had been engraved in red and the twelve hours of the night in black on two stones, each one of which was bigger than a millstone. By day the red stone came into motion. When an hour had elapsed, a part [or mark?: *bakhsh*] of it became black and a part turned red and the hour came to an end. Two drummers, two flautists, two horn players and a cockerel were made on a cardboard disk above that revolving stone; a big drum and a trumpet and a flute of copper were made for them and put in their hands, so that whenever it appeared that sixty minutes were completed, the drummers beat the two drums, the horn player and the flautist began playing music in such a way that the whole town was aware, day and night, that an hour had passed. The cardboard cockerel cried out and a bell was hung up, which, after they had finished playing, spontaneously chimed out the number of hours that had passed, so that it was known what hour it was. After these operations were completed, they returned to their cardboard state and did not move any more, but waited for the end of the next hour when they would spring into motion again.

A box was made and a number of cardboard figures were arranged in it, so that when someone wanted an intoxicant (*kaifiyyat*) or a drink, he came to Mulla 'Inayat and requested to see them. The Mulla would open one side of the box, which was rectangular, and set the cardboard figures in motion, and the 'addict' (*mukaiyif*) mentioned to the Mulla whatever stimulant he desired and [the Mulla] pointed to the figure that held the stimulant (*kaif*) peculiar to it with a stick that he had in his hand. Immediately, he brought that stimulant from the bottom of the box, placed in the middle of a dish. Another brought a goblet of wine from behind and they gave it to him and the intoxicated one (*sahib-i kaif*) drank it and became contented.

Other marvels like a lion and dragon had been made out of cardboard; the details of that exceed all bounds. This was brought before that mighty king, so that they could bring

² Fazli Beg Khuzani Isfahani, *A Chronicle of the Reign of Shah 'Abbas*, ed. K. Ghareghlou, Cambridge 2015.

³ Munajjim Yazdi, *Tarikh-i 'Abbasi*, ed. S. Vahidniya, Tehran 1366/1987, pp. 434–448.

⁴ Iskandar Beg Munshi, *'Alam-ara-yi 'Abbasi*, ed. I. Afshar, Tehran 1334/1956, pp. 832–847, trans. R.M. Savory, *Eskandar Monshi. History of Shah 'Abbas*, Boulder 1978, pp. 1039–1057.

cheer to his mind, which was distressed at his separation from his ancestral kingdom, throne and crown.

...

On the third day, they wished to see the lights of the city and the *qaisariyya* (bazaar), and that evening the lofty Khan was brought to the Maidan, which was the envy of the plains of paradise due to the rows of platforms or steps (*suffa*) that had been constructed and [the display of] Kirman carpets, Yazd brocades and Kashan velvets. They requested to see the mechanical clock. The great Khan became very cheerful at enjoying its strange figures; he ordered his entourage and wise men to go behind Mulla 'Inayat's shop [or stall] to see how these shapes were tied and who made them move. They saw nobody, except for the many bags of sand that Mulla 'Inayat had made, which being put in motion, gave movement to the cardboard figures. When the bags stopped moving, those shapes – each of which was attached to several bags, of which there were two to three thousand hanging there – also stood still. The Khan himself also went and saw for himself and was amazed.

Mulla 'Inayat was a man of few words, of a dervish disposition, barely literate and not eloquent in his explanations – prompting the Khan to ask 'Ali-Quli Khan if they had made Mulla 'Inayat too! He showed Maulana many favours and stayed in Kashan several days. Muhammad Zaman Beg the vizier and *kalantar* and the notables also brought gifts and rendered services. The party then left for Natanz.⁵

Discussion

It is remarkable that this contraption seems not to have been seen or described by other visitors to Kashan during Shah 'Abbas' reign, especially as it evidently performed a regular function of tolling the hours day and night, rather than being merely an occasional curiosity. It is true that the volume of European travellers passing through the city is relatively meagre compared with later periods, which I have not yet explored in their entirety; but neither Newberie (1581), Cartwright and Mildenhall (1603), Figueroa (1618), Hobbs (1619) Herbert & Stodard (1628) nor Tavernier (1632) – all of whom passed through Kashan during the reign of 'Abbas – make any reference to the clock; Figueroa at least describes the handsome Maidan, where he witnessed a bullfight, in some detail.⁶

For the moment, therefore, Fazli Beg's account is unique and I introduce it here for those with a keener mechanical mind than my own to follow up – for it provides new evidence to add to the scarce and up till now somewhat repetitive information available about the construction of mechanical clocks in Iran. Most of this derives from the treatise by the inventor (*mukhtari*'), Muhammad Hafiz-i Isfahani (fl. late 15th–early 16th c.), *Natijat al-daula, sih ikhtira* ' (Three inventions),⁷

⁵ Fazli Beg, *op. cit.*, pp. 579–580. Thanks to Elaheh Kheirandish and Kioumars Ghereghlou for advice on the translation.

