

Re-Thinking “Independence” of Science and Technology during King Sejong’s Reign

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This article re-evaluates the historical characteristics of science and technology during King Sejong’s reign. Most contemporary historians think that science and technology under King Sejong developed most brilliantly in Korean history and was independent from the Chinese which had been considered the best in the East Asian scientific community. Some scholars were proud that Korean science and technology was different from and superior to China at that time. Astronomy, instrumental technology, agricultural technology, indigenous medicine, and Korean alphabet were considered good examples.

But I disagree with their argument. I do not think science and technology in Joseon during King Sejong’s reign were different from or superior to Chinese science and technology but became independent. King Sejong and the scholar-officials undertook scientific projects to introduce, study, and naturalize Chinese counterparts in the areas of science, technology, liberal arts, and statecraft. The purpose of these projects was to elevate the level of Korean science and technology to the Chinese level that was considered the highest in the world. King Sejong believed these projects would make Korean culture develop and prosper to be on par with China.

In the first part of this article, contemporary perspectives on agricultural technology, indigenous medicine, and Korean alphabet are seriously reconsidered as not being independent of or different from the Chinese but, rather, products to introduce, study, and naturalize Chinese counterparts in Korea. In the latter half of this article, projects on national music and astronomy are analyzed. Through these projects, King Sejong wanted to develop Korean culture and prosper in view of the Confucian ideal.

Keywords: King Sejong, science and technology, mathematical astronomy, ancient systems, contemporary system, *a-ak*, *Nongsajikseol*, *hunmin jeongeum*

Introduction: Confucian Universality and the Meaning of Joseon's Independence

The history of science during King Sejong's reign has always received special attention because the scientific and technological development was more remarkable than any other period of Korean history. "King Sejong's reign was an unprecedented golden age in the history of Korean science" and contemporary scholars agree it was the most conspicuous in the results of science and technology throughout our history (Jeon Sang-un 1966: 318). Statements by historians such as "no other type of development could be found like the remarkable development during King Sejong's reign in the world's history of science and technology during the former half of the 15th century" and "it surpassed the scientific levels of China and the Arabian world not to speak of the Western world" show the positive evaluation of science and technology under King Sejong (Jeon Sang-un 1992:142). Actually, these are compliments that science and technology during King Sejong's reign produced the most advanced and highest-level results throughout the world in the first half of the 15th century.

Today, most researchers agree that specific scientific and technological fields such as astronomy and the production of precise mechanical watches achieved tremendous results during King Sejong's reign. However, the understanding that this was Korea's golden age of science and technology resulted in both a positive and a negative interpretation. For example, it was understood that science and technology of King Sejong's reign did not last long and deteriorated afterward.¹ Advances in science and technology were misrepresented as nothing but an exceptional phenomenon in our history.²

Recently, the historical interpretation by contemporary academics that science and technology in full bloom during King Sejong's reign deteriorated afterward has been criticized and reviewed. A reflective problem was why science and technology during King Sejong's reign deteriorated and was it also indicated that there was a discrepancy between the historical fact and the fact that science

1. Refer to Park Seong-rae (1995) for a discussion of the usual arguments that the science and technology in full bloom during King Sejong's reign deteriorated afterward.

2. In fact, Hong Yi-seop understood in his *Scientific History of Joseon* that the development of science and technology during King Sejong's reign was a temporary phenomenon resulting from King Sejong's physiocracy based on the people and that continued scientific and technological development couldn't be expected in medieval Joseon society.

and technology during King Sejong’s reign was in full bloom, deteriorated and did not continue afterward.³ The recent critical survey on science and technology during King Sejong’s reign will lead to a reexamination of the historical character and situation.

Until now, scientific historians have generally paid attention to the political and ideological character of science in relation to the historical character of science and technology during King Sejong’s reign. That is, it is understood that the brilliant scientific and technological achievements during King Sejong’s reign were the result of efforts by a “newly born” dynasty “to realize the way of the king” based on Confucian ideology. Traditional mathematical astronomy was essential to the study of kings according to Confucian political ideology and *gwansangsusi* (observing astronomical phenomena and setting the time signal) was the most important project for the king. Accordingly, it has been said that mathematical astronomy was what the newly born dynasty desiring Confucian social order and ideology tried to establish first in order to secure justification of the dynasty and easily manage the state systems.⁴

Meanwhile, contemporary scholars studying the political and ideological background were emphasizing the “independence” of science and technology during King Sejong’s reign. While Jeon Sang-un believed the most distinguished achievement of mathematical astronomy during King Sejong’s reign was the establishment of an “independent calendar system,” Park Seong-rae’s alternative view was that King Sejong achieved the “nationalization of science and technology” by accepting advanced Chinese science and technology (Jeon Sang-un 1992: 154-6; Park Seong-rae 1997: 200-1). Thus, Park Seong-rae even conceptualized astronomy as “national astronomy” and medicine as “national medicine.” Recently, Gu Man-ok emphasized the profession of “independence” based on *pungtobudongnon* (the theory that the wind and earth between China and Korea are not the same) as the key theory about the scientific and technological policy during King Sejong’s reign. According to Gu Man-ok, as proven in

3. The advocate of the former theory is Park Seong-rae and those of the latter are Moon Joong-Yang and Jun Yong Hoon. Refer to Park Seong-rae (1995), Moon Joong-Yang (2003) and Jun Yong Hoon (2004). Moon Joong-Yang and Jun Yong Hoon argue that science and technology during King Sejong’s reign continued and developed comparatively well and, moreover, the fields of medicine, geography and natural philosophy developed more brilliantly than science and technology during King Sejong’s reign.

4. Jeon Sang-Woon (1966: 318), Park Seong-rae (1984: 150-3), and Koo Mhan-Ok (2004: 220) all agree.

Nongsajikseol (Straight Accounts of Agriculture), the establishment of indigenous Korean medicine and the invention of the *hunmin jeongeum* (the Korean alphabet), the opinion that “Koreans differed from Chinese” resulted in the theory of *pungtobudong* (The wind and earth between China and Korea are not the same). On the basis of this theory, the development of scientific and technological fields was pursued and resulted in the “independent calendar system” during King Sejong’s reign (Gu Man-ok 2004).

What does the term “independent” mean to contemporary scholars? The lexical meaning of “independent” is “to be able to control one’s own affairs without help from anyone else.” This meaning seems incomplete when discussing science under King Sejong. Perhaps it means that science and technology accepted the advanced science and technology of China, arranged them and “constructed appropriate science and technology relevant to us and different from those of China.” For example, contemporary scholars understand that the achievements of mathematical astronomy actually surpassed the Chinese and produced our own independent mathematical astronomy. Then the science of Joseon had nothing more to learn from China. However, according to the scientific and technological trend of Joseon since King Sejong’s reign, there was much to learn from China and Joseon continued to accept those of China afterward, cherished and developed the science and technology of King Sejong’s reign.

Contrary to this opinion, Gu Man-ok emphasized the distinctiveness or individuality of Joseon in science and technology during King Sejong’s reign. His opinion was that the planners of scientific and technological policy thought highly of Confucian universalism and emphasized the theory of *pungtobudong* to make the most of the indigenous individuality of Joseon. However, the emphasis on the distinctiveness and individuality of Joseon can be said to be a little far from the pursuit of “universality.” It is true that King Sejong’s intention to establish “an independent calendar” as a national policy did not follow Confucian universalism so much as promote a policy to emphasize the unique individuality of Joseon.

This article agrees that the achievements in science and technology during King Sejong’s reign resulted from the efforts to realize a Confucian ideal state in the process of constructing a new dynasty. However, this article does not believe that they were “independent.” Although the science during King Sejong’s reign freed itself from dependence on China and developed into an “independent” level, this article can not agree with the evaluation that science during King Sejong’s reign was “different from that of China, surpassed it and became the

science and technology relevant to us,” as contemporary scholars have stated.

