Precepts and the Calculation of Time: The Case of the Buddhist Monk Yixing*

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Abstract: This study focuses on the reasons for the Tang dynasty monk Yixing's 一行 (683–727) participation in calendar formulation, examining the many changes that Buddhism brought to China from a social perspective. It is argued that on both doctrinal and practical levels, Buddhism played a significant role in promoting science and technology to an unprecedented height of development in medieval China, or even the whole of East Asia, before it ceded its influence to other religions in modern times.

Keywords: Buddhism and technological innovation, horological instruments, Yixing 一行 (683–727), precepts, calendrical science

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Introduction

Among the many advancements in the development of science and technology introduced through Buddhism, some were individual efforts brought about by the composition of medical texts such as the 'Hanshi san duiliao' 寒食散對療 [The Use of Cold Foods for Medical Treatment].[1] Others were collective contributions, including the development of print technology to disseminate classic texts.[2] Examples of these are too many to enumerate. This mutually beneficial relationship between ancient Buddhism and science is worth in-depth study. Many Buddhist monks participated in society's endeavors of science and technology during the Tang dynasty. One prominent example is the monk Yixing. This study therefore chooses Yixing as its primary object of research.

In this investigation, several previous studies are worth noting. Osabe Kazuo's 長部和雄 1944 *Ichigyō Zenji no kenkyū* 一行禅師の研究 [Research on Chan Master Yixing] offers detailed classifications of the relevant historical documents, focusing primarily on Esoteric Buddhism.[3] Yan Dunjie's 嚴敦傑 1984 'Yixing Chanshi nianpu' 一行禪師年譜 [Timeline of Chan Master Yixing] clearly recounts Yixing's life, with special emphasis on his work in astronomy.[4] Wu Hui's 吳慧 2009 *Seng Yixing yanjiu: Sheng Tang de tianwen, Fojiao yu zhengzhi* 僧一行研究——盛唐的天文、佛教與政治 [Research on the Buddhist Monk Yixing: Astronomy, Buddhism, and Politics in the High Tang] examines Yixing's life and work in astronomy and Buddhism, placing these topics in the sociocultural context of the High Tang 盛唐 (713–766) period.[5] These studies provide a firm foundation for this article, allowing us to delve more deeply into the reasons behind

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1 Du, comp., *Zhengshi fojiao ziliao lei bian*, vol. 8: 522.

2 Carter, *The Invention of Printing in China and Its Spread Westward*, 33.

3 Osabe, *Ichigyō Zenji no kenkyū*.

4 Yan, 'Yixing Chanshi nianpu', 35–42.

5 Wu, *Seng Yixing yanjiu*. For a source from the perspective of the history of science and technology alone, also see Lei, 'Tianwen xuejia seng Yixing yu "Dayan li"', 186–87.

Yixing's participation in calendar formulation, and to demonstrate the relationship between the Silk Road and Chang'an Buddhism during the Tang period.

Yixing's contributions to Buddhism were extensive. He also participated in the state's calendar formulation, glossed by historical records as the 'Buddhist production of calendars' (釋門制曆). This article therefore focuses on the relationship between Buddhism and science illustrated by Yixing's participation in calendar formulation. The study will examine the following three aspects:

First, within Indian culture, monks were closely connected to astronomy and calendrical science, providing a solid background for the Buddhist formulation of calendars.

Second, the Buddhist precepts called for the rigorous calculation of time, so Yixing undertook the serious study of calendrical science in order to better understand the precepts.

Third, the attitude of Yixing and, more broadly, Tang Buddhism toward '*Vinaya* methods' or 'methods of discipline' (*lüfa* 律法) can be observed by considering the time-based requirements of the precept against 'eating at inappropriate times' (非時食).

Buddhism and science/technology are two vast systems replete with complex negotiations. This study has selected only the subject of Yixing's calendar formulation to observe the relationship between Buddhism and science during the Tang dynasty from a focused perspective.

Monk and Calendrical Astronomy

Along with foreign Buddhist monks coming to the East and the return of Chinese monks who had traveled to West, Indian astronomy also entered China and influenced the imperial system of calendrical science. In this section I discuss two ways in which the Tang dynasty adopted and developed knowledge from Indian astronomy, against the background of Chinese calendar formulation.

The emperor 'received [his] mandate from Heaven' (受命於天), and the Son of Heaven's 天子 'virtuous conduct' 德行 was closely related to the movement of the sun, the moon, and the stars. Calendars therefore possessed a distinctly political character. Calendrical formulation represented one of the regular responsibilities of the state's highest office of astronomy. In Kaiyuan 開元 13 (725), Yixing had not obtained a position related to astronomy, so it was with the status of a civilian monk that he participated in formulating the 'Kaiyuan Dayan Calendar' 開元大衍曆, a project which even the court astronomer Nangong Yue 南宮說 (fl. eighth c.) also served. Regarding the 'Buddhist production of calendars', modern accounts argue that this was unrelated to religious status, with Wu Hui's *Seng Yixing yanjiu* pointing out that the determining factors in the event were Emperor Xuanzong's 玄宗 (685–762) political proposals and cultural decisions during the early years of the Kaiyuan era (713+).[6] This conclusion may explain the significance of Yixing's status as a monk, but it cannot clarify why Yixing, as a monk, possessed such a deep knowledge of astronomy. By Kaiyuan 6 (718), Gautama Siddha (Qutan Xida 瞿曇悉達; fl. eighth c.) was already participating in the calendrical formulation project,[7] which is to say that the Indian monastic Gautama family was more qualified than Yixing to be selected among people with the status of monks for participation in the project. In addition, the *Song Gaoseng zhuan* 宋高僧傳 [Song Biographies of Eminent Monks] recounts that Yixing was 'deeply knowledgeable of the *Vinaya*' (深達毗尼). However, the *Fo yijiao jing* 佛遺教經 [Bequeathed Teachings Sūtra] clearly advises that '[monks] should not observe the constellations, practice divination according to the waxing and waning of the moon, or calculate days of good fortune' (仰觀星宿, 推步盈虛, 曆數算計, 皆所不應).[8] So, why would someone who followed the precepts so assiduously then betray their spirit by studying astronomy (*yinyang* 陰陽) and divination (*chenwei* 讖緯)?[9]