⁶ *L'Ambassade de Don Garcias y Silva de Figueroa en Perse. Contenant la politique de ce grand Empire*, trans. M. de Wicqfort, Paris 1668, pp. 208–209.

⁷ M. Hafiz-i Isfahani, *Natijat al-daula, sih ikhtira* ', ed. T. Binish, Tehran 1971. Thanks to Elaheh Kheirandish for providing me with a copy of parts of this.

whose account of his own construction of a mechanical clock has been discussed by Muhammad Riza Nurbakhsh, Willem Floor and Parviz Mohebbi.⁸

Muhammad Hafiz built his clock on the basis of a European model (most probably Italian) originally sent from the Ottoman court to Herat, via Tabriz – where no-one could make it work – apparently in the reign of Sultan-Husain Bayqara (r. 1469–1506).⁹ He also built a clock in Samarqand for the Timurid prince governor, Sultan Ahmad (r. 1469–1494) and a larger one in Kashan, for which he made some modifications to the original design.¹⁰ This must be the clock associated with the Maidan-i Sang (Stone square) in Kashan, laid out by Khwaja ‘Imad al-Din Shibli Shirvani, a major patron of the mosque in the Maidan and adjacent buildings such as a caravanserai and infirmary (*dar al-shifa*), dating from the late 15th century.¹¹ According to Majd-al-Din Husaini, the author of the *Zinat al-majalis* (1004/1595), Maulana Muhammad Mukhtari‘ (‘the inventor’) constructed a small edifice alongside the hospital and set up a box above it; when an hour of the day had elapsed, a wooden cockerel on top of it came into motion.¹² Majd al-Din goes on to say that in his day [i.e. about a century later] the mechanism was defective and a character called Umīy ‘Inayat had made something that is not devoid of interest [worth seeing].¹³

A Kashani *vaqfiyya* or endowment deed dated 5 Dhu’l-Qa‘da, 877 / 12 April 1473, which refers to the pavilion (*‘imarat*) of the clock, refers to Maulana Fakhr al-Din b. ‘Ali b. Sadr-i Sa‘id Khwaja Shams al-Din Muhammad Kashi, the inventor of the *vaqf-o sa‘at*.¹⁴ This was evidently a water clock (clepsydra), for the *vaqf* made provision for the continuous presence of an attendant (*farrash*) to keep the construction swept clean and check the water levels.¹⁵ Fakhr al-Din’s clock should

⁸ M.R. Nurbakhsh, *Sa‘at-i mekaniki dar Iran*, “Ayandeh” 1366/1987, no. 6–7, pp. 395–408; W. Floor, *Clocks*, [in:] *Encyclopaedia Iranica*, vol. 5, fasc. 7, 1992, pp. 713–718; P. Mohebbi, *Techniques et ressources en Iran du 7e au 19e siècle*, Tehran 1996; *idem*, *Hafez Esfahani*, [in:] *Encyclopaedia Iranica*, vol. 11, fasc. 5, 2002, pp. 510–511.

⁹ For a fuller discussion of Muhammad Mukhtari’s clock, see now E. Kheirandish, *From Maragha to Samarqand and Beyond: Revisiting a Quartet of Scientific Traditions in Greater Persia (ca. 1300s–1500s)*, [in:] *The Timurid Century. The Idea of Iran*, vol. 9, ed. C. Melville, London 2019, ch. 8, pp. 161–170.

¹⁰ M. Hafiz-i Isfahani, *op. cit.*, pp. 12–18, 48–49, 80; M.R. Nurbakhsh, *op. cit.*, pp. 400–401; P. Mohebbi, *Hafez...*, pp. 191–192, 195.