This article will review the arguments of contemporary researchers about the independence of science and technology during King Sejong’s reign. This article will show that the scientific and technological achievements were not achieved through urgent necessity for “Koreans to be different from Chinese” and were not the results to make the most of the indigenous individuality of Joseon, either. On the contrary, it can be said that in the process of making an effort to pursue and realize Confucian universality, the fact that the individuality of Joseon actually should be fully considered was recognized and was shown in *pungto-budong*, *sintoburi* (the body and earth are not different) and *punggiisu* (the winds and vitalities of China and Korea are not the same). Also, this article will analyze the process of important change of recognition through the study of ancient systems and the arrangement of *a-ak* (classical ceremonial music), the national projects to realize a Confucian ideal state and that the brilliant achievements of mathematical astronomy derived from such projects.

Considering that Joseon society was developing on the basis of new Confucian social ideology and order, the understanding of new Confucianism was not satisfactory during the early Joseon dynasty. New Confucianism is an ideological system containing “the nature of vitality and temper” emphasizing peculiarity together with general “nature of Heaven and Earth.” Then, a key point will be how King Sejong and the gentry during the early Joseon period recognized and solved the problem of peculiarity and eventually the problem of reality while accepting the advanced systems of China, that is, universal and ideal ancient systems from the viewpoint of Confucianism.

The Rhetoric of Pungto-budong

The following three things are the controversial points of the independent or national science and technology during King Sejong’s reign: the publication of *Straight Accounts of Agriculture* (1429, the 11th year of King Sejong) and an effort for widespread disbursement of advanced agricultural technology from three southern Yangtze areas; the publication of *Hyangyak jipseongbang* (Collected Prescriptions of Native Korean Medicine) (1433, the 15th year of King Sejong) and the arrangement of native Korean medicine; and the invention of the Korean alphabet (1443, the 25th year of King Sejong). By reviewing the statements of project leaders after its successful completion, it seems that they

emphasized the distinctiveness of Joseon from China.

In the meantime, it must be scrutinized whether the statement “China is different from Korea” refused general science and technology of China and aimed at the distinctiveness and individuality of Joseon.

1. *Straight Accounts of Agriculture* and the Pursuit of Agricultural Technology in the Southern Regions of the Yangtze

“King Taejong ordered Confucian bureaucrats to select indispensable contents from ancient agricultural treatises, publish and distribute them in a block book with notes in dialects, teach the people and make them engage in farming hard... Because natural features of the five directions and the way to plant and cultivate grains are different from those of ancient agricultural treatises. King Taejong ordered governors of various provinces to collect and report experiences of local farmers. King Taejong also ordered me Jeong Cho to arrange them, delete the redundant with the help of Byeon Hyo-mun, select the essentials, edit and publish them in a book entitled *Straight Accounts of Agriculture*.” (The Preface of *Straight Accounts of Agriculture* by Jeong Cho, *Veritable Records of King Sejong*, May 16, 1429)

According to this book, Chinese agricultural treatises had been used since King Taejong’s period. The climate in every region was different; accordingly, there was a limit to Chinese agricultural treatises because diverse agricultural technology had to be applied properly to each region. This preface clearly states the objective to collect agricultural technology verified through experiences in each region, publish and provide it in a book and fix agricultural technology.

This content forces us to understand that Korea’s climate was different from China’s. Naturally, agricultural technology relevant to the climate was diverse so there was a limit to using Chinese agricultural treatises as they were. Therefore, King Sejong had our unique customary agricultural technology of three southern areas collected and arranged and widely dispersed. After all, the preface of *Straight Accounts of Agriculture* may well be understood as an example that shows the direction of agricultural policy under King Sejong pursuing the development of an “independent” agricultural technology.

However, the situation can be greatly changed considering the position of *Straight Accounts of Agriculture* in the historical trend of agricultural technology

during the early Joseon period and the ultimate purpose of its publication. What was the purpose of the publication of *Straight Accounts of Agriculture*? It intended to supply advanced technology of intensive agricultural technology like repeated cultivation established earlier in three southern areas to underdeveloped regions(Yi Tae-Jin 1984: 27). Meanwhile, it is very significant that intensive agricultural technology like repeated cultivation in the three southern areas was closely connected with the advanced agricultural technology of the southern Yangtze areas.

According to Yi Tae-Jin, the position of developmental stage of agricultural methods and technology written about in *Straight Accounts of Agriculture* was the agricultural tradition and technique of the southern Yangtze areas(Yi Tae-Jin 1979). He argues that the historical trend of agricultural technology during the early Joseon period was the process the gentry that had led the development of agricultural productivity through repeated and constant cultivation since the end of Goryeo tried to realize in Joseon advanced agricultural technology focusing on water rice farming of southern areas of the Yangtze, an area of origin of Confucianism they pursued as an ideal society. The advanced water rice farming technology of the southern Yangtze areas was inseparable from Confucianism to the new gentry armed with a new academic system of Confucianism and the settlement of farming technology in this area was also inseparable from the settlement of Confucianism. Yi Tae-Jin argues that the new gentry’s intention toward agricultural technology was reflected in *Straight Accounts of Agriculture*. In fact, the key agricultural technology points like the method of transplanting rice seedlings were not reflected directly in *Straight Accounts of Agriculture* because of insufficient irrigation facilities. The technical level of fertilization in *Straight Accounts of Agriculture* was that of Wang Zhen’s *Nong-shu* (Agricultural Treatise of Wang Zhen), the typical agricultural treatise containing agricultural technology for the southern Yangtze areas. In *Straight Accounts of Agriculture* the method of transplanting rice seedlings was suggested as a precautious method of water rice farming because of insufficient irrigation facilities and was also suggested as a supplementary method in comparison with the method of sowing seeds directly. It was the essential agricultural technology of the southern Yangtze areas utilized through reinforcement of irrigation facilities.

While the direction of agricultural policy led by the new gentry armed with Confucian social ideology and learning was repeated and constant cultivation based upon agricultural technology from the southern Yangtze areas, it should be reevaluated whether the meaning of the phrase *pungtobudong* was to empha-

size the distinctiveness of Joseon. There is a record of extracting the important contents of *Nung Sang Chi Yao* (Fundamentals of Agriculture & Sericulture), publishing it with notes in Korean dialects and distributing it nationwide in the 17th year of King Taejong (*Veritable Records of King Taejong*, May 24, 1435). Not only during King Taejong's reign but also King Sejong's, each province was encouraged to take advantage of agricultural treatises like *Nung Sang Chi Yao* (Fundamentals of Agriculture & Sericulture) and *Ssu Shih Tsuan Yao* (Monthly Ordinances for the Four Sorts of People) and engage in farming (*Veritable Records of King Sejong*, June 1, 1423). *Nung Sang Chi Yao* (Fundamentals of Agriculture & Sericulture) and *Ssu Shih Tsuan Yao* (Monthly Ordinances for the Four Sorts of People) were agricultural treatises on dry field farming in North China which were considered inferior to water rice farming of the southern Yangtze areas. Then, the phrase "...are different from those of ancient agricultural treatises" meant that the typical Chinese agricultural treatise such as *Nung Sang Chi Yao* (Fundamentals of Agriculture & Sericulture) did not correctly reflect agricultural technology used in the three southern Joseon provinces or the agriculture of the southern Yangtze areas. Joseon gentry were first introduced to *Wang Zhen's Nong-shu* (Agricultural Treatise of Wang Zhen) around 1313, but the Chinese agricultural treatise containing agricultural technology of the southern Yangtze was not published until King Jungjong's reign in 1543 (Moon Joong-Yang 2000: 15). The expression, "...are different from those of ancient agricultural treatises," can be regarded as the voice of discontent by the Joseon gentry who were not satisfied with Chinese agricultural treatises used mainly at that time.