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6 Wu, *Seng Yixing yanjiu*, 170.

7 *Xin Tangshu* 98.691.

8 *Fo chui boniepan lüeshuo jiaojie jing*, *T* no. 389, 12: 1.1110c26–27.

9 Translator's note*:* Throughout this article I have translated *yinyang* 陰陽 as 'astronomy', since it always seems to refer to that one aspect among various elements of the *yinyang* prognostic system (also including *fengshui*, for example), or to function metaphorically as a synonym for *tianwen* 天文, especially when refer-

The reasons for 'Buddhist production of calendars' are therefore worth further investigation.

Monks with extensive knowledge of astronomy were not unusual. Prior to Yixing, Buddhism had already accumulated large amounts of astronomical work related to calendrical calculation, which could be grouped into two categories. One was the translation of many classic texts containing astronomical knowledge. Among these, a great deal of this knowledge was contained within classics such as the *Chang ahan jing* 長阿含經 [Skt. *Dīrghâgama*; Lengthy Āgama], the *Za ahan jing* 雜阿含經 [Skt. *Saṃyuktâgama-sūtra*; Connected Āgama], the *Dafangguangfo huayan jing* 大方廣佛華嚴經 [Skt. *Buddhâvataṃsaka-mahāvaipulya-sūtra*; Flower Garland Sūtra], the *Abidamo jushe shilun* 阿毗達磨俱舍釋論 [Skt. *Abhidharmakośa-bhāsya*; Commentary on the Sheath of Abhidharma], the *Modengjia jing* 摩登伽經 [Skt. *Mātaṅga-sūtra*; Matanga Sūtra], the *Fo shuo shi fei shi jing* 佛說時非時經 [Sūtra on the Timely and the Untimely, Preached by the Buddha], and the *Da fangdeng daji jing* 大方等大集經 [Skt. *Mahāsaṃnipāta-sūtra*; Great Assembly Sūtra]. For example, the *Modengjia jing* contained considerable material on astrology and the calculation of time. The second way Chinese Buddhism had accumulated knowledge of calendrical astronomy was that eminent monks had brought their extensive knowledge of astronomy and calendrical science with them to China. The Parthian An Shigao 安世高 (fl. second c.) was not only the first recorded translator of classic texts, but also an expert on astronomy, being 'well versed in the appearances of the Seven Heavenly Bodies and the Five Phases, divination based on the wind and clouds, and prognostication based on the waxing and waning of the moon' (七曜五行之象, 風角雲物之占,

ring to Indian cases (where *yinyang* did not exist as such). When 'astronomy' appears without *yinyang* in parentheses, it translates *tianwen*. Similarly, 'divination' translates *chenwei* 讖緯, which originally referred to certain Han-era Confucian texts, but throughout this article seems to denote divination more generally, serving as a synonym for terms such as *zhanbu* 占卜. Since these distinctions do not seem relevant here, I have translated them all as 'divination' or 'prognostic' without specifying the Chinese terms.

推步盈縮, 悉窮其變).[10] At the same time that An Shigao transmitted the Buddhist Dharma, he also introduced Indian medical arts and astrology to China, and henceforth monks came from the West in an endless stream, most possessing extensive knowledge of astronomy. The Liang dynasty *Gaoseng zhuan* 高僧傳 [Biographies of Eminent Monks], for example, recounts that Dharmakāla (Ch. Tankejialuo 曇柯迦羅; fl. third c.) 'knew everything about the wind, clouds, and constellations, and the use of diagrams for divination' (風雲星宿, 圖讖運變, 莫不該綜).[11] Similarly, Kang Senghui 康僧會 (fl. third c.) not only 'clearly understood the *Tripiṭaka*' 明解三藏, but was also 'well read in the Six Classics, astronomy, and prognostic diagrams' (博覽六經, 天文圖緯, 多所綜涉).[12] Kumārajīva (Ch. Jiumoluoshi 鳩摩羅什; 344–413) was 'well-versed in the Four Vedas, all the treatises of the Five Sciences, astronomy (*yinyang*), and astrology' (博覽四圍陀典及五明諸論, 陰陽星算, 莫不必盡);[13] and Guṇabhadra (Ch. Qiunabatuoluo 求那跋陀羅; 394–468) 'as a child had studied all the treatises of the Five Sciences, the use of astronomy texts for divination, and the medicinal use of mantras, becoming an expert in all of these' (幼學五明諸論, 天文書算, 醫方咒術, 靡不該博).[14] These eminent monks had mastered all kinds of astronomical knowledge, and they passed it down through generations of monks by way of translation and teaching, thereby enriching China's astronomy and calendrical science.

