The Context of Artistic Expression Through Chinese Paper and Japanese paper – Washi

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Abstract

This report summarizes Koji Shibazaki's keynote at ICCCE 2025 (June 2025, Dalian Minzu University, China) on the cultural contexts of artistic expression through Chinese paper and Japanese Washi. Linking contemporary Washi-based art practice with historical research on paper's Eurasian transmission, the study frames ongoing collaboration between Aichi University of the Arts and Dalian Minzu University. It highlights a JSPS KAKENHI project that applies data science and AI to clarify the "Paper Road" using non-destructive, non-contact methods. Macro Figuregraphy, deep-learning classification, and multi-modal validation (fiber analysis, hyperspectral imaging, confocal microscopy) are integrated to infer materials, provenance, and techniques, and a Chinese handmade paper sample-book initiative is proposed.

Keywords: Chinese paper, Washi, artistic expression, Paper Road, handmade paper, non-destructive analysis, confocal microscopy, data science, sample book

1 Introduction

This document summarizes the keynote presentation given during the ICCCE 2025 International Academic Conference at Dalian Minzu University in China in June 2025. The presentation explored how East Asian cultural development was facilitated through the creation of Chinese paper—the foundational form of paper—and Washi, a distinctive material that emerged following the transfer of papermaking techniques to Japan. This summary provides context regarding the background, circumstances, and primary emphasis of our scholarly investigations into these subjects.

The research involves advancing our understanding of the evolution of paper culture and significant milestones in paper's historical development. This summary concentrates on "The Context of Artistic Expression Through Chinese Paper and Washi," a central theme of our paper-related research conducted under the auspices of the Japan Society for the Promotion of Science (JSPS) Grants-in-Aid for Scientific Research (A), commonly known as KAKENHI. This research initiative, entitled "Elucidation of the Paper Road by data science - Based on Quantitative, Qualitative research and AI Multidimensional analysis -" (fiscal years 2022–2026), operates under the direction of the Shibazaki Laboratory at Aichi University of the Arts. Additionally, this summary outlines prospective collaborative endeavors with paper research institutions under the leadership of Dalian Minzu University.

Since 2017, Dalian Minzu University and Aichi University of the Arts have maintained robust international academic partnerships. A collaborative seminar took place in Dalian, China, in 2018 as part of the JSPS Core-to-Core Program titled " The research for the culture of contemporary Hand-Made Paper and artistic expression. ~With the focus on the revival of Samarkand paper~ With the focus on the revival of Samarkand paper" (fiscal years 2017–2019).

This document begins by tracing the collaborative history between these two institutions. Subsequently, it examines "The Culture and Artistic Expression of Washi" and "The Elucidation of the Cultural History of Paper using AI," which constitute the principal research areas currently pursued at Aichi University of the Arts.

Additionally, regarding related publication initiatives, I recommend jointly developing a sample collection featuring numerous authentic specimens of handmade paper—a publication format with limited precedent in contemporary China. In Japan, within the field of Washi scholarship, numerous publications exist concerning traditional handmade paper, including sample collections showcasing diverse authentic specimens; such publications, however, remain scarce in China. If feasible, I propose launching a "Chinese Paper Book and Sample Book Production Project" to gather handmade papers from diverse Chinese regions and collaboratively produce such a volume.

2 Research Overview and Collaborative Exchange with Dalian Minzu University

The author creates art by treating Washi as art in its own right. Figure 1 shows a poster and exhibition diagram featuring Washi-crafted lighting installations and tapestries.

Fig. 1 Exhibitions featuring the author's Washi (Japanese paper) works.

To date, the author has created a variety of techniques appropriate for contemporary applications, commencing with the papermaking process itself, and has produced exhibition works including lighting installations and wall-mounted tapestries. These pieces have been displayed at venues including the Museum Five Continents in Munich, Germany (2019), the Oberhausmuseum in Passau, Germany (2023), and the Nippon Gallery at the Nippon Club in New York City, USA (2025).

These exhibitions aim to merge the intrinsic aesthetic characteristics of Washi and East Asian handmade paper with contemporary techniques and artistic perspectives. This creative practice is founded upon an academic methodology that interprets handmade paper culture and transforms it for contemporary artistic expression. It encompasses the scholarly investigation of artistic inquiry to reveal fundamental principles and seeks to illuminate previously unknown material properties in pursuit of innovative expressive modes. A core aim is to extract valuable creative processes from the techniques and methodologies preserved within traditional cultural heritage.

Therefore, our current research group's highest priority is obtaining fresh perspectives on approaches for clarifying paper's history—an undertaking we pursue through data science applications. The principal aim of this document is to forge connections with individuals committed to collaborative research focused on elucidating paper's transmission throughout Asia. This encompasses Eurasian papermakers, calligraphers and artists who employ paper, along with researchers and collectors.

Concerning international collaboration with Dalian Minzu University, our research team has strengthened relationships from 2017 through the present, facilitated by research funding investigating paper's dissemination. Moreover, the university's faculty includes numerous individuals who earned their doctoral degrees at Aichi Prefectural University of the Arts. Figure 2 shows a seminar conducted in Dalian in October 2018, organized under the Core-to-Core Program. Scholars from Uzbekistan, South Korea, and Japan gathered in Dalian for this gathering.

Fig. 2 Seminar in Dalian Minzu University School of Design (left) and The Lüshun Museum (right), 2018.

During our collaborative field investigations in China, we visited the Lushun Museum twice. This institution preserves and displays artifacts unearthed by the Japanese Nishi Honganji Otani Expedition, along with Dunhuang manuscripts. We also examined papermaking locations in China—paper's birthplace—where historical techniques continue to be investigated and applied today. Figure 3 illustrates Xuan paper production in Xuancheng. Furthermore, we examined a facility producing bamboo paper, a craft no longer practiced in Japan.

Fig. 3 Xiaoling Village Xuan Paper Factory and Museum of Chinese Xuan Paper (left), and Bamboo paper（Zhuangyuan Paper Workshop）from Leshan City, Sichuan Province (right).

Figure 4 documents our visit to the Xinjiang Uygur Autonomous Region Museum in Urumqi in August 2024, where we examined displays of ancient paper. Although Japan's paper history extends back to the 7th century, opportunities to observe ancient paper in museums are uncommon. It is historically noteworthy that this museum permanently displays Chinese paper predating the 7th century. Additionally, through a partnership with the Museum Fünf Kontinente (Five Continents Museum) in Germany, we have investigated ancient paper from Hotan.