The preface of *Straight Accounts of Agriculture* did not aim to develop a different agricultural technology relevant to Joseon climate because the climate between China and Joseon was different. On the contrary, its purpose was to collect and take advantage of customary agricultural technology from part of the southern provinces because former Chinese agricultural treatises were old-fashioned and not relevant to the agricultural technology needed by the new gentry. The agricultural technology collected in *Straight Accounts of Agriculture* was not independent from Chinese agricultural technology so much as a self-rescue method to follow advanced Chinese agricultural technology.

2. *Hyangyak jipseongbang* and Realization of Medicine of Chin and Yuan

The field of indigenous Korean medicine was one of many achievements in science and technology during King Sejong’s reign and conspicuously showed the unique and independent character of Joseon. From *Hyangyak gugeupbang* (First Aid Prescriptions of Native Korean Medicine) at the end of Goryeo (1233, the 20th year of King Gojong) to *Hyangyak jipseongbang* (Collected Prescriptions of Native Korean Medicine) (1433, the 15th year of King Sejong), Miki Sakae evaluated them as “unique medicine” and “independence of medicine” (Mike Sakae 1955: 60, 125). Kim Tu-jong understood the tradition of publishing native medical books since the end of Goryeo as “independent native medicine,” saying that “to encourage the use of native medicine aimed to establish independent policy of native medicine” (Kim Tu-jong 1966: 141). Furthermore, Park Seong-rae argued that “the publication of *Collected Prescriptions of Native Korean Medicine* meant the peak of innovative movement of independent medicine started in the middle of Goryeo” and evaluated “This book passed the limit of Chinese herbal medicine, dealt with things Korean first of all and is of great significance in the establishment of Korean unique medicine” (Park Seong-rae 1997: 104-5).

Thus, the primary basis of regarding *Collected Prescriptions of Native Korean Medicine*, published during King Sejong’s reign as the establishment of a unique and independent Korean medicine, was the establishment of local medicines to surpass expensive Chinese medicine (Chinese Drug) and use cheap and easily available native medicines (Native Korean Drug). The development of local medicine was insufficient to be regarded as “independent medicine.” But the establishment of the theory of native medicine based upon *sintoburi* (The body and earth are not different), that native Korean medicine was healthier than Chinese medicine because the climate and body are different between China and Joseon, was the very definition of a unique Korean medicine.

There is some doubt that the publications of native medicinal books from *First Aid Prescriptions of Native Korean Medicine* at the end of Goryeo to *Collected Prescriptions of Native Korean Medicine* in the early Joseon period were the result of the will to surpass the limit of Chinese medicine and establish an independent medicine. The questions faced by Joseon medicine since the end of Goryeo and the role native medicinal books played in solving the question, the historical character of the establishment of native Korean medicine will look

different.

The task of medicine from the end of Goryeo through the early Joseon period was to accept advanced Chinese medicine and rescue people from the fetters of disease based on Confucian “benign rule.”⁵ The Goryeo government and gentry earnestly tried to accept the medicine of Chinese Song and Yuan in their medical service to people by establishing the Public Dispensary under the influence of medical concepts of Chinese Song in the 7th year of King Yejong (1112). Even though knowledge about Chinese medicine was transmitted and learned, there existed a decisive limit caused by dependency on expensive Chinese medicine that was difficult to obtain. The publication of native medical books beginning with *First Aid Prescriptions of Native Korean Medicine* in 1233 was due to incessant efforts to solve this problem. *Collected Prescriptions of Native Korean Medicine*, published in 1433 during King Sejong’s reign, was a native medical book that compiled native medical books since the late Goryeo period and included various experiential prescriptions accumulated by civilians.

It is necessary to review the acceptance of the medicine of Chin and Yuan by the Joseon in the first half of the 15th century. The medicine of Chin and Yuan was understood as an epoch-making result uniting synthetically a theoretical tradition and an experimental tradition of Chinese medicine in Chinese medical history. *Uibang yuchi* (Classified Collection of Medical Prescriptions) with its contents published in 1444, the 26th year of King Sejong, was a comprehensive medical book that compiled the medical books containing the advanced medical knowledge of Chin and Yuan. On the other hand, *Collected Prescriptions of Native Korean Medicine* was a medical book that synthetically collected and arranged the experimental prescriptions of native medicine accumulated during the Goryeo and Joseon dynasties. *Classified Collection of Medical Prescriptions and Collected Prescriptions of Native Korean Medicine* were the medical books that took in and settled the medicine of Chin and Yuan from the theoretical and experimental viewpoint.⁶

Contemporary researchers believe that *sintoburi* (The body and earth are not different) emphasizes the establishment of independent medicine through the publication of *Collected Prescriptions of Native Korean Medicine* and suggests

5. Refer to Yi Tae-Jin (2002: 141-5) for an understanding of the effort to accept advanced Chinese medicine from the viewpoint of Confucian benign rule.

6. Refer to Kim Ho (1994: 4-5) for a discussion on the task and direction of development of medicine in the early Joseon period.

a theoretical need for an independent medicine from that of China. However, what cannot be overlooked is the fact that it was an effort to accept and settle the advanced Chinese medicine of Chin and Yuan. Moreover, it can be viewed that the compilers of native Korean medical books came to recognize the “distinctiveness” and “individuality” of Joseon medicine from Chinese medicine.⁷

3. The Invention of *Hunmin Jeongeum* and Phonology

“As the sounds of our language are different from those of China and are not the same as the letters, there are quite a few ignorant people who cannot express correctly what they want to speak. I have pity on this condition and invent 28 characters so that everyone can learn them easily and write them conveniently day by day.” (*Hunmin jeongeum*: 1)

This is the first part of the preface from *Hunmin jeongeum haeryebon* (Commentarial Version of *Hunmin Jeongeum*). It reveals the purpose of King Sejong’s invention of *hunmin jeongeum* in 1443, the 25th year of King Sejong. King Sejong invented our own alphabet so that ignorant people might learn to write easily because they could not express their thoughts conveniently for lack of letters to express our language. Contemporary researchers emphasized this content and indicated the historical meaning of the invention of *hunmin jeongeum* as the culmination of “independent consciousness” together with democratic consciousness during King Sejong’s reign.

There is doubt whether the necessity of the invention of “our own letters dif-

7. Refer to Kim Ho (1995: 62-76). Kim Ho’s argument is remarkable. According to Kim Ho, the first use of medicine of the Joseon based on *sintoburi* at the end of Goryeo became possible with the advent of Confucian worldview emphasizing the locality from the point of universal Buddhist worldview. According to the Buddhist medical viewpoint during the Goryeo period, it was recognized that not Chinese (universal) medicine but Korean (local) medicine was useless based on universalism. But the mentioning of *bonyeonjiseong* (innate nature) and *Gijiljiseong*’ (temperament) in the late Goryeo period and the acceptance of the study of the principle of human nature to emphasize locality changed the situation. Kim Ho argues that the new gentry at the end of Goryeo period and the early Joseon period came to recognize the local peculiarity and individuality of Joseon from China through the recognition of “the locality of *Gijiljiseong*” from the viewpoint of the study of the principle of human nature and the importance of *sintoburi*. Moreover, Kim Ho understood that the self-consciousness of locality of the Joseon created since the end of the Goryeo period came to recognize that Joseon medicine was superior to Chinese medicine in *Collected Prescriptions of Native Korean Medicine*.

ferent from Chinese ones” was ultimately the revelation of “independent consciousness.” Did the people ignorant of Chinese characters feel inconvenienced? At any rate, in a medieval society letters belonged to the boundary of rulers’ authority. Since it was not inconvenient to ignorant people and there was no particular reason to pity them, then inconvenience from the standpoint of rulers should be taken into consideration.