¹¹ H. Naraqī, *Tarikh-i ijma‘i-yi Kashan*, Tehran 1345/1966, p. 92. The 19th-century local history of the city by ‘A. Kalantar Zarrabi, *Tarikh-i Kashan*, 2nd ed. I. Afshar, Tehran 1341/1963, pp. 295, 424, makes no reference to the clock, but see the learned editor’s notes, below.

¹² *Zinat al-majalis*, ed. A. Ahmadi, Tehran, 1342/1963, p. 772, quoted by H. Naraqī, *op. cit.*, pp. 114–115, and P. Mohebbi, *Hafez...*; W. Floor, *op. cit.*, quotes H. Naraqī.

¹³ The printed text omits this last phrase.

¹⁴ Reproduced in ‘A. Kalantar Zarrabi, *op. cit.*, notes, pp. 523–529. On p. 528 he is also distinguished as *munajjim* (astronomer). The *vaqf* document itself, p. 529, is dated 5 Dhu’l-Qa‘da, but in all secondary sources the summary list of endowments gives the date 15 Dhu’l-Qa‘da, see *ibidem*, p. 510, and H. Naraqī, *Athar-i tarikhī-yi shahristanha-yi Kashan va Natanz*, Tehran, 1348/1969, p. 235.

¹⁵ ‘A. Kalantar Zarrabi, *op. cit.*, p. 528. P. Mohebbi, *Techniques...*, pp. 199–201, while noting two separate clocks in Kashan, appears to associate both as the work of Hafiz Isfahani on his reading of the *Zinat al-majalis* and to be unclear as to whether one was clepsydra. M.R. Nurbakhsh, *op. cit.*, p. 401, n. 36, for his part, repeats some confusion over the date of the *Zinat*.

have predated Hafiz Isfahani's by twenty years or so; it testifies nevertheless to a tradition of such devices in Kashan, which might have inspired Hafiz Muhammad's construction of a mechanical (weight driven) version.

The 'illiterate' 'Inayat must clearly be our taciturn Maulana 'Inayat who entertained the Uzbek Khan and his delegation, and this is the only other reference to him that I have so far come across.

This requires a modification of the view of Mohebbi, who considers that Muhammad Hafiz's clock was a one-off achievement with no further development or follow-up, perhaps due to an indifference to the way Europeans measured time in addition to a deficiency of technical knowledge, and accordingly, the art of making clocks was soon lost in Persia.¹⁶

However, in 949/1542 Michele Membré described a clock in Tabriz, housed in a separate pavilion in the bazaar, as having been built by a Persian with a white beard:

It was set inside a square enclosed pavilion of painted planks four ells high and two wide. [This clock] had these things: that is, on the summit of the said pavilion there was a bell with a clapper that struck the hours, which stood in the middle of the pavilion on the top, and in front of the said pavilion there were two men with horses and lances, as big as a hen, next to two buffoons as big as a large mouse, the size of those in a house, so that, when it came to strike the hour, however many hours the bell had struck, then so many times those horsemen with the lances thrust them forward, and those buffoons banged their foreheads together, and that all at once; it also showed the moon during the eclipse.

There was also another thing in the clock: There was a hole under it where women and men came to learn their futures. They put in this hole a copper farthing of their money, called *altun* and that fell down inside the pavilion, and immediately one heard the noise of a door opening, and out of it came a dragon, and from its mouth a small iron ball fell; under this door opened another one, and from it a cat came out. The said small ball fell into the mouth of this cat. Furthermore, on the other side another door opened, and a snake appeared, and from its mouth fell a written card. They read what was written on this card, and in this manner they learned their fortune... I asked the old craftsman who had made it if he had ever seen another like it and if somebody had taught him; he said that he had never seen one, nor had anybody taught him, but that he had found such a thing only in books.¹⁷

While the particulars are different, the association of the clock with other functions, in this case fortune telling rather than supplying intoxicants, is interesting and shows the multiple attractions provided by the whole assemblage.

Although I have not found a description of the Kashan clock by European visitors, it should be noted first that it was evidently still functioning in the time of 'Abbas II (r. 1642–1666), who visited it every evening after hunting while staying in Kashan before heading to Qazvin in the first year of his reign. In rather obscure terms, the text speaks of the emulation of human movements made by the lifeless images.¹⁸ According to Chardin, the youthful 'Abbas II had a special

¹⁶ M.R. Nurbakhsh, *op. cit.*, p. 402, P. Mohebbi, *Techniques...*, pp. 192–193, 202–204.