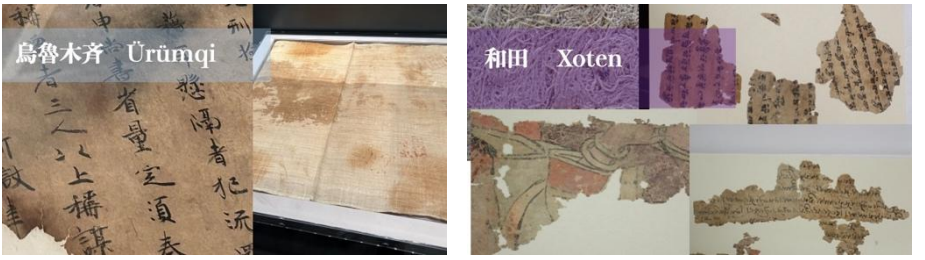

Fig. 4 The Xinjiang Uygur Autonomous Region Museum (left), and paper fragments from Hotan (Hotan Prefecture, China) in the collection of The Museum Five Continents, Germany.

This research stemmed from an investigation into Samarkand paper's history, a tradition believed to have ended approximately two centuries ago.

Figure 5 displays exquisite paper I have examined in international museums, which continues the lineage of Samarkand paper. Samarkand paper is a polished paper derived from linen, hemp, or cotton rags; the calligraphy and manuscript illustrations executed upon it constitute artistic expressions employing remarkably precise drawing techniques. Profoundly moved by Central Asian paper's beauty, developed alongside various cultural expressions, I have subsequently devoted myself to investigating its history and production methodologies.

Figure 5 (right) presents Interior Reception by Shaikh Zada, an illustration from a manuscript of the Būstān by Saadi Shirazi, preserved at The Metropolitan Museum of Art. My initial encounter with this piece at the museum ignited the fundamental impetus for my research: comprehending the nature of the precise paper capable of supporting such elaborate decoration.

Fig. 5 Samarkand paper from Uzbekistan (left), and "Interior Reception," an illustration by Shaikh Zada from the manuscript of Būstān by Saadi Shirazi, held by The Metropolitan Museum of Art.

The "Paper Road" from Samarkand to the West is believed to have traversed West Asia and North Africa before arriving in Europe. To examine this, we inspected facilities associated with the Archduke Rainer Collection at the Papyrus Museum in Vienna, analyzing materials considered analogous to paper transmitted to Europe (Figure 6). We analyzed the fibers of 13 selected specimens of particularly ancient paper dating from the 9th to 10th centuries, spanning from Central Asia to Europe. In prior studies, the paper identified by Karabacek (Joseph von Karabacek) as the oldest in the Rainer Collection includes specimens from the transitional era when the recording medium shifted from papyrus to paper. Nevertheless, exactly what papermaking technology was transmitted from China to Samarkand around the 8th century remains uncertain.

Fig. 6 Visit to facilities related to the Rainer Collection (Papyruskollektion Erzherzog Rainer) (Papyrus Museum of the Austrian National Library).

To further these investigations and research, a seminar was convened at Nagoya University on November 16, 2019, as depicted in Figure 7. Although research activities stagnated following this seminar due to the COVID-19 pandemic, they resumed in 2022. We are presently engaged in the project "Elucidation of the Paper Road by Data Science," funded by KAKENHI.

Fig. 7 Seminar for the Core-to-Core Program held at Nagoya University.

3 Washi and Artistic Expression

The well-established papermaking technologies in China and Japan have cultivated particular contexts of artistic expression. What, then, characterized these contexts? First, utilizing the author's personal experience, I will examine the relationship between Washi and artistic expression—a cultural context that developed specifically due to paper's existence in Japan.

Figure 8 shows Washi production at a workshop established within the university. Washi is paper created through the collaboration of human endeavor and natural forces. "Human endeavor" denotes craftsmanship, where the artisan's sensitivity is paramount. "Natural forces" refers to dependence on natural elements—including plant resources, water, fire (heat), and wood ash (alkaline components)—as well as materials and techniques adapted to the particular climates of various Japanese regions.

Fig. 8 Washi Workshop established at Aichi University of the Arts

Washi's history can be traced back approximately 1,400 years. One hypothesis suggests the technology was introduced around 610 AD by the Goguryeo monk Damjing (known as Doncho in Japan), a fact that can also be inferred from investigations into the Shosoin documents. Evidence includes surviving family registers from the second year of the Taiho era (702 AD), produced under the Taihō Code.

As a technology refined in the 7th century, Washi possessed exceptionally high quality, even from a global standpoint. The accomplishment of strong fiber bonding despite the paper's thinness initiated a culture that connected material quality to aesthetic expression. Figure 9 displays Kozo. Its fibers can be manually extracted. It is also feasible to utilize particular portions of the Kozo where substantial distinctive green bark remains.

Fig. 9 Hand-beating of Kozo. The white inner bark (Shirokawa) (left) and the green layer of the inner bark (Amakawa) (right).

Figure 10 demonstrates the drying process. When completely dried in sunlight, the paper obtains a firm texture and becomes whiter. Figure 11 provides a graphical map showing the locations of remaining paper production centers in contemporary Japan. The figure's right side summarizes Washi and art's development in Japan.

Fig. 10 Itaboshi of Kozo paper (method of drying Kozo paper by pasting it onto wooden boards and exposing it to sunlight).

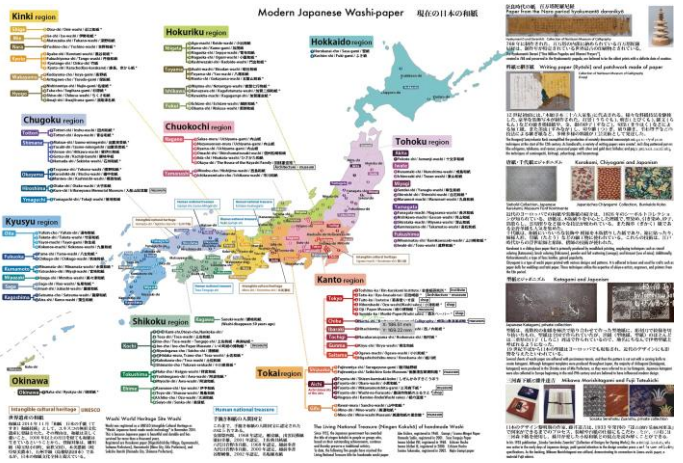

Fig. 11 Contemporary Japanese Washi. A map of Japanese paper production regions and the development of Washi and art.

