Resourceful Creativity (*kiji*) of *Tak* paper technoscience, made by artisans and *tak* trees

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Tak paper (닥종이), Korean paper made with the *tak* tree (a variety of paper mulberry cultivated and evolved in the Korean peninsula), is known for its durability.[1] While the word "hanji (韓紙, literally Korean paper)" only appeared in the 1930s, *hanji* is dubbed “thousand-year” paper, owing to the excavation of a Buddhist sutra from the eighth century in a pagoda in Kyŏngju. Surviving in fine shape more than a millennium, *tak* paper proved its durability with a test of time that no laboratory can reproduce. Restoration experts in Italy further confirmed its impressive durability by comparing it to other handmade paper like Japanese *washi* (和紙). As a result of this comparative analysis, they chose *tak* paper in restoring Vatican's large globe.

In fact, most handmade paper has a longer lifespan than machine produced paper. In European libraries, most 17th-century books are better preserved than 20th-century books, and in China, home of paper, papers over a thousand years old have been unearthed. It is because most handmade paper is neutral, made from basic lye, whereas acidic machine paper is prone to discoloration and corrosion. However, the durability of *tak* paper is still exceptional among handmade papers, as tested by those restoration experts. This article

[1] This article is based on my work, *Technoscience of Tak and Artisans: Resourceful Evolution of Chosŏn Papermaking* (Purŭnyŏksa, 2023).

illuminates two groups of contributors who had forged and then somehow sustained this special durability of *tak* paper over a millennium. The first group is artisans, alert to ins and outs of the *tak* tree and the second group is *tak* trees themselves. By following their collaborations in complexly changing socioecology that they shaped and reshaped, I will briefly look into the unique technoscience (a term recognizing the inseparability of technology and science) of *tak* paper.

One may wonder, "What technoscience is there to talk about making paper without machinery?" Indeed, it is rather anachronistic to say "technoscience" of *tak* paper since the terms like science or technology did not exist in Silla, Koryŏ, or Chosŏn Korea that had produced *tak* paper. The terms "science" and "technology" emerged only in the nineteenth century to become the prominent words that assess the level of society and culture owing to their impressive achievements from preventing epidemics to taking humans to the moon. Yet most technosciences of today are seriously weak at durability. Electronic media that had been predicted to replace paper books have shorter lifespans than paper books and the endless competition for storing more in smaller devices made them less stable and compatible, technologists worried. What will happen to all AI apps if these media could not sustain the stability of Big Data? What will happen to the perennial work of sharing and developing knowledge by passing it down from generation to generation? So let me contemplate on the strange "technoscience" of *tak* paper that achieved durability.

The durability of *tak* paper is special because it created not just long-lasting artisanal goods but also a fairly efficient production network. In late Chosŏn Korea around the 18th and 19th centuries, the population increased significantly as in other parts of the world. The growth rate of the *yangban,* the literati class who ruled the society, was particularly steep. They came to account for more than half of the population in some household registers by the nineteenth century, making the civil service exams ridiculously competitive. Despite this

rapid increase of reading population and high demand for paper, there was no shortage of paper or a hike in paper prices. The price of paper was the most stable of all prices due to the commensurate expansion of production. The laments were rather that paper, a cherished thing in China, was wasted so much in Chosŏn, to be used even for blowing noses or as shoe insoles. The production network also satisfied strong demand from Qing China and Tokugawa Japan, as confirmed by various records such as border trade data and custom tax data. It does not mean some general industrialization of Chosŏn as paper was almost the only "manufactured item" on the list of Chosŏn's exports. Its other exports were mostly ginseng, dried sea cucumber, and cowhide.

