

# **From Factories to Surgeries: Prototyping Threads**

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# Introduction

The supposed impermanence or invisibility of silk sutures straddles both the material world and the world of thought. Together, they afford contemplation as to how sutures also do more than close the physical wounds in human or animal flesh. Such an effort to notice and understand alternative histories of silk involves locating peripheral historical narratives that can lead to novel, surprising stories of the past. The emergent biotechnologies that have recently led to new means of silk manufacture through genetically engineered yeast, which obviates mulberry-munching silkworms, reflect a number of tensions about the relationship of the textile past and the biotechnological present.<sup>1</sup>

These new developments in the world of silk produce meaningful questions as we rethink the public history of silk and sericulture in Japan. The process of sericulture involves the reproduction and rearing of flightless silk moths, or *kaiko*, known also by their Latin binomial name, *Bombyx mori*. These silkworms (which are actually caterpillars) spin about themselves into cocoons, which are unraveled in basins of boiling water in factories tended by workers. In Japan, analyses of diaries of nineteenth-century female silk factory workers as well as works of fiction adapted into films such as *Aa Nomugi Tōge (Ah! The Nomugi Pass)* have seared into the Japanese public's memory a trying relationship between these cocoons, wage laborers, their overseers, and raw silk.<sup>2</sup> Analyses of the memoir of Wada Ei, a young woman recruited to work in Japan's first European-style silk filature and reeling factory in Tomioka, Gunma Prefecture (located north of Tokyo, in the center of the island of Honshū), particularly highlight the history of women and industrial labor. In the late twentieth century, high unemployment rates among Gunma's young and able-bodied workers marked the economically hard-hit prefecture, not least of all because Japanese silk manufacture had become less competitive on the global market. Tomioka Silk Mill also became museified as a tourist destination.<sup>3</sup>

The narratives retold by docents at the silk mill impress upon listening tourists how integral women and the silk fibers they unraveled have been to a valiantly modernizing Japan during the late nineteenth century.<sup>4</sup> These are the narratives we are supposed to know, and still, there is so much left to understand. In addition, in recent decades, numerous efforts have been made to document the silk heritage that stemmed from the industrial past surrounding the Tomioka Silk Mill in the later half of the twentieth century. The collection of stories of the work of sericulturists, silk weavers, and artists in the prefecture have been of great importance in their own right as a legacy of the industrial past, though several times removed.<sup>5</sup> Scholarly and NPO efforts to elevate awareness of the significance of silk have also helped cement the Tomioka Silk Mill as a UNESCO World Heritage site. This newfound public recognition of the mill, however, has come at the expense of recognizing the connection between the historical plans for the Tomioka Silk Mill as a site to train women factory workers and the harsh lived experiences of nineteenth-century workers, not only in Tomioka, but elsewhere in Japan.<sup>6</sup> The call that historian Patricia Tsurumi once made in 1995 to pay more attention to women textile workers and their histories remains salient as new narratives of Japan's silk history are written in the twenty-first century.<sup>7</sup> This missive to refine understandings of women's histories can and ought to be undertaken while grappling with current developments. By exercising a consciousness of a public history of objects, we can stitch



Figure 1. Multi-story cocoon warehouse at the front entrance to the Tomioka Silk Mill. Fresh cocoons would be prepared for filature and reeling by drying them in an oven. Photo by Lisa Onaga, 2008

the tapestries of the past and present together in ways that shed more light upon the narratives that get told less frequently.