In addition, the 'Bibliography, Part III' ('Jingji zhi san' 經籍志三) of the *Suishu* 隋書 [History of Sui] lists multiple texts about Indian astronomy:[15]

> *Poluomen tianwen jing* 婆羅門天文經 [Scripture on Brahmin Astronomy], 21 *juan*;
>
> *Poluomen Jiejia xianren tianwen shuo* 婆羅門竭伽仙人天文說

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[10] *Kaiyuan Shijiao lu, T* no. 2154, 55: 13.481a5–7.

[11] *Gaoseng zhuan*, *T* no. 2059, 50: 1.324c17–18.

[12] *Ibid.,* 1.325a16–17.

[13] *Ibid.,* 2.330c9–10.

[14] *Ibid.,* 3.344a6–7.

[15] *Suishu* 34.997.

[Astronomical Teachings of Brahmin Sage Garga], 30 *juan*;
Poluomen tian wen 婆羅門天文 [Brahmin Astronomy], 1 *juan*;
Modengjia jing shuo xingtu 摩登伽經說星圖 [Matanga Sūtra Teachings on Astral Charts], 1 *juan*;
Poluomen suanfa 婆羅門算法 [Brahmin Methods of Calculation], 3 *juan*;
Poluomen yinyang suanli 婆羅門陰陽算曆 [Brahmin Use of Astronomy (*Yinyang*) to Calculate Calendars], 1 *juan*;
Poluomen suan jing 婆羅門算經 [Brahmin Scripture of Calculation], 1 *juan*.

Most of these Indian astronomical works were translated by Buddhist monks, with the *Poluomen tianwen jing* being translated by Dharmaruci (Ch. Damoliuzhi 達摩流支; fl. 5th c.) himself.[16] The consummation of such texts and their transmission within Buddhism provided a rich background for Yixing's participation in calendrical formulation, while also further illustrating Buddhism's long-standing tradition of calculating time.

The Precepts and Calendrical Calculation

Based on accounts of Yixing's life, we can assume that his impetus for studying calendrical calculation was probably oriented towards making a more thorough study of the precepts. This section explores the importance of calendrical science for the precepts and Yixing's study of calendrical calculation.

According to current scholarship, Yixing was not fond of politics and paid little attention to disputes among religious sects.[17] Emperor Xuanzong's choice in selecting him was closely linked to Yixing's expertise in mathematics and calculation. According to Osabe Kazuo's research, Yixing had previously studied with eight experts: the Daoist monk Yin Chong 尹崇 (d.u.); a Buddhist monk who practiced

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16 *Da Tang neidian lu*, *T* no. 2149, 55: 5.271c6–8.

17 Wu, *Seng Yixing yanjiu*, 169.

divination at Guoqing Monastery 國清寺 on Mount Tiantai 天台山 (whose name is unknown); Chan Master Puji 普寂 (651–739); Vinaya Master Hongjing 弘景 (634–713); Chan masters Huizhen 惠真 (637–751) and Daoyi 道一 (d.u.) of the Yuquan Tiantai Lineage; Śubhakarasiṃha (Ch. Shanwuwei 善無畏; 637–735); and Vajrabodhi (Ch. Jingangzhi 金剛智; 671–741).[18] Among these eight figures, the anonymous monk of Guoqing Monastery was the one associated with mathematics. According to the 'biographies of diviners and magicians' ('Fangji zhuan' 方伎傳) in the *Jiu Tangshu*舊唐書 [Old Tang History] Yixing's motivation for seeking out the nameless monk was to 'find a teacher in order to acquire the knowledge [necessary to produce the] Dayan [Calendar]' (求訪師資, 以窮大衍).[19] While the *Song gaoseng zhuan* notes (as mentioned above) that Yixing adhered strictly to the *Vinaya*, it also records that he searched widely for knowledge of astronomy (*yinyang*) and 'divination'.[20] Both 'Dayan' and the prognostic arts involved calendrical science, so there can be no doubt that Yixing sought out the nameless monk to learn about calendars. Yixing's transformation, turning his acquired skills into real knowledge, was also connected to Ximing Monastery 西明寺.[21]

The reason Yixing studied calendrical science amid his *Vinaya* studies was that the precepts placed great value on 'methods of discipline'. Prior to this, he had studied the *Vinaya* at Mount Dangyang 當陽 with Master Huizhen 惠真. Later, after learning calendrical science, Yixing returned to Dangyang to continue his *Vinaya*

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18 Osabe, *Ichigyō zenji no kenkyū*, 47.

19 *Jiu Tangshu* 191.5111.

20 According to *Song Gaoseng zhuan* (*T* no. 2061, 50: 5.732c24–27), 'Since he went to Dangyang, he encountered the monk Huizhen composing his introduction to the Vinaya Piṭaka, so he achieved a profound understanding of the Vinaya. He also carefully studied all the texts about astronomy (*yinyang*) and divination, travelling as far as one thousand *li* to seek out experts in mathematics and calculation, visiting anyone of renown he heard of' (因往當陽值僧真纂成律藏序, 深達毗尼, 然有陰陽讖緯之書, 一皆詳究, 尋訪算術不下數千里, 知名者往詢).