Figure 12 displays Washi's raw materials: Kozo (paper mulberry), Mitsumata (Edgeworthia chrysantha), and Gampi (Wikstroemia sikokiana), alongside Tororo Aoi (Abelmoschus manihot) flowers, which provide Neri (mucilage added to supply viscosity to the fibers). Washi is manufactured from these plants, and the paper's properties vary considerably depending on the raw material employed.

Fig. 12 Raw materials for Washi and Tororo-aoi (Abelmoschus manihot).

Figure 13 shows the Tororo Aoi plant and its root, which are vital to the Washi manufacturing process. This material serves as a formation aid commonly called Neri. By crushing the root and combining it with water, a viscous component can be obtained. The right image shows this viscous component's addition. Neri is indispensable for dispersing fibers uniformly to form the paper.

Fig. 13 Leaves, flowers, and roots of Tororo Aoi (left), and the process of adding Neri (mucilage added to provide viscosity to the fibers, typically from Tororo Aoi) (right).

In recent years, Tororo Aoi producers have decreased in number, making procurement challenging; consequently, the author personally cultivates Tororo Aoi in a field. The capacity to produce high-quality paper depends on the Neri's effectiveness. The mucilage functions more efficiently in soft water, whereas its effectiveness decreases under high-temperature summer conditions.

Figure 14 illustrates the sheet-formation process utilizing the Neri effect, and the slurry's viscosity is apparent from the water's movement.

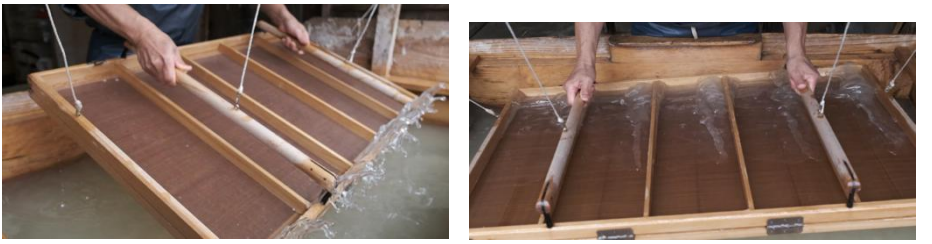

Fig. 14 Sheet formation (Papermaking) process using the Neri effect (left and right).

4 Washi's Origins and Distinctive Characteristics

This section investigates paper's introduction to Japan and clarifies the unique characteristics that define Washi.

Figure 15 (right) presents some of the oldest papers with confirmed dates and lineages. The upper row contains paper dated to 702 (the second year of the Taiho era), including Shosoin repository documents. The lower row displays paper preserved at Todaiji Temple in Nara. As is readily evident, a diverse range of papers has existed since antiquity.

Figure 15 (left) shows the Hyakumanto Darani (One Million Pagoda Dharani), contained within the "One Million Pagodas" commissioned in 768. It is regarded as the world's oldest surviving printed material with a confirmed production date. This photograph also captures authentic artifacts owned by Todaiji Temple, revealing variations in paper quality.

Fig. 15 Japanese paper with known dates and lineage (left), and Hyakumantō Darani (One Million Pagodas and Dharani Prayers) and Hyakumantō (Three-storied miniature stūp)

By the early 12th century, the nobility had become culture's primary patrons, creating lavishly decorated manuscripts that employed various Ryoshi (decorative paper) techniques. A notable example is the Nishi Honganji Sanjurokunin Kashu (Collection of Thirty-Six Anthologies), displayed in Figure 16. As Washi provided a thin yet resilient substrate, a culture of beautifully decorated paper prospered during the Nara and Heian periods. Techniques including dyeing, Tsugigami (collage or patchwork paper), gold leaf application, and Karakami (printed paper) were further developed through woodblock and stencil (Katagami) application.

Fig. 16 Reproduction of the "Nishi Honganji Sanjurokunin Kashu (Collection of Thirty-six Anthologies)" (Created by Shunsen Matsuzaki; Collection of the Naritasan Museum of Calligraphy).

These developments encompassed papermaking pattern techniques such as Uchigumo (lying cloud pattern), Tobikumo (flying cloud pattern), and Ramon (Ramon pattern). Some of these expressions, shown in Figure 17, are challenging to replicate today.

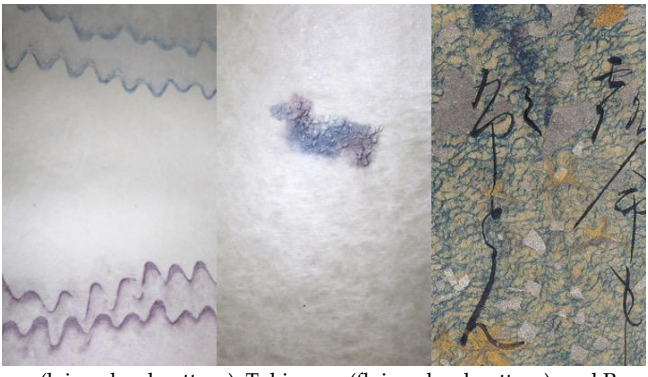

Fig. 17 Uchigumo (lying cloud pattern), Tobigumo (flying cloud pattern), and Ramon (Ramon pattern).

Figure 18 displays samples of dyeing and Kirazuri (mica printing). Karakami, paper printed using woodblocks, was employed for writing paper (Ryoshi) in the Heian period but transformed to be utilized for Fusuma (sliding door) paper during the Kamakura and Muromachi periods.

Fig. 18 Samples of dyeing and Kirazuri (mica printing) (left), and woodblocks used for Karakami (printed paper) (right).

In contemporary times, artists have emerged who apply these traditional techniques to architectural components. In the 19th century, works such as Karakami and Chiyogami disseminated globally, propelled by Japonism's popularity in Europe (Figure 19). Karakami and Chiyogami are Washi types decorated with various patterns using stencil dyeing or woodblock printing. Woodblock printing utilized the specialized expertise of Japanese Ukiyo-e artists, carvers (Horishi), and printers (Surishi) that had developed since the Edo period.