Therefore it is necessary to review the policy of arts and sciences to establish a stable national system of a new dynasty by means of Confucian social ideology and the intellectual system. According to the ideology of Neo-Confucianism of the Chinese Song period adopted by Joseon as its national education and learning, the real way to govern the state by a sovereign is to realize the morality of a saint. Language is the way to express the morality of a saint and it is impossible without the establishment of a proper language. Therefore, phonology and orthography are indispensable to ruling a state.

The problem was that there was a difference between the Korean and the Chinese language although both used Chinese characters. It must be noted that “...different from those of China,” or the first phrase of King Sejong’s preface from *Hunmin jeongeum haeryebon* (Commentarial Version of *Hunmin jeongeum*), emphasized not grammar or terms but the difference of sounds of letters. That is, when reading the same Chinese characters, Koreans read them differently than the Chinese; therefore, the way to read Chinese characters was chaotic without any standards. The way to transcribe the Korean language was not standardized. It was a serious problem in expressing and understanding the morality of a saint through books and language. There was an urgent necessity for a literal system to transcribe the sounds of Chinese characters and better express our language.⁸ After all, the invention of *hunmin jeongeum* was an enormous national academic project to develop an advanced phonology and orthography. Scholars from the Hall of Worthies such as Jeong In-ji, Shin Suk-ju, Seong Sam-mun, and Choe Hang made desperate efforts to study phonology, orthography and the medieval Korean language in the 15th century.

Such an environment can be judged by the fact that the major project after the invention of *hunmin jeongeum* in December of the 12th year of King Sejong was the arrangement of phonology. In fact, the problem of unifying the chaotic

8. Refer to Kang Shin-Hang (1987: 30-42) for the phonological motive and background of the invention of *hunmin jeongeum*.

sounds of Chinese characters at that time was solved with the publication of *Dongguk jeongun* (Dictionary of Proper Korean Pronunciation).⁹ It was completed in September of the 29th year of King Sejong, three years and nine months after the invention of *hunmin jeongeum*. The following passage by Shin Suk-ju expresses well the necessity of phonology.

“Before the invention of letters, the morality of a saint was entrusted to heaven and earth and after the invention of letters, it was published in books. Therefore, the meaning of the writing should be studied to reveal the morality of a saint and phonology to understand the key points of the meaning of the writing. Thus, phonology is the beginning of research on learning and morality.” (*Veritable Records of King Sejong*, September 29, 1447; Shin Suk-ju, “Preface,” *Dictionary of Proper Korean Pronunciation*)

The preface of *Dictionary of Proper Korean Pronunciation* suggested the invention of *Hunmin jeongeum* (Proper Sounds to Teach People) to solve the problem that people could not understand the morality of a saint in books written in Chinese characters because Chinese used different speaking sounds. It showed symbolically the goal of King Sejong’s achievements including those made in science and technology. After all, it was an essential task of a sovereign to lay the foundations of an ideal Confucian state.

King Sejong considered such tasks as a top priority during his reign. The most notable are nothing more than the study of ancient systems and the arrangement of *a-ak* (classical ceremonial music). It seems that even the achievements of mathematical astronomy during King Sejong’s reign were closely connected with the study of ancient systems and the arrangement of *a-ak* (classical ceremonial music).

The Study on Ancient Systems and the Arrangement of A-ak

Originally, ancient systems were Chinese systems that Confucian scholars

9. Refer to Kang Shin-Hang (1987: 63-77) for the motive and process of the publication of *Dictionary of Proper Korean Pronunciation* and the arrangement of phonology.

regarded as an ideal society. However, the meaning of ancient systems used by Confucian scholars since Goryeo and during the early Joseon period was more than the systems of the three ancient Chinese periods of Xia, Yao, and Zhou. Ancient systems occurred prior to the realistic system of the Ming or what is called *siwangjije* (contemporary system). Even the systems of Song and Yuan and those of Han and Tang were ancient systems (Han Hyeong-ju 1992: 80). The early Joseon period considered the realization of an ideal Confucian state as a paramount task and the study of ancient systems had already been made at the beginning of Joseon dynasty. The study on ancient systems began with Jeong Do-jeon during King Taejo's reign and the Research Bureau for Ceremony and Ritual and the Ministry of Rites led the systematic study during King Taejong's reign. An unprecedented study on ancient systems was pursued during King Sejong's reign. In particular, around the 10th year of King Sejong the Hall of Worthies earnestly participated in the study. The period of study on ancient systems was from around September in the 10th year of King Sejong until around the 17th year of King Sejong when the Research Bureau for Ceremony and Ritual was abolished. The Research Bureau for Ceremony and Ritual was abolished because it was originally a temporary institution for ancient systems, as Heo Jo, head of the Ministry of Rites said, and around the 17th year of King Sejong the study on ancient systems was almost finished.¹⁰ At the same time as the study on ancient systems occurred, national projects on *a-ak* (classical ceremonial music) and mathematical astronomy were carried out.

As the study on ancient systems was pursued with the intention of realizing an ideal Confucian state, its major content was *ye-ak* (ritual and music). For what were ritual and music? Ritual and music in Confucianism are understood by considering order apart from harmony. To give an easy example of sacrificial ritual, while *ye* (ritual) means the form of appropriate hierarchical order when humans contact gods, *ak* means music to harmonize humans with gods. When appropriate formal order is not guaranteed and music that gods cannot respond to is played, humans cannot contact gods. Such a ritual is nothing but formal and of no significance. A meaningful ritual in which humans can properly contact gods can be guaranteed by ritual and music according to ideal ancient systems. This was the background for the earnest arrangement of ritual and music

10. Refer to Han Hyeong-ju (1992: 80) for the trend of the study on ancient systems during King Sejong's reign.

through the study on ancient systems during King Sejong’s reign.

Thus, although *ak* was important in realizing an ideal Confucian state, *ak* of Joseon at that time, in particular *a-ak* as *jeong-ak* (court music), was in a state of imperfection. It was not until 1116, the 11th year of King Yejong, Goryeo that *a-ak*, the court music of the Northern Song’s period was first introduced to Korea. Although successive kings made an effort to play *a-ak* properly, they could not fulfill their intention. Because musical instruments of *a-ak* like *pyeonjong* (bronze bells) and *pyeongyeong* (stone chimes) were imported exclusively from China, the situation became worse. The same situation was true after the foundation of Joseon dynasty. For example, when King Taejong asked to purchase *a-ak* instruments from Ming in 1405, the 5th year of King Taejong, Ming just sent several instruments to show some mercy, and said, “The instruments of *a-ak* cannot be purchased privately.” Under this situation, it was impossible to guarantee perfect play of *a-ak* consistently.¹¹

Since it was difficult to play *a-ak* properly, it became customary to play music mixed with local music in various rituals. Local music means folk music as opposed to court music. While court music is the proper music gods can respond to at a banquet according to ancient systems, folk music means vulgar music appealing to sensitivity. The music mentioned in *ye-ak* naturally means court music and “Through this music, a saint nurtures his nature (disposition, character and temper), strives for the harmony between humans and gods, adapts himself to heaven and earth and harmonizes the morality of *yin* and *yang*.”¹² Accordingly, in ideal Confucian rituals court music should be played naturally and folk music which appealed to sensitivity was not relevant to *ye-ak*. *Ak* could not but rely on local music even into the early reign of King Sejong because *a-ak* could not be played properly.