21 Zhan, *Ximing Dongxia*, chap. 7.4.5.

studies.[22] The inscription on the 'Jingzhou Nanquan Dayunsi gu Lanruo heshang bei' 荊州南泉大雲寺故蘭若和尚碑 [Tablet for the Monk Araṇya (Ch. Lanruo) of the Dayun Monastery in Nanquan, Jingzhou] recounts the life of Huizhen, including the interesting detail that after he had received the *Vinaya* treatises from Yijing 義淨 (635–713) and studied them, he then proposed that 'beginning on the sixteenth day of the fifth month, the summer rains retreat will begin' (始以五月十六日結夏安居). The monks were astonished, until Śubhakarasiṃha arrived and pointed out that 'when the *Jialidijia* Star [i.e. Mars] reached conjunction [with the sun/earth?]' (迦利底迦星合時), this was indeed the proper time for the rains retreat.[23] Huizhen had educated himself in the precepts and extrapolated that the time for the rains retreat was not fixed but was determined according to the movement of the stars, and Śubhakarasiṃha confirmed that this method was correct according to the Vinaya. Besides this retreat, there were many other precepts requiring the calculation of time, such as 'recitation of the precepts' 誦戒 and 'the storage of goods' 蓄物. Belonging as he did to a generation of eminent monks, naturally Huizhen would not have ignored these details concerning time. He had received the *Vinaya* treatises from the hands of Yijing, who, himself, had praised the fact that 'according to the tradition passed down in the Western lands, one who observes water [in order to] observe time is called a *Vinaya* master' (故西國相傳云, 觀水觀時是曰律師矣).[24] Yijing's attitude toward the calculation of time would naturally have also influenced Huizhen, and may explain his outlook concerning the correct time for the rains retreat in the incident mentioned above.[25]

Śubhakarasiṃha reached Chang'an in Kaiyuan 4 (716), so it was probably prior to this that he passed through Dangyang. Yixing went to study calendrical science at Guoqing Monastery in Kaiyuan 2 (714). He had probably begun his studies with Huizhen before

22 Wu, *Seng Yixing yanjiu*, 185.

23 *Wenyuan yinghua* 860.4541.

24 *Nanhai jigui neifa zhuan*, *T* no. 2125, 54: 3.226c23–24.

25 Ibid, 226c23–28.

deciding there was more to learn elsewhere. The content of the calendrical methods that Huizhen had studied is unclear, but the tablet inscription indicates that he used the term '*Jialidijia* Star' for the planet Mars, so it was probably an Indian method. In the third juan of the *Darijing yishi* 大日經義釋 [Exegesis of the *Mahāvairocana-abhisaṃbodhi-tantra*], Yixing mentions 'Western calendrical methods' 西方曆法, explaining how Indian calendars determined the length of each month and the day it should begin, and introducing the significance of 'the division of each day and night into 60 [units called] *shi* 時' (晝夜六十時), 'the 27 lunar mansions' (二十七宿), and the 'nine heavenly bodies' 九曜.[26] This shows that he had studied Indian calendrical science extensively. In Kaiyuan 21 (733), a memorial presented to the emperor, signed by Nan Gongyue and Gautama Zhuan (Ch. Qutan Zhuan 瞿曇譔 [712–776]), among others, stated that 'The Dayan is an imitation of the Jiuzhi Calendar (Skt. Navagraha-karaṇa), [which is] technically inferior' (大衍寫九執曆, 其術未盡). The *Xin Tangshu* argues that the impetus behind this statement stemmed from Gautama's 'resentment that he had not been involved in the calendrical reform' (怨不得預改曆),[27] implying that the Dayan Calendar was actually superior to the Jiuzhi. It could be inferred from this, perhaps, that Yixing's discontentment with his study of Indian calendrical methods under Huizhen were related to the latter's calculation of the dates for the summer rains retreat, and that was why he sought out the nameless monk at Guoqing Monastery. Huizhen belonged to the Tiantai Yuquan lineage closely tied to its birthplace on Mount Tiantai [where Guoqing Monastery stands], so it was with a clear goal in mind that Yixing set out to study there. His attitude toward calendrical astronomy, therefore, was not at all part of a predilection for astronomy (*yinyang*) and divination, as claimed by the *Gaoseng zhuan*. In *juan* 4 of the *Da Piluzhe'na chengfo jing shu* 大毘盧遮那成佛經疏 [Commentary on the *Mahāvairocana-abhisaṃbodhi-tantra*], Yixing recounts that his attitude toward calendrical science was aimed at 'following opportunities presented

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26 *Dari jing yishi*, *X* no. 438, 23: 3.308a16–b11.

27 *Xin Tangshu* 27A.587.

by the circumstances of others' (順彼情機).[28] It was this tireless spirit in pursuit of knowledge that drove him to learn Chinese and Indian methods, finally putting them into practice with the Dayan Calendar. One major innovation of the calendar was to break free from the limitations that traditional calendars had placed on the use of sundials, clepsydras (water clocks), and solar eclipses, such that they had been effective only in certain locations, instead boldly attempting to create a calendar that would be valid all over the empire.[29] This fact is consistent with our analysis here that Yixing's aim in studying calendrical methods was to formulate a calendar appropriate for the Buddhist precepts.