## Prototyping as a means to historicize silk

Let us return to the object mentioned at the outset of this essay, the silk suture. This silken object of medicine and technology does not readily appear in the dominant histories of silk industries or women's work. Even in the history of medicine, scant mentions of silk sutures appear in the scholarship. Its relatively invisible scholarly presence is a curious analog to the deliberate invisibility that is demanded of a silk suture that does its job well, especially compared to the silk things we humans adorn on our bodies, be they silk ties and blouses, kimonos, or sarees. In order to understand how the alignment of silkworms with health and medicine came into the fore, I collaborated with scholars from multiple disciplines to delve into the meanings of the practical and imagined spaces created by silk textiles. This multidisciplinary project, entitled "Biomaterial Matters,"<sup>8</sup> centered upon prototyping a design for a hooded garment that embodied, on the one hand, the results of historical research into textile fabrics, motifs and patterns of silk originating from the field site of Amami-Ōshima (an island in the periphery of Japan known for its uniquely dyed woven silk). The project also provided a means to delve into the changing interactions between humans and the material of silk in the medical arena, on the other hand. Surgical silk sutures used as part of the stitching material for the prototype provided the unique opportunity for analyzing an alternative silk material, and for delving into the literal interface between silk fabrics and sutures. This essay focuses upon one development involving the latter, the history of silk sutures that surfaced from this prototyping project.

The suture-embroidery on the cocoon-garment took the form of a number of English and Japanese keywords like "sericulture," "metamorphosis," 経糸 (tate-ito, warp), 緯糸 (nuki-ito, weft), 'テーチ木染め' (tēchigizome, dyeing with bark of the Yeddo Hawthorne), 泥染 (dorozome, dyeing with mud), and "re-envisioning silk." These terms and phrases guided and represented a two-year period of work with fashion designer Galina Mihaleva, biological anthropologist Laura Longo, literature scholar Anne McKnight, design researcher Laura Forlano, and historian and maker Emily Anderson.<sup>9</sup> Through a think-tank style of collaborative work, individual historical and literary research cross-fertilized with speculative design and micrographic visual analysis. The research was shaped, encouraged, emboldened, and refined in ways that foregrounded the complicated relationship between past and present as it became articulated through "inventive problem-making."<sup>10</sup> These keywords were sewn into hidden pockets of the garment's body, and into accordion-like concavities sewn into the garment to represent the insect's respiratory apertures. Keywords were also embroidered by our talented assistant Ong Yii Mei onto white sleeves that were made to represent silkworm glands, and a white train that could be tied up in a bustle. Among them, a phrase was stitched with black medical-grade sutures: "WHAT IS VISIBLE AND PRESENT AND INVISIBLE AND NONTHELESS PRESENT." The word "invisible" nearly blended in to the fabric of the sleeve, for it alone had been stitched with white sutures instead.

Invisible. The persistence of the word bears a reminder of how far removed are the processes of ideation, making, and production, from



Figure 2. Tourists viewing the filature and reeling building at Tomioka Silk Mill. Electricity-powered industrial filature machines are covered with plastic tarps. Photo by Lisa Onaga, 2008.

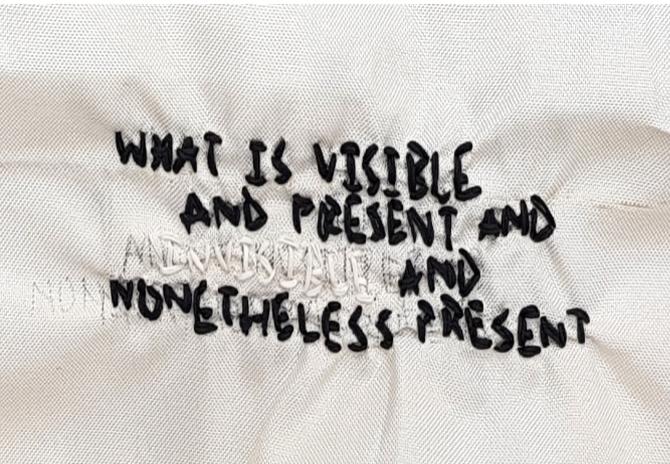


Figure 3. The embroidery of keywords and phrases from *Re-visioning Silk Through Amami Ōshima* appear on the prototype garment's sleeves and on a long train of white silk that can also be folded into the style of an obi. Embroidery by Ong Yii Mei. © Biomaterial Matters 2017

the typical consumer of silk. The gendered labor that went into the making of cocoons and finished silk objects, the myriad objectives of surgeries that employ silk sutures, the technologies used to weave and braid raw silk into sutures - these require work on the part of scholars and more, to bring into the public's consciousness. In this project, we centered our analysis on the history of technology and medicine as it related to dyed and woven silk products, in order to recognize material forms of silk that are less apparent to the public imaginary.