Fig. 19 Examples of architectural use such as on Fusuma (sliding doors) (left), and vivid Chiyogami (patterned paper) (right; Collection of Bunkeido Workshop).

Katagami (stencils) are produced by carving patterns into Kata-jigami (stencil base paper), which comprises multiple Washi sheets laminated with persimmon tannin (Kakishibu). They were predominantly employed for dyeing kimono fabrics (Figure 20). While usage peaked during the Meiji and Taisho periods and carving was conducted in various regions, the overwhelming majority of Shibugami (persimmon tannin-treated base paper) was manufactured in the Ise region; therefore, they are termed Ise Katagami. The designs of Chiyogami and Katagami traveled overseas as part of the Japonism movement. Collected in Europe from the mid-19th century, they reportedly influenced modern design (Figure 21).

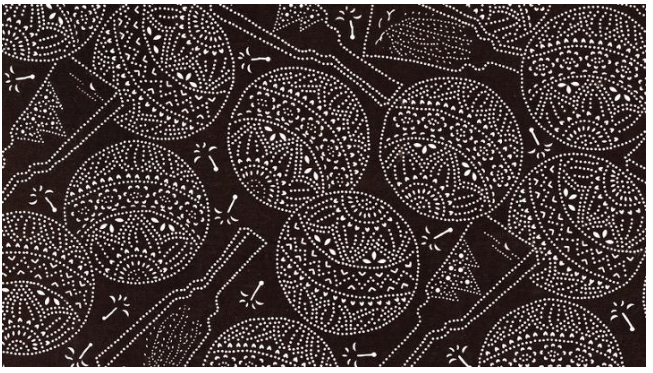

Fig. 20 A detailed and beautiful Katagami (right; Private Collection).

Fig. 21 Various designs of Chiyogami and Katagami.

Furthermore, Tatsukichi Fujii, a pioneer of modern Japanese design, published his passionate work, Tatsukichi Creative Dyeing and Weaving Design Collection (Tatsukichi Sōsaku Senshoku Zuanshū), in 1933. This collection comprises 50 simple yet powerful designs based on natural themes (Figure 22). Fujii designed beautiful patterns with nature motifs, executing most using woodblocks. In response to Westernization's trend, Fujii sought to return to his origins by using Mikawa Morishita Kami—a rustic Washi—for the mounting paper. In the preface, titled "On the Occasion of the Birth of this Design Collection," he expressed his determined resolve not to lose Japanese culture's essential sensibilities.

Fig. 22 "Tatsukichi Creative Dyeing and Weaving Design Collection" by Tatsukichi Fujii, published in 1933 (Left and Right; Private Collection).

5 Clarifying Paper's Cultural History through AI

This section elaborates on the previously mentioned KAKENHI-funded project: "Elucidation of the Cultural History of Paper by AI" (also referred to as "Elucidation of the Paper Road by data science"). Our research concentrates on clarifying the "Paper Road" (paper's dissemination), numerous aspects of which remain unclear. By integrating art and data science, we seek to reveal paper culture's hidden truths and the diversity that existed globally.

Figure 23 presents a diagram synthesizing the relationships among the Paper Road, paper culture topics, and raw materials. It maps the geographical routes, cultural themes, and plant-based raw materials. To unravel paper culture's history, one must concentrate on the era preceding the 18th century, before papermaking technology's modernization—an era when paper was manually crafted.

Fig.23 A global perspective on paper culture research and historical considerations

In Eurasia's East, from China to Japan, the investigation of diverse plant bast fibers was perfected alongside processing methods customized to specific uses and calligraphic expressions. Conversely, in the West, the examination of paper transmitted from China to Samarkand in Central Asia in the latter half of the 8th century, and its subsequent dissemination, remains a crucial issue in paper's history. In the Islamic cultural sphere, this paper functioned as a substitute for parchment (vellum) used in official Qurans; it was employed for miniatures accompanied by intricate drawing and gold leaf application, preserving valuable writings.

While paper's transmission from Samarkand is considered European paper's origin, the actual circumstances remain largely unclear. Specifically, the route through West Asia and North Africa—connecting Central Asia to Europe—is cited as a particularly obscure point in history until modern papermaking's advent.

Papermaking methods worldwide display a diversity that embodies their respective cultures' essence. In China, paper's birthplace, numerous ancient papers remain. Although I have observed pre-Tang Dynasty papers exhibited in Chinese museums, many appear damaged or fragmented (Figure 24).

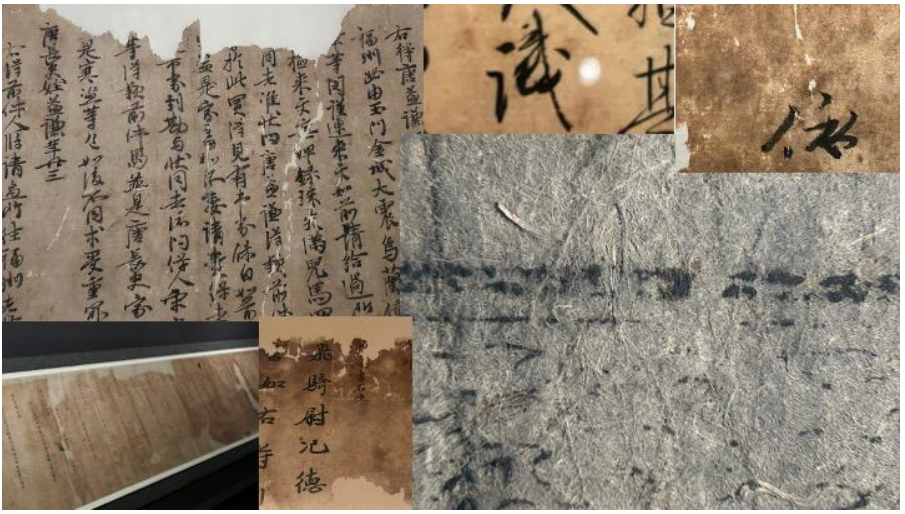

Fig. 24 Figuregraphs of pre-Tang Dynasty Chinese paper (Figuregraphed at The Xinjiang Uygur Autonomous Region Museum).