In addition, calendrical science represented an indispensable aspect of *Vinaya* studies in the Tang dynasty. This notion derived from Daoxuan 道宣 (596–667), patriarch of the Four-Part Vinaya (*Sifenlü* 四分律) tradition. First there was his *Guanzhong chuangli jietan tujing* 關中創立戒壇圖經 [Illustrated Sūtra on the Construction of Ordination Platforms, Written in Guanzhong]. In that document, Daoxuan's ideal 'Jetavana Monastery' 祇園精舍 included a 'World Astronomical (*Yinyang*) Library' 天下陰陽書院, demonstrating that he believed calendrical science was one of the requisite skills.[30] Secondly, when Daoxuan composed the *Sifenlü hanzhu jieben shu* 四分律含注戒本疏 [Commentary on the Annotated Prātimokṣa of the Four-Part Vinaya], he had already noticed differences between Indian and Chinese methods of formulating calendars, and when the Song-era monk Yuanzhao 元照 (1048–1116) added interlinear notes to the text, he explained these differences in more detail, pointing out:

> As the Buddhist vernal equinox begins on the sixteenth day of the last month, an expert of astronomy (*yinyang*) and calendars is necessary. Great Cold (*Dahan* 大寒) is the major solar term (*zhongqi* 中氣) in the twelfth month. Thus, the sixteenth day would be the Start of Spring (*Lichun* 立春). By ascertaining the number of steps,

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28 *Da Piluzhe'na chengfo jing shu*, *T* no. 1796, 39: 4.618b8–9.

29 Ma, *Han-Tang Fojiao yu kexue*, 195.

30 *Guanzhong chuangli jietan tujing*, *T* no. 1892, 45: 1.811a12.

> the specific time can be determined, so within the [Indian] saṃgha, footprints were used to tell time. This is why, conventionally, the day and the night were each divided into nine *shi*, while the saṃgha divided one day and night into 30 *muhūrta* [*xuyu* 須臾 = 48 minutes], whereas in the Tang State, sundials and clepsydras divided one day and night into 100 'notches' [*ke* 刻 = 14 minutes 24 seconds].[31] 如佛法春分, 以臘月十六日為始者, 須准陰陽曆家. 大寒是十二月中氣, 如是類例, 十六日便為立春, 克定步數, 可知時分, 故僧祇中令作腳影, 此即是也, 多論晝夜各分九時, 僧祇日夕三十須臾, 唐國晷漏箭為百刻.[32]

Since Daoxuan was not proficient enough in calendrical science, however, he could only resign himself to say 'an expert of astronomy and calendars is necessary'. Xuanzang 玄奘 (602–664)'s *Da Tang xiyu ji* 大唐西域記 [Record of Travels to Western Lands] pointed out that Indian monks had to study the 'Five Sciences' (Skt. *pañcavidyā*; Ch. *wuming* 五明), among which 'science of fine arts and crafts' (Skt. *śilpa-karma-sthāna vidyā*; Ch. *gongqiaoming* 工巧明) included 'crafts, mechanics, astronomy (*yinyang*), and calendrical science'.[33] The calculation of calendars would thus have been a rather ordinary thing for Indian monks at the time. Many eminent monks who came from India also demonstrated this. Yixing's teacher Śubhakarasiṃha, for example, was also proficient in calendrical methods, having evaluated Huizhen's calculation of the time for the rains retreat, and being praised in the *Kaiyuan Shijiao lu* 開元釋教錄 [Record of Śākyamuni's Teachings Compiled During the Kaiyuan Period] as 'expert at all kinds of arts and technologies' (藝術異能, 無不諳曉).[34]

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31 Translator's note: The term *ke* 刻 literally means 'notch' because it was calculated according to physical notches cut into material such as wood. During the Tang period one day was divided into 100 notches, so each notch indicated 14 minutes 24 seconds. Later this was changed to 96 notches per day, giving us the modern sense of 15 minutes per *ke*.

32 *Sifenlü hanzhu jieben shu hangzong ji*, *X* no. 714, 40: 4.114b17–21.

33 *Da Tang Xiyu ji*, *T* no. 2087, 51: 2.876c18–19.

34 *Kaiyuan Shijiao lu*, *T* no. 2154, 55: 9.572a7–8.

The father of Vajrabodhi (another of Yixing's teachers mentioned above) had been proficient in the Five Sciences, and with such a learned family background, it was only natural that the son would have been skilled in calendrical methods as well.[35] In addition, their contemporary Bodhiruci (Ch. Putiliuzhi 菩提流支; d. 527) was also said to have known astronomy (*yinyang*) and calendrical science 'like the back of his hand' 如指掌.[36]

In sum, Yixing's aim in studying calendrical science was two-fold: He wanted to better understand the precepts, but he also believed the science to be a method of 'skillful means' (Ch. *fangbian* 方便; Skt. *upāya*) befitting the needs of all sentient beings, which could be traced back to the days of the Buddha.

Observing the Precepts and Telling Time with Clepsydras

In addition to calculating years and months, Buddhism also required methods for calculating smaller units of time. Yixing improved upon earlier models to produce a 'Bronze Armillary Sphere' (*huntian tongyi* 渾天銅儀) that could automatically indicate the time. This

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[35] According to the 'Biography of Vajrabodhi' 金剛智傳 in the *Song Gaoseng zhuan* (*T* no. 2061, 50: 1.711.8–11), 'His father was a brahmin, who was skilled at the Five Sciences and was the teacher of the King of Kāñcī. When Vajrabodhi was only a few years old, he could already read tens of thousands of words in one day, and after seeing them with his eyes he could understand and remember them for the rest of his life. When he was 16, he suddenly awoke to the Buddhadharma, and he lost interest in the theories of Nirgrantha, so he cut off his impurities and left home to become a monk' (父婆羅門善五明論, 為建支王師, 智生數歲日誦萬言, 目覽心傳終身無忘, 年十六開悟佛理, 不樂習尼揵子諸論, 乃削染出家).