I tried to capture this technoscience of *tak* paper with the word "kiji (機智)," similar to tacit or embodied knowledge that historians of technoscience have shown to be crucial in all technoscientific practices from artisanal workshops to high-tech laboratories. By introducing this vernacular term, I join with those who emphasize the creativity of this embodied practice and its inseparability with things and socioecological environment. The character ki 機 is a pictograph modeled after the first important machine, the loom, and came to mean machinery in general. Ki also means the skill, nuances, and chances that determine the quality of cloth. The character ji 智 corresponds to the wisdom of recognizing and dealing with these nuances of things that are constantly changing. Summoning all these meanings, I define *kiji* as an alert technoscientific wit responding to subtle and dynamic changes of materials, tools, and environment. I translate it as "resourceful creativity" in English.[2]

The first *kiji* in *tak* paper shows the depth of creativity involved in close interaction with things. Making best of their choice material *tak*, the artisans in Korea reinvented every

[2] Resourceful, with "resource" at its root, emphasize its attention to things. "Creativity" expresses creative wit or renovations in this embodied practice in close interaction with things and environment.

process in papermaking that they learned from China. Paper is considered one of the four great inventions of ancient China, but the process looks simple. The plant material that will be the ingredient is broken down and dissolved in water like a thin porridge, and then it is formed into a sheet using a molding frame, and then it is dried to finish. Of course, in practice, every process has its challenges, and papermaking techniques were not easily transmitted between regions and countries as historians like Jacob Eyferth and Leonard N. Rosenband have shown.

Artisans in Korea, the peninsula connected to the vast Chinese land, learned papermaking probably the earliest outside China and they obviously had all intimate knowledge of how Chinese artisans made their paper with hemps, bamboos, or some tree bark (The earliest paper made in Korea was hemp paper). Yet, they made *tak* trees, growing wild in tough mountainous lands, as their choice material. And by that choice, they modified all the processes of papermaking. The Korean variety of paper mulberry, actually a shrub unlike the Chinese paper mulberry (*Chu* or *Gŭ*) that was a tree, had inner bark that was whiter than any materials in China when the outer crust was removed. That fibrous inner bark was strong enough to be used to make clothing on some Pacific islands. Korean artisans must have cherished the tough and white fibers of *tak* bark. For the first process, they chose not to fully pulp the material by just pounding them on stones with mallets. They ignored the Chinese method that grounded their materials with millstones. Koreans also used weak lye produced from rice or bean stalk ashes to minimize fiber loss.

Keeping the lengthy fibers affected the rest of the processes. They needed something to keep these lengthy threads afloat in a molding vat. They found that sticky material in the roots of plants, mostly *Hibiscus manihot*, which they came to call *tak-pul*, i.e. *tak* starch. Then, when they molded and lifted the sheet from the vat, the one directional move that

Chinese artisans applied for their fully pulped material was not enough. They mixed vertical and horizontal moves in molding the sheet as if they were interweaving the fibers.

The problem was that the surface of this elaborately molded paper could be uneven, with some fibers sticking out. To even them out, they introduced a singular finishing process called *toch'im* (搗砧). It consists of repeated beating on the stack of half-dried sheets, which gave the sizing effect of slowing the absorption of ink by its density. This physical method allowed them to do away with the often corrosive sizing agents used in Chinese papermaking.

All these modifications that reinvented Chinese processes for lengthy *tak* fibers worked quite nicely. The original whiteness of *tak* bark became more radiant by the fulling effect of *tochi'im*, while crisscrossed fibers made it very difficult to tear apart. The renowned durability came not just by doing away with corrosive sizing agents. According to the contemporary analysis, the material combination of *tak* bark and *tak* starch makes a kind of natural polymer. Chinese literati soon noticed these qualities of *tak* paper, calling it "Mirror Bright" paper, "Silk Cocoon" paper, and "Koryŏ" paper, a generic term noting its regional specificity. By this appreciation, *tak* paper came to be circulated beyond the tributary trade channel and became the stable luxury imports in Chinese paper shops by the eighteenth century.