Paper produced in those times had distinct purposes, such as writing or drawing. Artistic expressions evolved alongside papermaking technology's development. Paper's cultural heritage remaining today has been protected, inherited, and carefully preserved by people. Paper enables us to relearn various wisdom forms across time and space (Figure 25).

Fig. 25 From left: A miniature produced in 16th-century Bukhara (The Metropolitan Museum of Art), Shoso-in Documents (Reproduction), and Yuan dynasty paper money (Shanghai Museum).

However, a fundamental principle for examining valuable cultural assets is that methods must be non-destructive and non-contact, even for significant research. A common challenge worldwide is that research often advances without definitively identifying the paper type.

We seek to reconfirm the transitions and connections in paper's dissemination by observing as many samples as possible. Current theories regarding paper's spread across various Eurasian regions contain many uncertainties. Once papermaking traditions are interrupted, research stagnates, techniques are lost, and folklore is often documented as fact. Consequently, many facts in paper's cultural history remain unexplained; yet, existing theories are rarely revisited, and a vast number of samples remain unverified. The challenge, therefore, is discovering a method to clarify these mysteries. While many papers exist globally as cultural assets, non-destructive and non-contact analysis principles must be maintained.

The following describes the AI-based analysis methodology we have designed. First, we capture numerous fiber images using a consumer-grade digital camera via simple macro photography. Subsequently, we conduct image analysis using deep learning to identify characteristics of identical or similar papers. We perform various observations and measurements, connecting these multi-faceted analytical results with the simple macro images to train the AI. By establishing these data connections, we are developing a methodology to identify the raw material, production location, era, and manufacturing method of paper using only simple macro images.

A. Examination Procedure

• Initial examination: This is a quantitative investigation using consumer-grade digital cameras. We conduct visual inspections and simple macro photography of dated papers to gather as many fiber images and as much paper information as possible, establishing a training database for the AI (Figure 26).

Fig. 26 Photography setup using a consumer digital camera (left) and the conceptual diagram of an AI training database (right).

•Secondary examination: This involves analyzing paper's potential characteristics contained in image data using deep learning to classify and visualize various types. Simple macro images are segmented into scalable patch images to enhance deep learning classification accuracy. After trimming, the patch images are divided scalably. The primary architectures employed for deep learning are EfficientNet and Inception-ResNet-v2, though we plan to develop compatibility with others in the future (Figure 27).

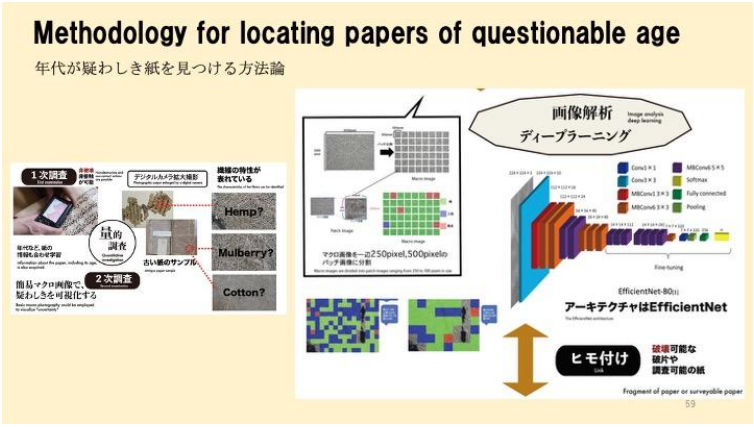

Fig. 27 Conceptual diagram of analysis by AI.

•Tertiary examination: This is a qualitative examination. It involves optical investigations extracting fibers and non-destructive investigations using cutting-edge equipment to accurately determine raw materials, fiber characteristics, and inclusions in the target paper. Essentially, this is an investigation to establish the paper fibers' "ground truth."

The qualitative investigation comprises the following three methods (Figure 28):

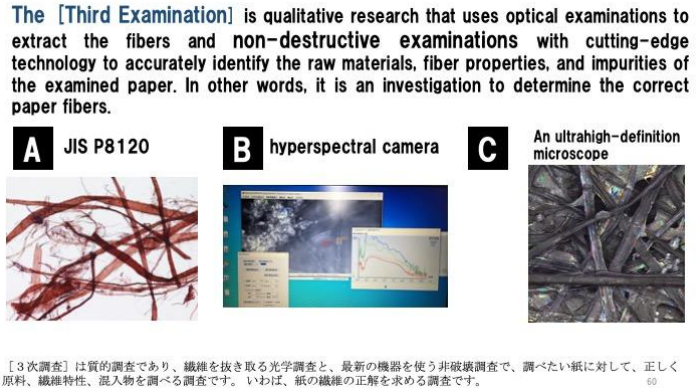

Fig. 28 Three methods of Qualitative Research. From left: JIS P8120, measurement via Hyperspectral camera attached to a microscope, and observation via White light confocal microscope.

B. Methods

• Method A: This follows JIS P 8120 (Paper, board and pulps—Fibre furnish analysis). It involves collecting and staining paper fibers, followed by analysis using an optical microscope. Fiber characteristics and inclusions are analyzed through color changes induced by the stain. While this is the most prevalent method for analyzing paper fibers, it is a destructive investigation. Figure 29 displays fibers of Mulberry (Kuwa), Cotton, Ramie, Flax, and Hemp. In this investigation, fibers are extracted, and observation points include folds, breaks, kinks, and nodes (indicated by red lines in the photograph).

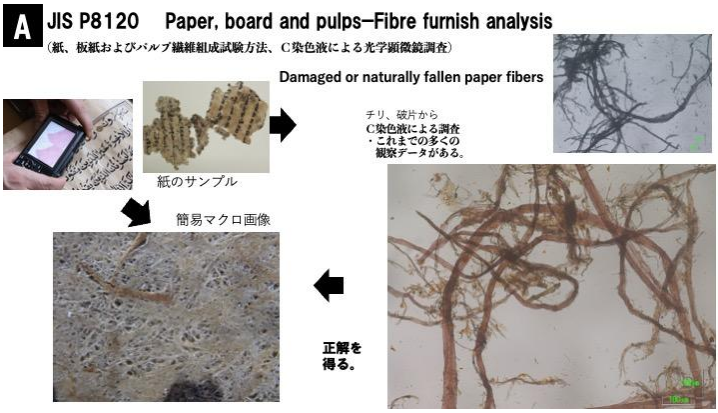

Fig.29 Identification based on JIS P8120.