[36] According to the *Kaiyuan Shijiao lu* (*T* no. 2154, 55: 9.570a6–8), 'The master learned from Parāśara's knowledge of classic texts, acquiring profound insight into linguistics (Skt. *śabda-vidyā*), and becoming especially proficient in Sāṃkhya philosophy, astronomy (*yinyang*), calendrical science, the art of mantras, and medicine' (師稟波羅奢羅, 學彼經術, 遂洞曉聲明, 尤閒數論, 陰陽曆數, 地理天文, 呪術醫方, 皆如指掌).

was closely linked to Buddhist practices of personal cultivation (*xiuxing* 修行). Observation of the precepts (*chijie* 持戒), being the foundation of Buddhist practice, involved many specific and detailed procedures, and when those involving time-related considerations were performed 'at inappropriate times' 非時, that was considered a transgression. Most notable was the precept against 'eating at inappropriate times' 非時食. According to the *Mohe sengqi lü* 摩訶僧祇律 [Skt. *Mahāsāṃghika-vinaya*; Great Canon of Monastic Rules], 'Inappropriate times mean if a moment has passed [after noon], even a moment as short as a leaf of grass, then this is called an inappropriate time [for eating]' (非時者, 若時過如髮瞬、若草葉, 過是名非時).[37] This was later detailed in Hongzan's 弘贊 (1611–1685) Ming period text, the *Sifenlü mingyi biaoshi* 四分律名義標釋 [Explanation of the Names and Titles in the *Dharmaguptaka Vinaya*], which pointed out that the vernal and autumnal equinoxes had to be recalculated each year, and that due to geographical differences, calculation had to be done according to the local time in any given location.[38] In addition to methods based on the sun's shadow, clepsydras were also used to calculate time, as mentioned above.[39] In his *Nanhai jigui neifa zhuan* 南海寄歸內法傳 [Record of Buddhist Practices Sent Home from the Southern Sea], Yijing described mastery of the clepsydra as a major affair for monastics, writing, 'If [monks] could present a request [for the emperor] to install a clepsydra, this would be profoundly beneficial to the saṃgha' (若能奏請置之, 深是僧家要事).[40] Below we look at Yixing's improvement of the armillary sphere and Buddhism's contribution to the development of horological instruments more generally.

Armillary spheres were first created in the Western Han. In the Eastern Han, Zhang Heng 張衡 (78–139) invented a water-powered model, after which they continued to be improved over the centuries, until Yixing and others such as Liang Lingzan 梁令瓚 (b. 689) intro-

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37 *Mohe sengqi lü*, *T* no. 1425, 22: 17.360a8–9.

38 *Sifenlü mingyi biaoshi*, *X* no. 744-A, 44: 13.505a1–c1.

39 *Mohe sengqi lü*, *T* no. 1425, 22: 17.359a1–7.

40 *Nanhai jigui neifa zhuan*, *T* no. 2125, 54: 3.226a18–19.

duced their own enhancements in the Tang dynasty. This is detailed in the *Jiu Tang shu*'s 'Treatise on Astronomy' 天文志, which recounts that their device not only demonstrated the movements of the celestial sphere, the sun, and the moon, but also included two wooden mannequins that would beat a drum at every 'notch' [*ke* 刻 = 14 minutes 24 seconds] and strike a bell at every *chen* 辰 [= two hours]. The Bronze Armillary Sphere thus combined the functions of a conventional armillary with those of a chiming clock into one instrument.[41] Chiming clocks had already existed before the time of Yixing, according to historical records. The Song dynasty *Lebang wenlei* 樂邦文類 [Manuscripts from Paradise] mentions that [during the Eastern Jin period] Huiyuan's 慧遠 (334–416) disciples had created a 'Lotus Clepsydra' 蓮花漏, consisting of a wooden lotus blossom with twelve petals surrounding a mechanism that would cause one petal to unfold with the passing of every *chen*.[42] The Tang dynasty monk Shenqing 神清 (d. early ninth c.) praised it as 'no less accurate than a sundial' (晷景無差), mentioning in the interlinear notes that Huiyao 慧要 (d.u.) had been adept at machinery, creating a wooden bird that could fly one hundred paces.[43] In the *Nanhai jigui neifa*

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[41] *Zhongguo tongshi*, volume 6, 1576.

[42] According to the *Lebang wenlei* (*T* no. 196B, 47: 1.235c2–5), 'Huiyuan had a disciple called Fayao who could carve wood into a lotus with twelve petals and plant it in water as mechanism. The opening of each petal marked the passing of one *shi* 時 with no difference from the clepsydra, so when chanting the monks would not lose track of time, so his community was named the Lotus Community' (遠公有弟子名法要, 能刻木為十二蓮華, 植於水中用以機關. 凡析一葉是一時, 與刻漏無差, 俾禮念不失時, 因此名其社為'蓮社'也).