The arrangement of *a-ak*, ideal Chinese court music, resulted from the memorial of Park Yeon, judge of the Office of Memorial Rites-Offering in 1426, the 8th year of King Sejong. In a memorial to the Throne on April 25, 1426, Park Yeon said that there was music for humans and gods to harmonize in accordance between positive and negative sounds until the Han period but in the Tang period music inclined toward positive sounds and strayed from the morality of a

11. Refer to Song Hye-jin (2000: 183-5) for the imperfect situation of *a-ak* before King Sejong.

12. This is the first phrase of the preface by Jeong In-ji in “A-akbo” (Musical notes of classical ceremonial music) (*Veritable Records of King Sejong*, leap year December 1, 1430).

saint. He also proposed that a variety of local music should be corrected because it strayed from the music of a saint. Park Yeon's suggestion was immediately accepted and King Sejong ordered him to study music and rearrange the Bureau of Music (*Veritable Records of King Sejong*, April 25, 1426).

The project of arranging *a-ak* was carried out largely in two directions. One was the production of standard sounds under the leadership of the Office of Memorial Rites-Offering with Park Yeon as a central figure. This was the production of pitch pipes and the publication of musical notes. The other was the study of *Lü-Lü hsin-shu* (New Book of the Pitches), a theoretical book of pitches under the leadership of the Hall of Worthies. *New Book of the Pitches* was a book written by Chae Won-jeong, a Confucian scholar during the Song period. It was contained in *Hsing-li ta-ch'üan* (Great Compendium on Human Nature and *Li*) and was widely distributed as a typical book on New Confucianism among Confucian scholars. This book was first published in 1415 in China, was introduced to Joseon in 1419, the first year of King Sejong and was reissued in 1427, the 9th year of King Sejong, the same year as the arrangement of *a-ak* began.¹³ Volume 1 of *New Book of the Pitches* contains the general contents of the production and principle of pipes including the measure of size and length of pipes and the measure of the eleven sounds of *huang-chung*. Accordingly, the study of *New Book of the Pitches* progressed as theoretical research on the production of pipes and the arrangement of *a-ak* based on the level of ancient systems among the scholars of the Hall of Worthies.¹⁴

It seems that King Sejong was greatly interested in the arrangement of *a-ak* and had lectures at *gyeongyeon* (royal lectures) about *New Book of the Pitches* in 1430, the 12th year of King Sejong. In fact, the production of pipes and the arrangement of *a-ak* began in the 7th or 8th year of King Sejong and peaked in 1430, the 12th year of King Sejong. Perhaps, it was because King Sejong was reading *New Book of the Pitches* and recognized the principle of pipes. However, there was a difference of opinion between King Sejong who was knowledgeable about *New Book of the Pitches* and understood ancient systems and Park Yeon who was in charge of the production of pipes.

King Sejong wanted to produce pipes according to ancient systems and, con-

13. Refer to Jeong Yun-hi (1999: 486-91) for the process of the first introduction of *Lü-Lü hsin-shu* (New Book of the Pitches) to Joseon and the reissue.

14. Refer to Jeong Yun-hi (1999: 521-2) for the fact that a study on *Lü-Lü hsin-shu* (New Book of the Pitches) was mainly done by the scholars of the Hall of Worthies.

sequently, complete the same perfect *a-ak* as that of a saint while Park Yeon regarded such an attempt as impossible. The production of pipes and the arrangement of *a-ak* were completed in February in the 12th year of King Sejong. Park Yeon’s experience is well documented in a long memorial to the Throne through the Research Bureau for Ceremony and Ritual and the Ministry of Rites. The memorial contained the results and problems of the work continuing since the 7th or 8th year of King Sejong. According to the memorial, the key arguments on the production of pipes were how to produce the pipes of *huang-chung* sounds in accordance with ancient systems and how to accord the sounds of *huang-chung* of stone chimes given by Ming in the 5th year of King Taejong.¹⁵

Park Yeon concluded after many trial and errors the following:

“When setting tunes historically in China, grains of *gijang* (millet) were used even though they were not constant and the pitches of sounds were different in each period. How can we know that the Chinese tunes of today are not true but our grains of *gijang* (millet) of Joseon are true? However, the standardization of tunes, lengths, volumes and weights is the duty of the Son of Heaven and not the one of a land of a feudal lord at his own will. If black grains of *gijang* (millet) do not accord with Chinese *huang-chung*, use another kind of grain of *gijang* (millet) for convenience sake and make pitch pipes according to Chinese *huang-chung*. Then, it will be proper to correct harmonic sounds according to one-third subtraction and one-third addition (the method of setting up the twelve tunes in traditional Chinese music).” (*Veritable Records of King Sejong*, February 19, 1430)

According to ancient systems, the sounds of *huang-chung* corresponded to those of pitch pipes stuffed with 1200 natural black grains of *gijang* (millet). Meanwhile, as the standard sounds of *huang-chung* at that time were the contemporary system and were the sounds of stone chimes given by Ming, the pitch pipes of *huang-chung* had to be made according to ancient systems and the

15. The only standard for the sounds of *huang-chung* was a stone chime given by Ming until the 7th year of King Sejong. Meanwhile, various stones were found and the production of bronze bells was pursued together with stones used in various sacrifices. In the process, Park Yeon tried to do his utmost producing the pipes of *huang-chung* sounds identical with the sounds of *huang-chung* of stone chimes. Refer to Han Hyeong-ju (1992: 98) for further information.

sounds also had to correspond to those of *huang-chung* in accordance with the contemporary system. As Park Yeon indicated, the problem was that grains of *gijang* (millet) were different in size and shape according to the period and area of the production and the pitch pipe stuffed with 1200 grains of *gijang* (millet) was not constant. It was also natural for sounds to change. Park Yeon made a test product using grains of *gijang* (millet) produced in Haeju, Hwanghae Province, and these were higher in sound than those of stone chimes of *huang-chung* given by Ming. Since Park Yeon could not produce the sounds of *huang-chung* with natural grains of *gijang* (millet), he recognized the contemporary system and gave up using the ancient systems. As the standardization of tunes, lengths, volumes and weights was the unique duty of the Son of Heaven, Park Yeon argued that in accordance with the sounds of *huang-chung* of stone chimes grains of *gijang* (millet) should be made artificially for the time being and then pitch pipes should also be made.¹⁶ Thus, Park Yeon expressed doubt that no one could be sure whether the true Chinese sounds of *huang-chung* were the Ming ones or those produced by *huang-chung* using natural grains of *gijang* (millet) produced in Haeju, Joseon.

In fact, Park Yeon's argument was unsatisfactory from the viewpoint of King Sejong. King Sejong wanted to construct the pitch pipes that produced ideal sounds of *huang-chung* faithfully following the ancient systems and it was not a true realization of ancient systems to change and adjust them forcibly. King Sejong did not immediately respond to Park Yeon who had consistently presented memorials to the Throne. In August that same year, King Sejong who had *New Book of the Pitches* lectured about at Gyeongyeon and was directly involved in reading it, began an earnest review of the theoretical analysis on the production of pitch pipes and the arrangement of *a-ak* and its realistic difficulties. He also began to show his dissatisfaction with Park Yeon's argument. King Sejong's criticism was that Park Yeon's production of pitch pipes was not faithful to ancient systems. The complaint was that it could not be considered a real production of pitch pipes following ancient systems to produce pitch pipes using grains of *gijang* (millet) and bamboo in Joseon because winds, vitalities and products between China and Joseon were different. After all, King Sejong

16. Then, Park Yeon gave up according tunes with Chinese sounds of *huang-chung* of stone chimes with black grains of *gijang* (millet) produced in Haeju, made with 1200 artificial grains of millet and produced the pitch pipes of *huang-chung*. This fact was described in the *Veritable Records of King Sejong*, January 1, 1433.