Notwithstanding this excellent outcome, this reinvention looks curious. Every process appears more challenging and laborious than the original one. So all these choices were not for themselves but for their technoscience of hearing the clearest of what *tak* had to say. By these modifications, their choice material would exert all its power in collaboration with other materials, tools, and careful skills. It was a resourceful creativity that resuscitate *tak* as in the old meaning of 'resource' and made the *tak* tree a major contributor to their technoscience.

I have to admit that my explanation of papermaking with *tak* is just my best guesses. There is no extant document that records the process and the artisans who inherited the

techniques had disappeared over the Japanese colonial era, during which the Government-General of Korea attempted to introduce the techniques of *washi*. Furthermore, the process, which must have evolved through long trial and error in various parts of Korea with different availability of socioecological resources, would not be uniform. Moreover, there are so many different types of *tak* paper, depending on thickness, size, and use, to diversify the process accordingly. As a historian so remote from the time, I merely tried to listen to what *tak* paper says, relying on the achievements of paper enthusiasts who grew *tak* trees and made paper countless times, craftsmen and scientists who tried to restore traditions, and researchers who physically and chemically analyzed remaining paper relics and recorded their variously changing characteristics over time. I compared what I learned from them with scattered records in archives to trace out some rough trajectories.

What is less known than this reinvention and the roles of *tak* tree seems the rapid expansion of the production network in late Chosŏn. Historians mostly assumed that *tak* paper followed the same path of decline as Koryŏ celadon and Self-striking water clock (自擊漏 chagyŏngnu), more famous and technoscientifically sophisticated achievements in early Korea. However, while Koryŏ celadon and Self-striking water clock failed to make lasting legacies, *tak* paper, as mentioned, managed to prosper, satisfying growing needs of the society and becoming the important export product in late Chosŏn.

It was not like paper artisans worked under more favorable conditions than clockmakers. Rather, the artisans who took over papermaking in late Chosŏn came from the least favored group of the society: Buddhist monks. In the consciously and growingly Confucian Chosŏn society, they came to be disenfranchised with little status. Yet, these artisan-cum-monks managed to construct a very resilient network of producing *tak* paper by late Chosŏn, by forming new alliances through the *tak* tree.

In discussing the emergence of monk-cum-artisans, it is necessary to make some reexamination of the history of Buddhism in Chosŏn. While the history emphasized the continued disdain on monks and suppression of Buddhism, the strange thing is the number of temples. There were more than a thousand temples already by the seventeenth century, defying the drastic measure of leaving only 36 temples in 1464. Given that a monk cannot be born a monk, even that 36 temples should have gone empty if the court had kept at suppressing Buddhism. Many temples, expelled from cities and scattered in mountains, had hundreds of monks too.

Chosŏn society appeared to produce new monks more by creating socioeconomic pushes rather than by religious pull. The population historians showed early on that the population registered in Chosŏn was about 40% of the total population. It was not that the household census, which duly took place once every three years, was a hoax. Rather, the census expressed a socially agreed compromise in the late Chosŏn tax system, shaped by many who, not having been born into the privileged *yangban* class of much tax exemption, left home and lived undocumented to avoid multiple layers of taxation. The thousand or so temples scattered throughout the country were important refuges for these undocumented. Temples' mountainous locations, near stream, firewood, and above all *tak* trees, and the techniques accumulated through the printing of Buddhist sutras, made papermaking a promising livelihood for new monks.

The temples of the nineteenth century enjoyed impressive prosperity, which is ironically revealed through their appeals for help, mostly seeking aid in the fire. They reported fire damage of hundreds or thousands *kan* (2.4m * 2.4m approximately) facilities, in seeking the court's help. In Chosŏn Korea, no house, except for palaces, could exceed 100 *kan*. Temples, unaffected by this regulation, were the largest building complexes in late Chosŏn. What they sought after as aid was also notable as it was neither food nor money but monk or office-

holder certificates, the goods for the undocumented. By such aid, one temple restored its thousand *kan* facilities after fire and then tripled its size in thirty years when they reported the second fire disaster. These big temples mostly had a thriving papermaking business. One temple specifically claimed to have 120 paper molding rooms and hundreds of monks. It meant that they could produce at least 60,000 sheets a day (500-700 sheets per vat).