[43] According to the *Beishan lu* (*T* no. 2113, 52: 4.596b17–21), 'There was a [monk] named Huiyao who was concerned because there were no clepsydras in the mountains, so he installed a lotus with twelve petals in the water that would indicate the twelve *shi* as the water flowed no less accurately than a sundial. [*Shenqing's Interlinear note:*] He also made a wooden bird that could fly one hundred paces. There was also a person from Mount Zhang who, in Guangzheng (938-965), set up an armillary structure in front of the audience hall of the King of Shu, pouring mercury inside that would cause wooden mannequins to hold up two signs indicating the time. As

zhuan, Yijing had written that the Indian method of calculating time was to use a type of clepsydra with small holes in the base of a copper bowl, which was placed in a copper basin. After the bowl filled up with water it would sink down, indicating the length of one *gu* 鼓 [= forty-five minutes, in this case], with four bowls indicating one *shi* 時 [= three hours], and eight *shi* comprising one day and night.[44] The Chinese method, by contrast, was to divide a wooden board into one hundred units, position it vertically within a copper basin, and as water flowed in, the board would float to the surface, with engravings of the twelve animals of the zodiac indicating each of the twelve *shi* [each *shi* here being two hours].[45] The horological methods

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the mercury moved they would announce the time to the hall as accurately as a sundial' (有慧要者, 患山中無刻漏, 乃於水上立十二葉芙蓉, 因波轉以定十二時, 晷景無差耳(又嘗作木鵶, 令飛數百步. 有張山人者, 廣政中, 於蜀主殿前立渾儀樓, 注以水銀, 令木人執二時牌子, 隨水銀轉對殿報時, 晷刻不差)).

[44] According to the *Nanhai jigui neifa zhuan* (*T* no. 2125, 54: 3.225c24–28), 'In addition, the large monasteries in the Western lands all have clepsydras donated by kings in the past, with 'funnels' (*louzi* 漏子) also donated to help the monks keep track of time. Below, copper basins are used to collect water, with copper bowls floating on top. The bowls are thin and exquisite, holding two *sheng* 升 [about 0.6 liters at the time of writing] of water. There are holes in the bowls through which the water can flow upwards, the holes as narrow as a needle so the time is measured precisely. After the bowls fill up with water, they sink down until there is a drum sound' (又復西國大寺皆有漏水, 並是積代君王之所奉施, 並給漏子為眾警時. 下以銅盆盛水, 上乃銅椀浮內. 其椀薄妙可受二升, 孔在下穿水便上湧, 細若針許量時准宜. 椀水既盡, 沈即打鼓).

[45] According to the *Fahua jing wenju fuzheng ji* (*T* no. 593, 28: 10.813c9–13): 'In the term *guike* 晷刻 (sundial), [*gui* 晷] refers to the sun's shadow, [and] *ke* 刻 refers to the *qiehushi* 挈壺氏 in the *Zhouli* 周禮 [Rites of Zhou], who oversaw the clepsydra. This was a vessel (*qi* 器) made by suspending a pot (*hu* 壺) underwater to indicate the water level. There were small holes in the pot from which water would drip into the vessel beneath. Within the vessel there was an upright wooden board with one hundred notches carved into it. As the board floated upward, the notches gradually surfaced, and after an entire day and night, all one hundred notches would have surfaced. There were also images of [twelve]

coming from India pushed Chinese monks to combine them with such Chinese technologies in order to improve the precision of their own practices of self-cultivation, such that the Lotus Clepsydra was already capable of automatically indicating every two-hour period.

During the Tang dynasty, lotus clepsydras began to spread among the greater public. The *Tang yulin* 唐語林 [Forest of Anecdotes about the Tang Period] recounts that at Mount Lu 廬山, Lingche 靈澈 (746–816) obtained a lotus clepsydra said to have been passed down from Huiyuan.[46] This occurred about half a century after Yixing's death, so the clepsydra must have been in use at the monastery continuously since the Eastern Jin. Later in the ninth century, lotus clepsydras would appear repeatedly in Tang poetry,

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animals on the board indicating the twelve *shi*. This is used by the imperial court today' (晷刻者日影也, 刻者周禮有挈壺氏, 掌漏刻懸一壺而成, 水下安示水器, 壺有小孔, 漏滴其水於下器中, 器內有豎木, 刻為百刻, 水浮豎木, 其刻漸出, 竟一日夜百刻方盡, 仍於木上為二獸形, 以正十二時, 也今國家用之).

[46] According to the *Tang yulin* (494), 'The monk Lingche of Yue 越 [Prefecture] who obtained a lotus clepsydra from Mount Lu and passed it on to Wei Dan 韋丹, the surveillance commissioner (*guancha shi* 觀察使) of Jiangxi. Originally, Huiyuan, living in the mountains, had not heard of clepsydras, so he fashioned a sheet of copper into a vessel shaped like a lotus, placed it in a basin of water, and the water seeped in through holes in the bottom. When it was halfway full of water, the vessel sunk. Within one day and night it would sink twelve times, serving as a temporal reference personal cultivation practice. It remained accurate despite the changing length of the day in the winter and summer, and even when the sky was overcast or dark' (越僧靈澈, 得蓮花漏於廬山, 傳江西觀察使韋丹. 初, 惠遠以山中不知更漏, 乃取銅葉制器, 狀如蓮花, 置盆水之上, 底孔漏水. 半之則沈. 每晝夜十二沈, 為行道之節. 雖冬夏短長, 雲陰月黑, 亦無差也).