Our research anchored to textiles created on a Ryūkyū island where its recent history of silk production, using silk imported from the main islands of Japan (or elsewhere) and dyed with endemic plant substances preceding weaving, has highlighted a distanced human relationship between humans and silkworms. The exploration thus involved a reflexive exercise of thinking with cocoons, and not a normative restoration of sericulture on Amami Ōshima, or a prototyping practice involving collaboration with silkworms. This abstention from rearing silkworms has knowingly differed from the work of award-winning silk weaver Katsu Chiemi of Amami Ōshima, who cultivated her own personal batch of cocoons in a Tokyo suburb with the Tama Silk Life 21 Research Society to produce silk for her own woven handicrafts, which exhibit designs that differ from Amami Ōshima's conventions.<sup>11</sup> In contrast to artisanal craft, the silkworm co-produced work of bio-artist Vivian Xu and conceptual artist Liang Shaoji stress the corporeal traces of silkworms, often without sanitizing them. Their approaches additionally note the challenges and responsibilities of growing, caring, and working with silkworms and their silk, not as cocoons but coaxed into different forms, in different global locations (Liang's studio is situated on a mountain in China far from the pollution of cities, and Xu's artistic inquiries take place in different countries).<sup>12</sup> As these artists worked with silkworms, they highlight for us an awareness of the inheritance of expertise and the importance of local environments as they bridged geographies in order to generate new works. Their artistic collaborations with insects also usefully underscore key tensions among the fragility of maintaining sericultural and silk heritage, historical awareness, and the employment of critical design practices.

The approach that we employed toward developing the prototype regarded critical design practice as something that can generatively foster historical awareness. In this case, we wished to articulate a consciousness about distance between places of silk consumption, processes of making and producing silk, the invisibility of human silk workers, and the limitations that challenge historical empathy as a result of perpetuated myopic perspectives. By concentrating on finished silk textiles, and drawing upon participant-observation of sericulture and silk reeling instead of inserting live silkworms into the prototype process, we could reflect upon the gendered handling of textile materials. Stress was placed upon the practiced hands of human historical actors, ranging from factory girls, artisanal dyers, designers, and weavers, to surgeons. An emphasis upon creating a prototype to express historical dynamics differs from other kinds of design projects involving interspecific collaborations that have more agenda-setting purposes that draw upon inspiration from nature in order to create sustainable building materials, for instance.<sup>13</sup> Our prototyping work could thus function as a vehicle for supra-textual interpretation and representation of the findings that emerged through this research.<sup>14</sup> The final object, a hooded garment inspired by the body and cocoon of the silkworm, ultimately represented the mutual exchange between a design studio and historically-informed multidisciplinary research concerning human relationships with cocoons and silk weaving.<sup>15</sup> In addition to embodying our research process, the prototype has also

become an object with which to think through additional historical and social problems.

## Are We Supposed to Notice Sutures?

The Japanese word for suture, “hōgōshi” means “thread that sews things together.” Medically regulated silk sutures braided into a desired diameter from raw and degummed silk filaments are usually waxed and often treated with silicone to ensure their effectiveness. Silk sutures are often used for closures and ligatures in microsurgeries, skin surgeries, caesarian operations, and ophthalmic surgeries. The uses of silk in the human continue to grow, from stitches, to replacement bones, vessels, and skin. These developments prompt other sociohistorical questions about when and how silk and surgery started to become used in Japan more regularly. Here, I explore one of the earliest known published accounts of a surgical method in Japan that explicitly stated the use of silk sutures to transform the body for aesthetic purposes: the double-eyelid procedure, also known as blepharoplasty (the technique used to correct damage of the eyelid without incurring new damage to the skin).<sup>16</sup>