¹⁷ M. Membré, *Mission to the Lord Sophy of Persia (1539–1542)*, trans. and annotated by A.H. Morton, London 1993, repr. Cambridge 1999, p. 33; cf. W. Floor, *op. cit.*

¹⁸ Muhammad Tahir Vahid Qazvini, *'Abbasnama*, ed. I. Dehgan, Tehran 1329/1941, p. 20. Cf. H. Naraqī, *Tarikh-i ijtimā'i...*, p. 92, n. 2.

clock pavilion built in the Maidan of Isfahan, to mark his coronation – possibly inspired by the Kashan example. Figures were painted on the walls and movable wooden heads, arms, and hands holding musical instruments were attached. There were also painted birds and beasts that moved, regarded with great admiration. The clock struck every hour.¹⁹ The Dutch painter Cornelis de Bruijn, who visited Isfahan in 1703, evidently also referred to this “striking clock, the only one in all Persia” and nearby [he speaks rather obscurely of it being “on the same side”] is the “pavilion of the machines or of the clock” (which he also called *Wagtis-sai-aet*, i.e., *vaqt-i sa’at* “timepiece”), “which moves some wooden puppets in a wheel, not worthy to be seen by an European”.²⁰ His illustrations indicate that this construction was quite a tall building, located between the Shaikh Lutf-Allah mosque and the southeast corner of the Maidan.²¹

As for how the Muhammad Hafiz’s clock worked, this is explained, with diagrams, by Mohebbi; it is possible that Maulana ‘Inayat’s was along the same lines, though there is little in common with its description beyond the revolving wheels and the figures, in Muhammad Hafiz’s Kashan clock simply involving a rotating wooden cockerel. Muhammad ‘Inayat’s construction with cardboard characters powered by hundreds of suspended bags of sand was perhaps the rather idiosyncratic product of a maverick inventor, not unlike the clock seen by Membré in Tabriz – though apparently his was based on a description “in books”, possibly even Muhammad Hafiz’s *Natijat al-daula*. Fazli Beg’s description recalls the detailed workings of an astronomical clock of comparable complexity, namely the celebrated *sa’at-vaqt* in the Rukniyya madrasa in Yazd, built by Khalil b. Abu Bakr b. Muhammad Amuli in 1325, as described by the 15th-century local historians of the city.²² This also had revolving wheels with notches, two bronze birds that emerged from windows on the completion of every hour, dropping a seal into a dish. When this happened five times (i.e., every five hours) a flag waved from one minaret, and a drum beat once in the observatory building (*rasadkhana*) below. A copper bird on the other minaret always faced the direction of the sun. It was powered from a copper tank (*tanura*) the height of two men, which was filled with water every day.²³

Suffice it to conclude by remarking that although the construction and even understanding of mechanical timepieces as introduced by Europeans to Iran seems to have been rather late and also intermittent, it is clear that the principles of the operation of such devices, whether powered by water or weights, had a long history. The clock in Kashan that was shown to Vali Muhammad Khan the Uzbek

¹⁹ J. Chardin, *Voyages*, vol. 7, ed. L.M. Langlès, pp. 355–356; W. Floor, *op. cit.* The accompanying picture of the entrance to the bazaar depicts a different clock, which was not then working, J. Chardin, *op. cit.*, p. 357 and plate xxxvii.

²⁰ C. De Bruny, *Travels into Muscovy, Persian and part of the East Indies... Translated from the original French [sic.]*, vol. 1, London 1737, pp. 195, 196.

²¹ *Ibidem*, plate 75 (D) and 76 (C); Plate 76 (D) shows the “house of the musical instruments” (i.e. the *naqqara-khana*) and the clock above the entrance to the *qaisariyya*; cf. W. Floor, *op. cit.*

²² Ja’far b. Muhammad Ja’fari, *Tarikh-i Yazd*, ed. I. Afshar, Tehran 1343/1964, pp. 81–83; Ahmad b. Husain Katib, *Tarikh-i Jadid-i Yazd*, ed. I. Afshar, Tehran 1345/1966, pp. 123–125.

²³ M.R. Nurbakhsh, *op. cit.*, pp. 396–397; P. Mohebbi, *Techniques...*, p. 199; W. Floor, *op. cit.*

ruler in 1611 can be considered as further evidence of the ingenuity of the Persian engineers, and also to provide significant additional details about the durability of these devices in the Safavid period.

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