ordered officials of the Superintendency of Music to study this issue because he did not believe Park Yeon. Meanwhile, there was also recognition that the ancient systems had not been satisfactorily followed in China, either. That is, the then Chinese law as the contemporary system did not accord with the ancient systems because *a-ak* was not constant and the sounds of *huang-chung* were varied in high and low.¹⁷

King Sejong who was a little disappointed with Park Yeon’s work and argument ordered Jeong In-ji, Deputy Academician of the Hall of Worthies, to refer to *New Book of the Pitches* and other texts and to fix the ruler of the Zhou dynasty (*Veritable Records of King Sejong*, September 29, 1430). But King Sejong canceled his order to fix the ruler of the Zhou dynasty twenty days after his first order. Originally, the Zhou dynasty ruler derived from the ruler of *huang-chung* and the production of pitch pipes of *huang-chung* would finally make possible that of the *huang-chung* ruler. Meanwhile, it seems that King Sejong’s order to Jeong In-ji to make the Zhou dynasty ruler meant the production of a standard ruler of the Zhou dynasty only through the survey of literature independent of the pitch pipes of *huang-chung*. Such a ruler of the Zhou dynasty would be a makeshift ruler made through the survey of literature and could not be an ideal ruler based on ancient systems. Recognizing the fact that “the systems of the ruler of the Zhou dynasty became different historically with the change of the times and, accordingly, the pitch pipes of *huang-chung* also became different,” King Sejong frankly revealed his feelings, “I’m afraid that we cannot get correct pitch pipes if we produce them even through a study on ancient systems. It’s because ancient people made music according to vocal sounds and the vocal sounds of our people are different from those of the Chinese.” Eventually, King Sejong stopped the production of the ruler of the Zhou dynasty, saying that its production would be “nothing but an object of ridicule and it would be better not to produce it” (*Veritable Records of King Sejong*, October 18, 1430).

While King Sejong did not accept Park Yeon’s argument to change ancient systems according to the contemporary system at that time (around September of the 12th year of King Sejong), he recognized the difficulty of realizing ancient systems ideally because our winds, vitalities and vocal sounds were different

17. King Sejong’s viewpoint is well documented in *Veritable Records of King Sejong*, September 11, 1430.

from those of China. King Sejong did not accept the argument proposed in February by Park Yeon until September when he said that Park Yeon had better quit his post if he could not do his job properly. According to the *Veritable Records of King Sejong*, the Treatise on Ceremonial Music was completed three months later on leap December 1 (*Veritable Records of King Sejong*, leap December 1, 1430). On New Year's Day, the 13th year of King Sejong, newly produced *a-ak* was played for the first time at the New Year's Ceremony at *Geunjeongjeon* (Central Hall of Gyeongbok Palace). Historians evaluated the arrangement and play of *a-ak* very positively, saying, "When newly produced *a-ak* was played for the first time, the properties for the ceremony and music were brilliant to see" (*Veritable Records of King Sejong*, January 1, 1431). Such a change in three months shows that King Sejong finally recognized the argument of Park Yeon and the production of pitch pipes of *huang-chung* and the arrangement of *a-ak* were pursued according to political expediency.

What does the controversy between King Sejong and Park Yeon about the arrangement of pitch pipes of *huang-chung* and *a-ak* mean? Can the use of artificial wax grains of *gijang* (millet) be regarded as the abandonment of ancient systems? Can it be seen as the abandonment of ancient systems and a makeshift acceptance of the contemporary system? Cannot it be seen otherwise? Only artificial grains of *gijang* (millet) were used and ancient systems were surely followed within the contemporary system. The reality was that using artificial grains of *gijang* (millet) could solve the problem. Through this process, King Sejong came to recognize that the winds, vitalities and vocal sounds between China and Joseon were different and understood that the sounds of Chinese *huang-chung* were different because Chinese grains of *gijang* (millet) were also different. At the beginning of the project, it was believed that the realization of ancient systems was impossible because of the difference of winds, vitalities and vocal sounds between China and Joseon but it was possible to use ancient systems by making adjustments such as the use of artificial grains of *gijang* (millet).

However, many bureaucrats opposed such a change of recognition and they opposed the use of artificial grains of *gijang* (millet) unlike Chinese pitch pipes of *huang-chung*. According to the *Veritable Records*, many officials opposed Park Yeon's production of pitch pipes using artificial grains of *gijang* (millet), saying that it was a fake because Chinese sounds were abandoned. But King Sejong changed his perception, saying, "What the King wants to do is often opposed by subjects and vice versa. Even though the King and subjects want to do something, the times are often against us. Now, I have made up my mind.

The nation is peaceful. Let the project be done with all your might.”¹⁸ Thus, King Sejong who had been dissatisfied with Park Yeon in the past praised him and had him take charge of the arrangement of *a-ak*.

Park Yeon under King Sejong’s initiative began the production of pitch pipes and the arrangement of *a-ak* around the 7th or 8th year of King Sejong. Because King Sejong was indulged in reading *New Book of the Pitches* and understood the principle of pitch pipes and music, this project could be completed. An arrangement of *a-ak* was completed around the 15th year of King Sejong (*Veritable Records of King Sejong*, January 1, 1433; June 28, 1433). The period between the 12th and the 15th year of King Sejong was a very precious time to King Sejong who tried to obtain an ideal Confucian state. During this period, King Sejong came to recognize that the winds, vitalities and vocal sounds between China and Joseon were different and that such differences were not obstacles to realizing ancient systems and an ideal Confucian state.

Project on Mathematical Astronomy and Realization of an Ideal Confucian State

The project on mathematical astronomy during King Sejong’s reign was pursued for the realization of an ideal Confucian state through a study on ancient systems and their materialization as shown above. This section will detail the scientific results from King Sejong’s reign within the historical context that traditional science is essentially different from modern science.

The project on mathematical astronomy during King Sejong’s reign can be divided into two parts. The first was a study on the calendar resulting in *Chiljeongsannaepyeon* (Inner and Outer Book for Calculation of the Motions of the Seven Determinants) and the other was the arrangement of the contemporary system such as the invention of astronomical observatory instruments and the production of a standard water clock like *jagyeongnu*. The study on the calendar was completed with the publication of *Inner and Outer Book for Calculation of the Motions of the Seven Determinants* under the leadership of Lee Sun-ji in 1442, the 24th year of King Sejong and this project seems to have

18. Refer to *Veritable Records of King Sejong*, January 1, 1433 for further information.

been pursued for a long time. The study on mathematical astronomy under King Sejong began with the suggestion by Seongsangun Lee Jik for the correction of the calendar in 1420, the 2nd year of King Sejong (*Veritable Records of King Sejong*, March 2, 1431). In 1423, the 5th year of King Sejong, King Sejong ordered civil vassals to compare *Hsuan-ming li* (Calendrical Astronomy of the Tang Dynasty) with *Shou-shih li* (Calendrical Astronomy of the Yuan Dynasty) (*Veritable Records of King Sejong*, February 10, 1423). It is notable that King Sejong ordered the comparative analysis of the calendar to be performed not by officials of Seoungwan (Bureau of Astronomy) but by civil vassals. Perhaps, the comparative study on the calendar was not considered urgent and, therefore, King Sejong had civil vassals study *Calendrical Astronomy of the Tang Dynasty* and *Calendrical Astronomy of the Yuan Dynasty* at the same level as ancient systems on a long-term basis. Afterward, King Sejong often ordered civil vassals to study astronomical mathematics and calendar. King Sejong himself studied *Suan hsueh ch'I meng* (Introduction to Mathematical Studies) and explained the reason to Jeong In-ji, "It does not seem necessary for the King to study astronomical mathematics but I'll learn it because it was made by a saint." (*Veritable Records of King Sejong*, October 23, 1430)