The ancient historical record shows that in Japan and elsewhere, surgical methods were used to treat injuries and illness. Since the 1700s, European surgical methods spread in Japan as Dutch surgeons traveled through the island trading post of Dejima. The translation and production of manuals and books also contributed to an interest in surgeries. One of the earliest recorded uses of silk in a surgical procedure appears in *Kishitsu geryōzukan*, a visual compendium in 1804 by Hanaoka Seishu. Silk sutures connected European and Japanese medical knowledge in operations like cataract surgery. Tracing the literal thread in this history has proven challenging, partly because far more attention in the records is paid to surgical tools. Just as silk sutures were supposed to leave an invisible scar, silk in the historical records is less than apparent. The box depicted in the 1891 *Jitsuyōgankagaku* (Practical Ophthalmology) by Kōmoto and Seo appears within a section on the preparation of sponges and silk sutures subtitled “Schwämme und Fäden” [Sponges and Sutures].<sup>17</sup> The German titling is less remarkable than how the illustration pays unique attention to the material shape and form of the container used to store spooled silk sutures. Yet, the spool for the suture itself remains absent, remaining as invisible as the scars supposedly left by the silk.

By 1889, the lead author, ophthalmologist Kōmoto Jūjirō (1859-1938) had returned to Japan from studying in Berlin. Although many medical students of the era traveled to Germany to further their medical training, Kōmoto notably became the first chair of ophthalmology at the Tokyo Imperial University. Detailed textual reports on late nineteenth century drying and sterilizing methods to prepare silk sutures began to appear in Japanese medical journals around the same time. Kōmoto became synonymous with the ophthalmology field, and his exhaustive 3-part textbook *Gankagaku* [Ophthalmology] published in 1893 had been reprinted sixteen times by the end of the Meiji period. In *Gankagaku*, he described a surgery to relieve a condition called entropion, in which the eyelid rolls inward (perhaps due to conjunctivitis). He reported that the surgery resulted in a double eyelid and deemed the patient more attractive.

A shift from repair to enhancement and aesthetic transformation is



Figure 4. “Fitting Humans in Cocoons, A Speculative Prototype,” a collaborative work of the Biomaterial Matters Project, created in the studios of Galina Mihaleva. Pocketflaps hide several project keywords. At the heart is “Amami Ōshima,” in recognition of the place and people who designed, dyed, and wove the textile. For more information, see *Re-visioning Silk Through Amami Ōshima*. © Biomaterial Matters 2017



Figure 5. Black silk sutures at 300x magnification exhibiting silicone coating. Micrograph by Nicole Ong Yii Mei with Keyence VHX-5000. © Biomaterial Matters 2017

documented in an 1896 paper in *Chugai Ijishimpō* [Chugai Medical Journal] by surgeon Mikamo Mitsutaro that described a new kind of ophthalmic surgery. Mikamo detailed a procedure of fusing three braided silk sutures to pull back the skin of the upper eyelid, ligating outside of the skin. Four to six days after the operation, the removed sutures left behind a crease responsible for what he called “natural-looking” double eyelids. This now-iconic record of silk sutures in Japan signaled a shift from using stitches to repair and conserve an original form, to deliberately transforming the human body. Mikamo took Kōmoto’s work a step forward technically, and notably also put forth his own concept of Japanese beauty. Mikamo’s work on converting single eyelids into double eyelids represented a development that pathologised the absence of the double eyelid as a “defect” of the structure of muscle fibres underneath the skin of the upper eyelid and, simultaneously, promoted aesthetics as a reason for electing surgery. The writing in Mikamo’s medical paper was at times exalted, as he emphasized that the double-eyelid surgery was a real problem that the medical community and even shrewd Western observers had missed.