• Method B: This employs a hyperspectral camera connected to a microscope (Figure 30). This method measures and visualizes spectral values

for dots in image data using reflection from the fibers. It permits observation of visible light (RGB) as well as non-visible light with fine wavelengths. We are currently advancing investigations based on waveform visualization via spectral reflectance separation at the dot level. By designating several points for observation for each fiber type, we have discovered commonalities in the graphed reflectance.

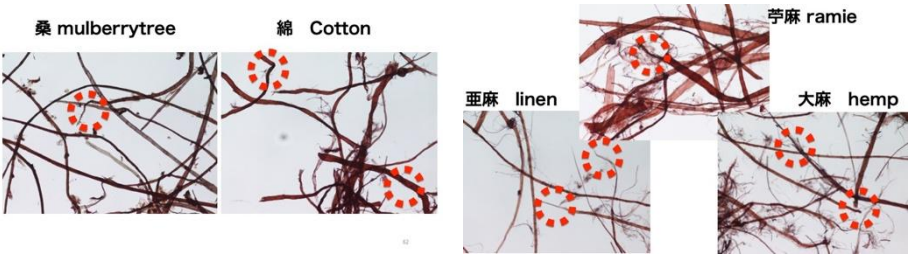

Fig. 30 Fiber images of Mulberry and Cotton (left), and fiber images of Flax (Linum usitatissimum), Ramie (Boehmeria nivea var. nipononivea), and Hemp (Cannabis sativa) (right).

• Method C: This method employs a white light confocal microscope to observe details (Figure 31). Fiber identification primarily involves observing fiber morphology, cross-sections, nodes, epidermal layers, and crimps. With a standard microscope, fibers appear transparent, making it impossible to see fold characteristics without staining. A feature of this microscope is its high resolution; by using functions such as depth composition (focus stacking), one can observe the fiber's epidermis and folds (wrinkles) without staining. Figure 32 displays images of Kozo fibers observed with this microscope at 20x, 50x, and 100x magnification.

Fig.31 Hyperspectral camera attached to a microscope (left) and a graph of reflectance in initial experiments (right).

Fig. 32 White light confocal microscope.

Below, we compare images from the simple camera, C-Stain liquid, and the white light confocal microscope. If these are connected through AI training, deep learning should enable inference of precise investigation results from simple camera information.

Figure 33 displays an investigation of a manuscript under restoration at the International Islamic Academy of Uzbekistan (Tashkent). Results using C-Stain liquid suggest the raw material is likely linen. This is a 13th-century Central Asian paper.

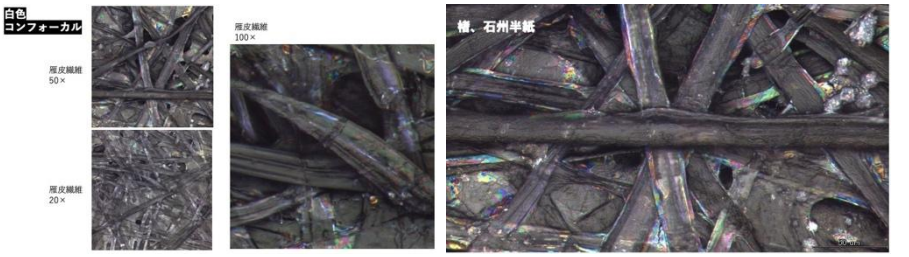

Fig. 33 Observation images from a white light confocal microscope at 20x, 50x, and 100x **magnification (left), and observation image of Kozo fiber pleats (Dislocations) (right).**

Figure 34 shows 16th-century Samarkand paper from a manuscript under restoration at Samarkand State University. The raw material is cotton. These papers were coated with starch and polished; the starch is clearly observable.

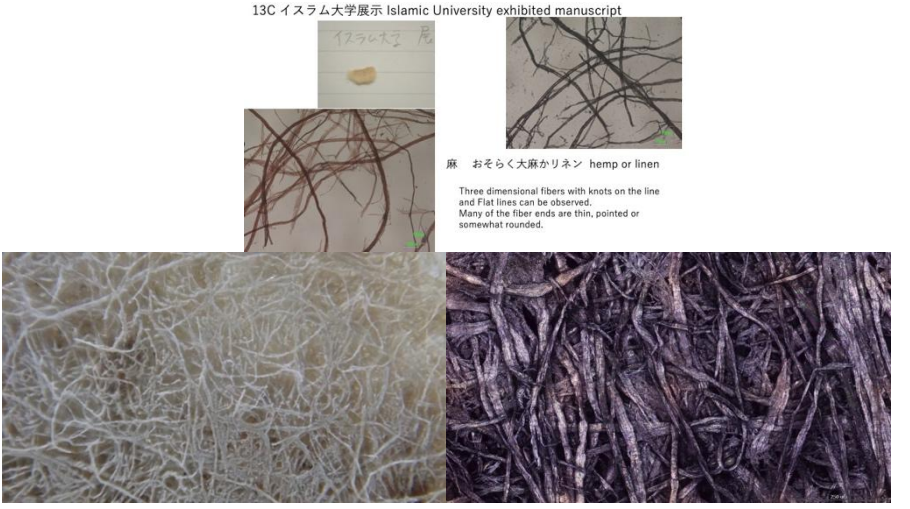

Fig. 34 Paper fragment from an Islamic manuscript (Linen/Hemp paper), Graff C stain (top), image from a simple still camera (left), and image from a white light confocal microscope (**right**).

Figure 35 is an investigation of manuscript paper from the same university, being an 18th-century Samarkand paper. The raw material is cotton, but differences in the applied starch's polishing are evident.