Lingche was also a famous Vinaya master who wrote the twenty-one-*juan* *Lüzong yinyuan* 律宗引源 [Origin of the Vinaya School], as recorded by his biography at *Song Gaoseng zhuan*, *T* no. 2061, 50: 15.802b6–18: '[Lingche's] conduct according to the way was without any cause for shame, and his wisdom of emptiness was serene and lofty. Later he wrote the *Lüzong yinyuan* in twenty-one *juan*, in which the saṃgha took refuge' (其道行空慧, 無慚安遠, 復著《律宗引源》二十一卷, 為緇流所歸).

most representatively in Pi Rixiu's 皮日休 (834–883) 'Feng he Lu Wang tong you Beichanyuan' 奉和魯望同游北禪院 [In Honour of Wandering Together with Lu Wang to the North Chan Monastery], which includes the lines: 'Chanting for a few more rounds of the lotus clepsydra / Sitting for as long as it takes to burn another coil of cedar incense' (吟多幾轉蓮花漏, 坐久重焚柏子香). This poem illustrates that clepsydras were used to calculate time during meditation at Chan monasteries in those days, and that religious rituals such as burning incense were performed according to this time-telling function. In Yixing's lineage, Puji and Hongjing were both famous Chan masters at the time, so it was only natural that they would have been in close contact with lotus clepsydras in Chan monasteries.

As for the specific design, details are no longer extant. In the Song dynasty, Yan Su 燕肅 (961–1040) made improvements on the design to produce a more precise clepsydra. The *Qingxiang zaji* 青箱雜記 [Miscellaneous Records from a Green Chest] explains that the new model took the floating piece of wood with 100 notches and divided it into four segments of 25 notches each. In total there were 64 surfaces, so 100 notches were divided into 1,000 parts.[47] From this we can see that the Buddhist lotus clepsydra was superior to the conventional water clock. By Chongzhen 崇禎 11 (1638) during the Ming dynasty, in order to produce a more precise clepsydra for Buddhist offerings, a shrine was concealed within the basin that would float to the surface at certain times. The clock would also automatically strike bells and drums to announce the time, like Yixing's Bronze Armillary Sphere.[48]

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47 *Qingxiang zaji*, 99.

48 According to *Shijian jigu lüe xuji* (*T* no. 2038, 49: 1.916c27–917a2), 'The palace clepsydra stood about six or seven *chi* 尺 [1 *chi* = 32 centimeters for craft production in the Ming dynasty] high, consisting of a wooden cabinet containing a pot, with water flowing downwards. On top of the cabinet stood a Hall for the Three Sages of the Western Pure Land [Amitâbha, Avalokitêśvara, and Mahāsthāmaprāpta]. In the middle stood 'precious maidens' (Skt. *kanyā-ratna*; Ch. *yunü* 玉女) holding up rods that indicated the time, floating upwards with the water at the appropriate time. On the left and right stood two devas wear-

Prior to the Tang, the many classic texts transmitted by Buddhism had laid a firm foundation for the 'Buddhist production of calendars'. In order to better observe the precepts for practices of personal cultivation, moreover, Chinese monks had been synthesising and improving upon both Indian and Chinese methods of calculating time since the Eastern Jin dynasty. Executing skillful designs and conceptions, they created ever more refined and precise horological instruments, providing a practical foundation for Yixing's development of the self-chiming Bronze Armillary Sphere.

Conclusion

With the status of a civilian śramaṇa, Yixing's participation in the state's establishment of the calendar was closely tied to the synthesis of Indian and Chinese calendrical science. Many Indian calendrical methods proved impractical after being introduced to China, leading to all kinds of mistakes. The saṃgha required a unified time in order to make plans more conveniently, and they urgently needed someone to rectify the situation. At that point, Yijing gave the texts he had brought from India to Huizhen, who consequently transmitted the Indian calendrical knowledge from those texts to Yixing. Yixing then went on to study Chinese calendrical science at Mount Tiantai, combining the two in a way that laid the foundation for the Dayan Calendar. As for horological instruments, the Buddhist lotus clepsydra had come into popular usage since the Eastern Jin, and on this basis Yixing produced the Bronze Armillary Sphere that could indicate the time automatically, providing a concrete and accurate time-telling method that monastics could use for observing the precepts and

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ing golden armor, one holding a bell, the other holding a *zheng* 鉦 [a bell-like martial percussion instrument with a long handle], which the two figures would strike at every *geng* 更 [the term for *shi* (two-hour periods) during the night]' (宮漏約高六七尺, 為木櫃, 藏壺其中, 運水上下. 櫃上設西方三聖殿, 櫃腰設玉女, 捧時刻籌, 時至輒浮水而上. 左右列二金甲神人, 一懸鐘, 一懸鉦, 夜則神人自能按更而擊).

practicing personal cultivation. On both the levels of doctrine and practice, then, Buddhism provided impetus and support for the development of science and technology.

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Abbreviations

T *Taishō shinshū daizōkyō* 大正新脩大藏經. See Bibliography, Secondary Sources, Takakusu and Watanabe, eds.

X (*Wan*) *Xuzang jing* (卍)字續藏經. See Bibliography, Secondary Sources, Xinwenfeng chuban gongsi 新文豐出版公司, comp.

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