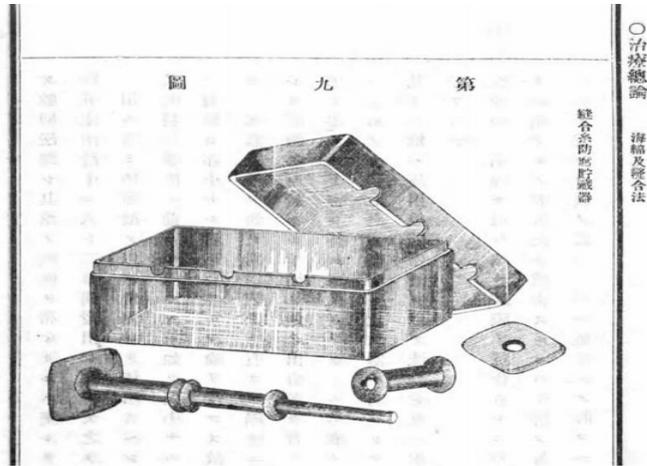


Figure 6. Bobbin container for sterilized silk. Kōmoto and Seo (1891). *Jitsuyō gankagaku* [Practical Ophthalmology], 42. The silk suture is a present absent in history, while the material shape and form of the bobbin containers used to store spools of silk sutures endure, much like the legacy of Kōmoto Jūjirō’s 1893 surgical procedures that preceded current-day double-eyelid surgeries. © Kōmoto and Seo: *Jitsuyō gankagaku* (1891)

## Redefining the Look of Normalcy

A close reading of Mikamo’s report shows how the surgeon justified aesthetic surgery in the context of reinforcing a notion of what a “normal” eye ought to look like. It described his observations of several hundred individuals carried out over two years. Mikamo described that nearly one out of five people examined had single eyelids, leading him to conclude that double eyelids were the proper, normal form of eyes. His methodologies were evocative of the biometric approach made popular by Francis Galton, a cousin of Charles Darwin.<sup>18</sup> Mikamo did not simply look at the eye: he measured the distances from the eyelid fold to the eyelid margin. By asking patients to look down and pulling on their eyelid, he could measure a distance that usually ranged between eight and twelve millimetres, with a total range for double eyelids varying from four to fifteen millimetres. These measurements would help him draw the line where a desired double eyelid would eventually be placed, six to eight millimetres from the margin to the fold. In Mikamo’s world view, beauty had a number.

Female teenagers between ages 16 and 18 constituted Mikamo’s case subjects. This focus on women was no coincidence. In his paper’s concluding remarks, Mikamo urged his fellow surgeons to try his surgical technique and thus tap into the opportunity presented by a potential stable of appearance-conscious young women patients. He impressed upon the surgeons how the improvement of vision and appearance of the patient worked in tandem, and he presumed in a rather misogynistic way that the patients would be more than grateful and express their adoration and appreciation for their doctors after their procedures. Elsewhere in the article, Mikamo describes the preoperative patients as having “monotonous” and “impassive” facial expressions. These glib remarks framed the two actual medical reasons for the surgery: alleviating narrowed vision due to eye infections in single eyelids cases, and operations on patients with asymmetric eyelids (one single eyelid and one double eyelid).

The surgical methods by Mikamo intended to create new eyes that were close to “natural looking” double eyelids that existed already in the population, regardless of the prompt for surgery. Four years later in 1900, Mikamo’s attempts to promote prevailing beauty

standards of “mild-mannered looks” appeared in the form of surgical instruction. In his book *Shōchin Gankagaku* [Pocket Ophthalmology], among other ophthalmic treatments, he defined *ganzen keiseijutsu*, or blepharoplasty, the technique used to correct damage of the eyelid without incurring new skin damage. He emphasized that it was important to the procedure to save the skin as much as possible and to heal the damage in the first phase as much as possible. He then outlined the best approaches, from the skin transfer method (transferring skin from around the place of damaged skin), the skin folding method (folding the skin from one side to other side to fix the damage), to the skin transplantation method (collecting skin, and transplanting it around the eye, which was considered advantageous due to possibility of repeating the method). Prior to Mikamo, physicians and surgeons had not quite framed the single-eyelid in Japan as a medical problem per se.