The study on mathematical astronomy started around the 2nd to 5th year of King Sejong and had not been developed until the 12th year of King Sejong. The study on mathematical astronomy was developed rapidly beginning in the 12th year of King Sejong. This was at the same time as the full-fledged study on ancient systems resulted in the arrangement of pitch pipes and *a-ak* and also the period King Sejong learned *New Book of the Pitches* at *Gyeongyeon*. But the study on mathematical astronomy was still difficult. In December of the 12th year of King Sejong, King Sejong asked Yu Sun-do, an expert in mathematical astronomy, about the situation because of fruitless efforts and even asked Jeong Cho who was in charge of the project on mathematical astronomy if it would not be better to stop the project. However, Jeong Cho hoped to continue the project and said that it would be possible to arrange the project with the consistent study on *Huang-ming li*, *Tang I-hsing li* (Calendrical Astronomy of I-Shing in the Tang Dynasty), *Calendrical Astronomy of the Tang Dynasty*, and other texts (*Veritable Records of King Sejong*, December 11, 1430). The following March, King Sejong concluded that the arrangement of mathematical astronomy would result from thorough knowledge of astronomical mathematics. King Sejong planned to choose experts in Chinese language and have them study in China and ordered the sixth grade officials Kim Han, Kim Ja-an, and others of

Sayeogwon (Bureau for Foreign Languages) to study astronomical mathematics (*Veritable Records of King Sejong*, March 2, 1431). King Sejong also ordered Kim Bin, sixth grade official of the Hall of Worthies and Wu Hyo-gang, seventh grade soldier of Hanseong (Seoul) to learn astronomical mathematics (*Veritable Records of King Sejong*, March 12, 1431).

As a result of earnest pursuit since the 12th year of King Sejong, anticipated reports on solar and lunar eclipses and seasons became almost the same as those of the Chinese calendar. But King Sejong was not satisfied with this. If the project on arranging the calendar ceased at this point, twenty years of hard labor would be wasted. King Sejong accelerated the project on arranging the calendar again in order to complete the project in a book and be a model in the future (*Veritable Records of King Sejong*, October 30, 1432). The long project on arranging the calendar was completed with the publication of *Chiljeongsannaepyeon* (Inner Book for Calculation of the Motions of the Seven Determinants) in the 24th year of King Sejong.

In the 14th year of King Sejong the project on arranging the calendar began to a certain degree and the project on producing astronomical observatory instruments also began. The fact is written in *Veritable Records of King Sejong* as follows:

“In July of the 14th year of King Sejong, the King attended *Gyeongyeon*, discussed the theory of mathematical astronomy and said to Jeong In-ji, Deputy Academician of the Office of Royal Decrees, “Our eastern country lies far away from China, has followed consistently Chinese systems and omitted using instruments for observing the Heaven. As you have been in charge of calendrical mathematics, review the classics together with Jeong Cho, Academician, produce observatory instruments and clocks and prepare for experiments. The point is to decide the altitude of the North Pole. First of all, make and present *ganui* (astronomical observatory instrument) to me.

“Following the King’s order, Jeong In-ji and I took charge of surveying ancient systems and Lee Cheon, Official of the Central Council took charge of directing the production...” (Kim Don, April 15, the 19th year of King Sejong)

This is how the production of astronomical observatory instruments began. In no time, many astronomical observatory instruments were made by the study on

ancient systems by civil vassals Jeong Cho and Jeong In-ji and in cooperation with military vassal Lee Cheon and genius technician Jang Yeong-sil. To begin with *ganui* (astronomical observatory instruments such as small *ganui*), *ilseong jeongsiui* (instrument for determining the time by using the sun and stars) and *gyupyo* (ancient sundial), *jagyeongnu* and sundials such as *angbuilgu* (scapho-sundial), *cheonpyeongilgu* (portable horizontal water-level sundial), *jeongnamilgu* (self-orienting armillary sundial), and *hyeonjuilgu* (portable horizontal plumb-sundial) were produced no later than the 19th year of King Sejong. *Cheonsangyeolchabunyajido* (an astronomical chart) was produced according to the method of *Calendrical Astronomy of the Yuan Dynasty* in the 15th year of King Sejong.¹⁹

The intention and background of producing such observatory instruments is shown in the following inscription of *ilseong jeongsiui*.

“King Yao respected mathematical astronomy and King Shun observed with armillary sphere. The instruments were transmitted generation after generation and became more elaborate. Sometimes, as the instruments were called *ui* or *sang*, the name was not fixed. But surveying geography by looking down at the earth and observing stars by looking up at the heaven, it told the correct time to the people. As it is very old and the system becomes obsolete, who can grasp the real intention of the old book even if it remains until now? At the right moment, our saint King followed King Yao and King Shun and restored such ancient systems as *gyupyo*, *guru* (sundial and water-clocks), *honui* (armillary sphere) and *honsang* (celestial globe).”

This describes the symbolic image that mathematical astronomy and astronomical instruments has in a Confucian society. King Yao and King Shun who were respected by Confucian scholars as ancient ideal saint sovereigns invented the systems of mathematical astronomy and astronomical instruments, observed the stars and told the correct time to the people. As King Yao and King Shun respected as ancient ideal saint sovereigns did, mathematical astronomy and

19. Refer to the epilogue of *Jegayeogsangjip* contained in *Veritable Records of King Sejong*, March 30, 1445 for the contents of the astronomical chart engraved on a stone plate according to *Calendrical Astronomy of the Yuan Dynasty*.

telling the time were not simply astronomical behavior but also a top priority when a sovereign performed “politics respecting the Heaven.” Since such meaningful systems as mathematical astronomy and astronomical instruments had been transmitted since King Yao and King Shun, they could not be grasped correctly during King Sejong’s reign. Literally, such an ideal Confucian ancient system as mathematical astronomy had disappeared. After all, various astronomical observatory instruments were produced by King Sejong’s order following the intention of King Yao and King Shun. It must be the real restoration of ancient systems during King Yao’s and King Shun’s reigns.

It seems that the project on producing astronomical instruments that began in July of the 14th year of King Sejong was completed in a rather short period. Most of the astronomical instruments seem to have been completed around the 15th year of King Sejong. A *ganui* platform of 31 *cheok* (30.3 cm) high and 47 *cheok* long was built around the northern part of Gyeonghoeru. Placed on the platform were *ganui* (equatorial torquetum), *jeongbangan* (square dais carrying the azimuth circle), *dongpyo* (ancient sundial made in copper), *honui* (armillary sphere), and *honsang* (celestial globe) (Kim Don, April 15, the 19th year of King Sejong). It was considered the royal observatory complex within the palace but it was not only for observational activities. Although observational activities were actively done with *ganui* (equatorial torquetum) and *dongpyo*, the instruments on the *ganui* platform were also for educational purposes such as the movement of heavenly bodies and principles and remembering the deep meaning of King Yao’s and King Shun’s “politics respecting the Heaven.” “The Crown Prince reached the *ganui* platform and had the systems of equatorial torquetum and armillary sphere questioned and answered together with Jeong Cho, Jeong In-ji, Lee Cheon, and Kim Bin” (*Veritable Records of King Sejong*, August 11, 1433).

Ilseong jeongsiui was the last device invented. Although most of the instruments were made around the 15th or 16th year of King Sejong, the article of *Veritable Records* tells that *ilseong jeongsiui* was made on April 15, the 19th year of King Sejong. The article provides a comprehensive report on the completion of producing astronomical instruments pursued since the 14th year of King Sejong while reporting the production of *ilseong jeongsiui*. Surprisingly, there is not any historical data on the ideal realization of ancient systems occurring in the process of the production of pitch pipes and the arrangement of *a-ak* nor the difficulties related to the production of astronomical instruments contrary to the ideal realization. Can it not be said that to realize “ancient systems” through “the

contemporary system” in the process of the production of pitch pipes and the arrangement of *a-ak*, furthermore, to recognize the “locality” of Joseon and then to reflect differences between China and Joseon was not a realization of ancient systems?