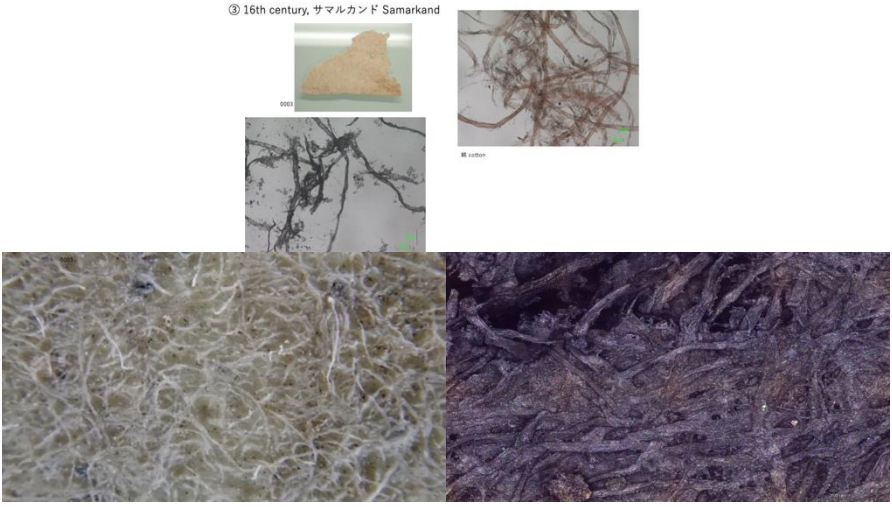

Fig. 35 Paper fragment from an Islamic manuscript (Linen/Hemp paper), Graff C stain (top), image from a simple still camera (left), and image from a white light confocal microscope (right).

Figure 36 is a conceptual diagram of the multi-faceted analysis system. Method A is the conventional method, which is destructive as it requires fiber extraction. Methods B and C are non-destructive investigations using the latest equipment—innovative methods we are exploring. The [Primary Survey] is quantitative; the [Secondary Survey] utilizes deep learning; and the [Tertiary Survey] is qualitative. By connecting the resulting images and information, we further train the deep learning model. These methods bring us closer to the possibility of conducting detailed, non-destructive paper analysis using only simple macro Figuregraphy with consumer-grade cameras.

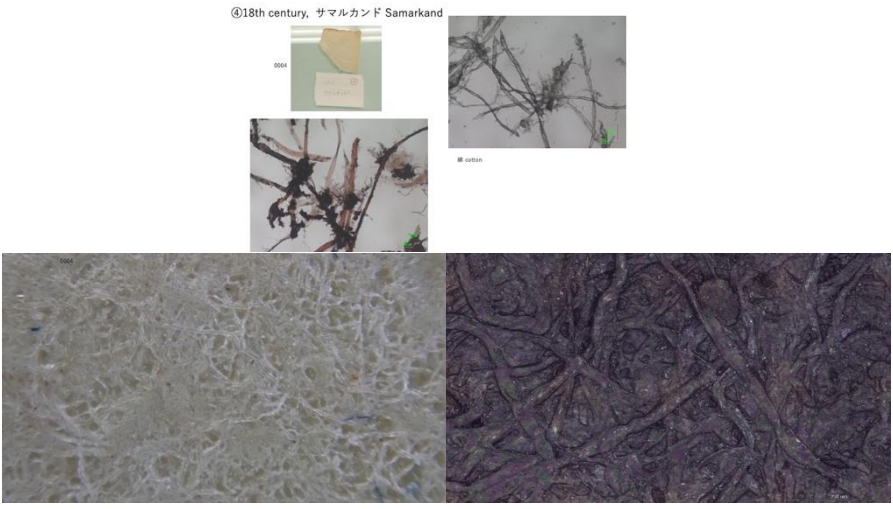

Fig. 36 Paper fragment from an Islamic manuscript (Linen/Hemp paper), Graff C stain (top), image from a simple still camera (left), and image from a white light confocal microscope (right).

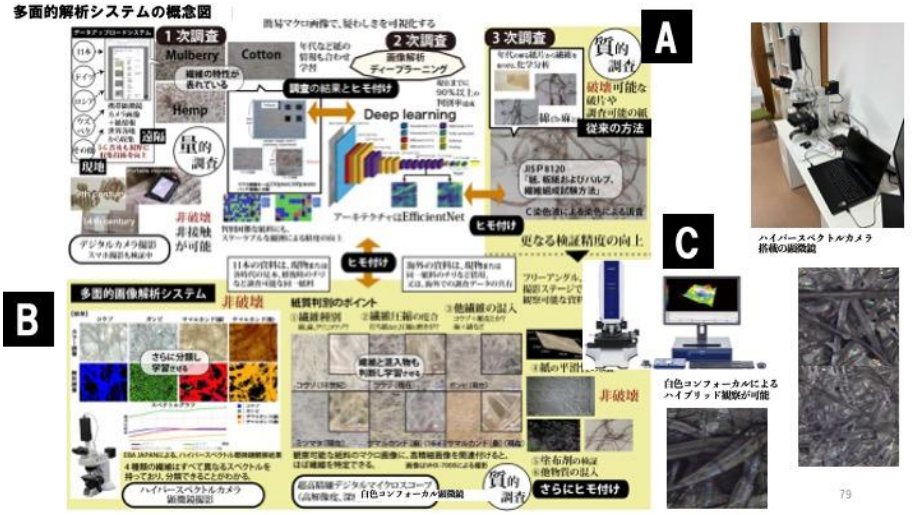

Fig. 37 Conceptual diagram of the multifaceted analysis system.

Figure 38 displays slides (preparations) of paper specimens currently being developed in the laboratory. We are generating fundamental AI training data using relatively new papers with definitively known raw materials, such as commercially available papers and sample books. For papers that absolutely cannot be cut, we position the entire sheet directly onto the microscope for Figuregraphy. We have also commenced investigating Chinese papers and need to collect as many samples of handmade Chinese paper as possible.

Fig. 38 Microscope slides of paper specimens currently being prepared in the laboratory.

If we can advance this research and employ this methodology globally, we believe it will become a scientific approach capable of revealing the undisclosed routes of paper dissemination and histories obscured in the past due to conflicting historical interpretations.

In this methodology, for unidentified paper materials, we apply highly reliable methods applicable to the situation: simple macro Figuregraphy, fiber extraction where possible, receiving paper fragments, or positioning items on a microscope. While the observations possible under non-destructive/non-contact rules vary, we aim to construct a system where connecting these data enriches the training set, enabling us to derive significant information about the paper from simple macro Figuregraphy alone.