Mikamo’s interests aligned with a eugenic culture of comparing differences and similarities. For example, in 1934, a group of researchers in southwestern Japan at the Kyushu Imperial University surveyed 6277 people, including 1384 pre-school children, 4099 elementary school children, and 784 adults, only to find that nearly 75% of pre-schoolers had single-eyelid compared to 53.4% of the elementary school children, and 36.9% of the adults. The study concluded that the young humans carried a larger amount of fat on their face, which bears the effect of stretching out the eyelid. The loss of fat with age would cause an eyelid wrinkle, allowing one to naturally develop a double-eyelid. While Mikamo’s work did not directly figure into the Kyushu study, fat removal would indeed become one of the more aggressive techniques that surgeons would use later on.

In the late twentieth century, plastic surgeons have celebrated Mikamo in hindsight for pioneering double-eyelid surgery techniques, even though Mikamo’s 1896 publication was scarcely referenced by contemporaries. By following this story of double eyelid procedures, we understand that Mikamo’s aesthetic interests were also relatively conservative compared to the Western-influenced standards of beauty that defined surgically created double eyelids three decades later. And, Mikamo’s own record does not reflect any rampant popularity of double eyelid surgeries—he seems to have only carried out in actuality about fifteen such procedures. We also realize that silk was joined by other suture materials in the practice of this surgery. Silk was a common material used throughout World War I, but it was not the only material used or developed in the whole history of sutures. Blepharoplasties in the 1920s and 1930s used catgut (derived from cattle), for instance. Mikamo and his tools represent a brief but crucial snapshot of time, in which silk began to materially fuse the human body to a new future. The silk sutures would be removed, but their effects would endure.

## Threading Silk Between Past and Present

Perhaps, it is a stretch to call surgery a form of human metamorphosis, even if surgical procedures can lead to profound bodily transformations, either for repair and restoration or for aesthetic reasons, or both. Considering silk as something sewn into or through the human body accentuates an otherwise invisible side to the material. By inquiring into the object of the silk suture, another facet to the historical relationship between silk and women has also

become more clear. In addition, this analysis of the materiality of the simple surgical procedure shows silk's fungibility. The trade of silkworm and silk for cow and catgut returns us to the speculative question of how might the cultivation of cocoon change as the uses of and public appreciation for silk change. This question is poignant, given the decline of Japan's once robust silk trade that earned the country its vast wealth leading before World War II.

The prototyping methodology has afforded a means to identify under-explored problems and questions about silk histories, specifically, about how silk is used to repair or re-fashion the human body. The relationships humans have had with both silk textiles and surgical sutures have changed the longer they have been handled. They became both familiar and unfamiliar at the same time, and that discomfort, like the straightjacketed feeling when wearing the cocoon garment, produces the tensions necessary to arrive at several new planes of research and analysis. This process of locating the unfamiliar will prove useful for delving into new research topics. Over the past year, scientists have been using silkworm bodies to develop vaccines for COVID-19, for instance. To make sense of forthcoming developments requires a willingness to see the silk suture as a foundational case among histories of silk in health and medicine. More recent biomedical silkworm stories are, ultimately, sutured to histories of making silk textiles to adorn the human exterior. They are simultaneously historical and future-building stories concerned with the formation of practices, infrastructure, and scientific knowledge—and above all, embracing the unexpected.

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## Notes

<sup>1</sup> Laura DeFrancesco, “Hanging on a Thread,” *Nature Biotechnology* 35, no. 6 (June 2017): 496-99, <https://doi.org/10.1038/nbt.3894>.