Meanwhile, the production of *ongnu* (jade automatic clepsydra) in January of the 20th year of King Sejong and its establishment at the newly built Heumgyeonggak (Palace Observatory) was the real completion of the project on producing astronomical instruments. *Ongnu* (jade automatic clepsydra) was a very delicate automatic water clock produced by Jang Yeong-sil based upon his experience and technique with producing *jagyeongnu* (clepsydra with automatic time-signal apparatus). According to Confucian ideology, mathematical astronomy and telling the time was a top priority of a sovereign in “the politics of respecting the Heaven.” The production and operation of a clock which measures and accurately tells time was no less important than the arrangement and observation of the calendar.

Jagyeongnu (clepsydra with automatic time-signal apparatus) was primarily made under the leadership of Jang Yeong-sil fourteen months after the start of the project, around September 1433, the 15th year of King Sejong (*Veritable Records of King Sejong*, September 16, 1433). King Sejong was very pleased with the quick production of *jagyeongnu* and awarded a special promotion to Jang Yeong-sil who had been a slave. The *jagyeongnu* was completed and was officially proclaimed to be the standard clock of Joseon as of July 1, 1434, the 16th year of King Sejong. This fact is written in *Veritable Records* together with a precise description of the structure of *jagyeongnu* (*Veritable Records of King Sejong*, July 1, 1434). After the successful production of *jagyeongnu* won the encouragement and praise of King Sejong, Jang Yeong-sil made another water clock named *ongnu*. *Ongnu* was a kind of astronomical clock operated by the simulation of reviving astronomical theory in the mechanism of a water clock. It was nothing more than an instrument that the mechanism of precise water clock and so-called traditionally symbolic astronomical instrument *honcheonui* combined. Completion of this astronomical clock was of particular significance to King Sejong.

In *Heumgyeonggakgi* (Records on the Palace Observatory) by Kim Don (Kim Don, January 7, the 20th year of King Sejong), the significance of *ongnu* is described as the long and laborious production of astronomical instruments, sundials and water clocks resulting in *ongnu*. King Sejong was very proud that the astronomical instruments and clocks of Joseon were superior to those from

China. King Sejong was also pleased because he could go into politics secondary to King Yao, King Shun, King Tang and King Wu because of the production of instruments like *ongnu*. The *ongnu* observatory (Heumgyeonggak) was named after the phrase of Chapter Yojeon, *Shu-ching* (Classics of Documents), “Like respecting the Heaven, let the people know the time.” Therefore, King Sejong had Heumgyeonggak built very close to the western part of his bedroom, Cheonchujeon.

The shape of *ongnu* that completed the production of astronomical instruments during King Sejong’s reign makes its significance clearer. Although *ongnu* was a water clock with delicate mechanisms, none of the parts were shown on the outside. In the center of *ongnu*, there was a seven-*cheok*-high mountain made of starched paper with dolls telling the time at an appointed hour by beating a wood block, bell and drum on all sides. On the hillside there was a golden bullet-sized sun realizing the movement of the sun by turning around with a cloud once a day. On every side of the mountain there was a beautiful and abundant Confucian landscape of paradise with four seasons prescribed in the *Book of Odes* and *Song of Bin*.²⁰ Actually, *ongnu* was not a clock so much as a beautiful and peaceful society a sage king ruled, realizing the natural world where natural law worked reasonably. Such a society was nothing more than the goal Confucianism ultimately pursued and which King Sejong also pursued during his reign.

Thus, while the production of *ongnu* and the establishment of Heumgyeonggak (Palace Observatory) meant the completion of the project on producing astronomical instruments started in the 14th year of King Sejong, it also meant the statecraft pursuing the “politics respecting the Heaven” according to Confucian political ideology through the arrangement of mathematical astronomy. Here, the independence, locality or individuality of Joseon did not matter.

Conclusion

This article started with a critical look at the opinions of contemporary researchers of the history of science as to the character of science and technolo-

20. Refer to *Records on the Palace Observatory* by Kim Don contained in *Veritable Records* for a description on the shape of *ongnu*.

gy during King Sejong's reign. This article tried to review critically and stipulate again the implication that the brilliant science and technology during King Sejong's reign was evaluated as "independent."

The lexical meaning of "independent" is "able to control one's own affairs without help from anyone else." It is evident that the science and technology during King Sejong's reign was lexically "independent." Science and technology broke away from being fully dependent on China to an equal level with China. A good example was the publication of *Inner and Outer Book for Calculation of the Motions of the Seven Celestial Determinants*, the first calendrical calculation based on the latitude of Hanyang (Seoul). However, it is true that earlier understanding that science and technology during King Sejong's reign was "independent" was far different from such a lexical meaning.

Perhaps, the "independence" of science and technology mentioned by contemporary researchers of the history of science means that they fully accepted and overcame the advanced science and technology of China, resulting in producing our own unique science and technology. The meaning of independence being the case, this article concluded that it did not suit the stipulation as to the historical character of science and technology during King Sejong's reign. The realization of Confucian political ideology through science and technology and the establishment of our own unique science and technology independent from China were not concurrent historical aspects. From the beginning, Joseon was a country operated on the basis of Confucian political ideology and social order. The understanding of Neo-Confucianism by the ruling class during the early Joseon period had not yet developed. During the early Joseon period, it was an imperative task to realize Confucian political ideology through the acceptance and settlement of advanced Chinese things; whereas to pursue our own unique ones different from China was a future task.

This article reviewed the so-called independent science and technology during King Sejong's reign. The tentative conclusion is that science and technology during King Sejong's reign was not the pursuit of a unique individuality or distinctiveness of Joseon so much as the results from many years of learning universal and advanced Chinese knowledge. Some examples are: *Straight Accounts of Agriculture* aiming for the agricultural level of southern areas of the Yangtze; *Collected Prescriptions of Native Korean Medicine* aiming for acceptance and settlement of the medicine of the Chin and Yuan Dynasties; and the invention of *hunmin jeongeum* on the basis of arranging complicated phonology and orthography of Joseon, a hindrance to realizing the "morality of a saint." Theories such

as *pungtobudong*, *sintoburi* (The body and earth are not different), and *punggi-isu* discussed in the literature were not theories pursuing the unique individuality of Joseon so much as expressions shown in recognizing the distinctiveness and individuality of Joseon for the first time. In the process of elevating science and technology of Joseon to the advanced level of China, it was shown as being different from China.

The study on ancient systems and the arrangement of *a-ak* during King Sejong’s reign were reviewed. King Sejong pursued ancient systems to realize an ideal Confucian state and society. The difficulty derived from the difference between the universality of China and the locality of Joseon. The universality of China was not only ideal “ancient systems” of old times but also the “contemporary system” given by a contemporary emperor. The locality of Joseon was different from both ancient systems and the contemporary system. Through the difficult process of arranging the production of pitch pipes and the arrangement of *a-ak*, King Sejong chose a method applicable to the contemporary system by changing ancient systems. Such a choice was possible by recognizing that the locality of Joseon was no less natural than universality. This allowed King Sejong to produce pitch pipes and arrange *a-ak* in an ideal Confucian state.

The project on mathematical astronomy during the King Sejong’s era was realized an ideal Confucian state and society through the study on ancient systems and the arrangement of *a-ak*. It was not pursued for stable agricultural productivity or an independent calendar different from that of China. We reviewed the meaning of mathematical astronomy during King Sejong’s reign through *ongnu* that completed the project on producing astronomical instruments. It was a practical meaning of the statecraft on the basis of King Yao’s and King Shun’s “politics respecting the Heaven” according to Confucian political ideology through the arrangement of mathematical astronomy.

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