A future challenge is the distribution of numerous dedicated cameras equipped with microscope functions capable of simple macro Figuregraphy. We are currently customizing cameras from a Japanese manufacturer, but if a dedicated macro camera can be produced inexpensively, external parties wishing to investigate paper can participate in this system. This would facilitate the collection of data on papers worldwide via the cloud. In the future, we hope to distribute these to paper collectors and museums, establishing an open database that focuses on paper itself as a cultural asset.

The above represents our research's interim progress. This content, including investigations into Washi and Uzbekistan Samarkand paper, was featured in a three-page article in The Nikkei (Nihon Keizai Shimbun) (Figure 39).

Fig. 39 Nikkei Inc., Sunday Edition, NIKKEI The STYLE, "The History Hidden in 'The King's Paper'," July 9, 2023.

6 Proposal for Collaborative Design of a Chinese Paper Sample Book

We intend to extend this research to China in the future. As an initial step, we have been searching for sample books containing production information on modern to contemporary paper to serve as data for basic specimens; however, it appears that very few sample books of handmade Chinese paper have been published to date. Consequently, we propose developing a Chinese paper sample book. We aim to design and publish this through joint international collaboration.

In Japan, numerous books containing Washi samples have been published over the years. Figure 40 displays the Encyclopedia of Handmade Japanese Paper (Tesuki Washi Taikan), published by Mainichi Shimbun (1973–74). This publication, created over five decades ago, is a sample book gathering as many domestic handmade Washi papers as possible at the time. It represents the culmination of research examining Washi from every conceivable perspective.

It is a large-format, substantial publication consisting of five volumes, measuring 54.5 cm vertically and 40 cm horizontally. Even after opening the outer cardboard box, the contents are wrapped in cloth-bound boxes and multiple layers of folded paper, making access to the content labor-intensive.

However, the binding is beautiful, and the experience of viewing the various Washi papers is deeply satisfying. The design supervision was conducted by Hiromu Hara, a prominent 20th-century Japanese graphic designer highly acclaimed for his book binding and editorial design.

A key feature of the book is its editorial structure: for each paper type, a sample is mounted on a sheet alongside an explanation of its raw materials and manufacturing method. The text volume is separately bound in the traditional Japanese style (Japanese bookbinding). The design is robust and elaborate, utilizing papers from various production regions for the covers, mounts, and endpapers, categorized by type—such as raw paper (Kigami), dyed paper, decorative paper, and processed paper (Figure 41, 42).

Fig. 40 Cover of "Encyclopedia of Handmade Japanese Paper " (left) and the complete set of five volumes including the outer cardboard box (right).

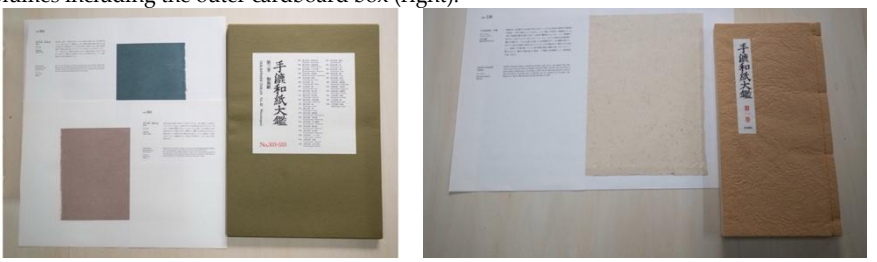

Fig. 41 Page with actual samples of "Encyclopedia of Handmade Japanese Paper " (left) and actual samples with commentary (right)

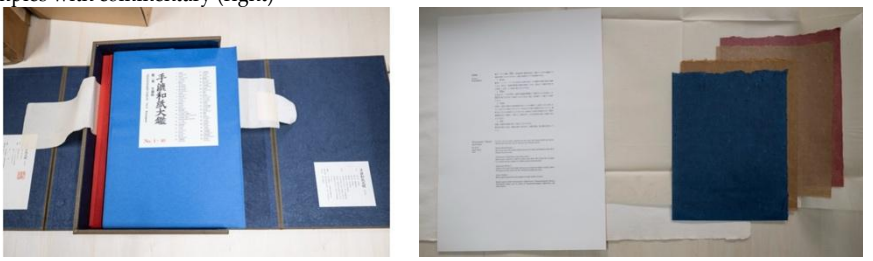

Fig. 42 Page with actual samples of "Encyclopedia of Handmade Japanese Paper " (left) and actual samples with commentary (right)

While this encyclopedic set is an exceptionally lavish publication, I aspire to collaborate with a Chinese university to collect, edit, and preserve a sample book of papers currently being handmade throughout China.

This endeavor requires cooperation not only from our research team but also from producers. I believe this is a critical task that must be undertaken immediately, before these papermaking techniques decline further.

7 Conclusion

Although I am a designer and an artist, art and design are currently merging with science. This convergence is becoming a means to discover

innovative methodologies for clarifying paper's history—as I am currently doing—and for resolving social issues that were previously unsolvable.

The relationship between artistic engagement's power and engineering can be observed, for example, in the capacity to visualize ambiguous images where no clear goal is visible, or in successful instances where works emotionally affect people despite lacking a strictly defined objective. These processes involve capturing concepts through sensation and organizing them through constant trial and error during production. I believe this approach leads to new ideas' realization.

Through the fusion of art, design, and science, I anticipate that ideas which were previously unrealizable will begin to materialize as various concrete projects.

DECLARATIONS

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Koji Shibazaki is a professor in Faculty of Fine Arts, Department of Design and Craft, Aichi University of the Arts. He is qualified as a Commercial Space Designer and registered as a Second-Class Architect. He is also a member of the Japanese Society for the Science of Design.

In his research, he broadly grasps the field of art and design under the theme of "media, the environment, and manufacturing," and focuses on the design of the relationship between people, things, and the environment, and tackles various themes from a comprehensive standpoint. His research topics include

design for regional revitalization, washi paper, manufacturing culture, and education-related design.

Recently, he has been focusing on research on paper. With the primary goal of "knowing and experiencing paper," he established his own washi workshop at the university and has been incorporating washi into his educational program for 14 years. He also sifs the washi paper of his own works in his workshop and holds research exhibitions on washi materials in collaboration with his students. The exhibition with the "Nightface Series" lighting work made of washi paper is a representative activity.

Abbreviations

ICCCE	International Symposium on Intelligent Cultural Creativity and Communication Engineering
JSPS	Japan Society for the Promotion of Science
AD	Anno Domini

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