If the daily production is about 60,000 sheets, the demand for *tak* is more than 1,000 *gŭn* (1 *gŭn* is approximately 375g), according to the average weight standard of paper in the late Chosŏn legal code. This 375 kg of *tak* could not be cultivated and harvested daily by a single temple, no matter how big it was. Indeed, *tak* became the most promising cash crop in late Chosŏn, to be recommended by many statecraft scholars. Nonetheless, those huge temples had a more stable supply network. The undocumented people who shared the roots with the monks joined in the network. Among the undocumented 60% who expanded their reach to the coast, islands, and mountains, and even to Manchuria across the border, some showed clear links to temples. The border inspectors repeatedly reported about a new kind of "married monks" in the border region who even spoke Chinese too and lived on making paper. One claimed that a certain monk Kim led people to make a hundred villages at the foot of Mt. Paekdu. In Jeolla province, there was a village of slash-and-burn farmers called '*tak* cultivating town' which provided tens of thousands of *tak* bark to a temple famous for papermaking. Then, the temple helped them establish papermaking facilities in the village. While the relationships between monk-cum-artisans and undocumented slash-and-burn farmers would vary greatly, some obviously forged strong alliances and shared skills, both seeking their livelihood through *tak*.

The nineteenth century in Chosŏn Korea, after the "enlightened" reigns of King Yeongjo and King Jeongjo, used to be called "a century of decline," or "a century of popular riots." These people connected around *tak* trees created a different kind of century for them,

producing enormous amount of paper for rapidly increased domestic population as well as for various high-end consumers abroad. They created a new social contract for their production practice by different tactics than costly riots. While the diverse paths of this undocumented 60 percent are to be examined further, some of them apparently tamed certain ambitions of the Chosŏn court by constantly moving from towns to temples, to borders, and beyond. These artisans turned their technoscientific *kiji* obtained through their close interaction with *tak* into social *kiji* for complex socioecological evolution with *tak*. *Tak* paper did not follow the path of the self-striking water clock or Koryŏ celadon because of this constant evolvement of *kiji*.

One may wonder whether this socioecological evolution was ecologically sustainable. Probably it was not, given the amount of *tak* to sustain their expansion, and the constant encroachment to less habited peripheries in every direction. Yet, they also developed impressive recycling culture and techniques coining the unique term of ‘resting paper (休紙 hyuji)’ and 'returned paper (還紙 hwanji)' to make governmental offices strictly manage the used paper and individual household keep baskets and boxes of 'resting paper' for recycling. While paper has been the best recycled item in most cultures, artisans in late Chosŏn seem more successful. With strong fibers of *tak* intact, they could more easily produce upcycled products, such as raincoats more expensive than imported glass lamps, etc

I hope this rough trajectory of tak paper have shown the power of *kiji* obtained by hearing things out. It is a power that has gradually changed every relationship surrounding the *tak* tree. We know that our relationship with things is not at its height and needs some serious changes. The story of *tak* paper shows the power of small choices. It was by small choices of hearing *tak* and collaborating by *tak* that those who made *tak* paper did not join the century of decline. They obtained new techniques hearing *tak* tree, negotiated new rules, and even learned foreign languages moving together with *tak* trees; they thus not only produced much desired durable paper but changed how Chosŏn society produced, consumed, and disposed of

paper while expanding the possibilities for those who were willing to move with them. Perhaps, like those undocumented or half-documented monk-cum-artisans who heard and moved with *tak* trees, we, scattered in our respective fields, leave our comfort zones to start reexamining our relationship with things, and learn new languages to hear them?