<sup>2</sup> E. Patricia Tsurumi, *Factory Girls* (Princeton University Press, 1992); Shigemi Yamamoto, *Aa Nomugi Tōge (Ah! The Nomugi Pass)* (Tokyo: Asahi Shinbunsha, 1969).

<sup>3</sup> For historical unemployment data by age, see <https://www.stat.go.jp/data/roudou/longtime/zuhyou/lt03-04.xlsx>

<sup>4</sup> Wada Ei, *Seikai Tomioka Nikki: Tomioka Nyūjō Ryakki*, ed. Imai, Mikio (Maebashi, Gunma Pref.: Gunma ken bunkajigyō shinkōkai, 1999); Naho Ueda Maruyama and Kyle Maurice Woosnam, “Representation of ‘Mill Girls’ at a UNESCO World Heritage Site in Gunma, Japan,” *Journal of Sustainable Tourism* 29, no. 2-3 (March 4, 2021): 277-94, <https://doi.org/10.1080/09669582.2020.1738443>. All Japanese names appear as they do in Japan, with family name preceding given name.

<sup>5</sup> *Mayu no Kioku* [The memory of cocoons] (Maebashi: Jōmo Shimbunsha, 2008); *Kenjin Ōrai* [The passage of silk] (Maebashi: Jōmo Shimbunsha, 2008).

<sup>6</sup> Tsutsui Masao, “The Establishment of the Prefectural Hikone Silk Mill in Relation to the Tomioka Silk Mill,” *Hikone Ronsō*, no. 389 (2011): 22-39; David Wittner, *Technology and the Culture of Progress in Meiji Japan* (London; New York: Routledge, 2007); Maruyama and Kyle Maurice Woosnam, “Representation of ‘Mill Girls.’”

<sup>7</sup> E. Patricia Tsurumi, “Whose History Is It Anyway? And Other Questions Historians Should Be Asking. In This Case About The Cotton And Silk Thread Factory Women Of Meiji Japan,” *Japan Review*, no. 6 (1995): 17-36.

<sup>8</sup> Lisa Onaga, Galina Mihaleva, Anne McKnight, Laura Forlano, Laura Longo, Emily Anderson, “Biomaterial Matters: Historicizing the preservation of silkcrafft and the production of purified silk protein in the long twentieth century,” Ministry of Education, Singapore, AcRF Tier 1 Grant (2015-T1-001-026), 2015–2017. See [www.biomateriamatters.org](http://www.biomateriamatters.org) for more information.

<sup>9</sup> Lisa Onaga and Anne McKnight, eds., *Re-visioning Silk Through Amami Ōshima* (Singapore: KHL Printing Co. Pte. Ltd., 2017). <https://issuu.com/biomateriamatters/docs/1210-khl-publication-nocrop-marks>

<sup>10</sup> Mike Michael, “‘What Are We Busy Doing?’ Engaging the Idiot,” *Science, Technology & Human Values* 37, no. 5 (2012). For further discussion on this point, see Laura Forlano and Lisa Onaga, “Fitting Humans into Cocoons: A Speculative Interspecies Encounter,” 22-23, in *Re-envisioning Silk through Amami Ōshima*, Lisa Onaga and Anne McKnight, eds., Singapore: KHL Printing Co. Pte. Ltd., 2017.

<sup>11</sup> Katsu san (Amami-shi) ni kurafutoten de saikōshō, “*Nankainichinichi Shinbun*, January 11. The Tama Silk Life 21 Research Society is an “Ethnic Costume Culture Merit Group” designated by the Ministry of Education, Culture, Sports, Science and Technology.

<sup>12</sup> Liang Shaoji, Vivian Xu, and Lisa Onaga, “Panel Discussion: Sericultural Practices with Artists Liang Shaoji and Vivian Xu” (Trees of Life: Knowledge in Material, Nanyang Technological University Centre for Contemporary Art, Singapore, Sept. 8, 2018). Even though Liang’s studio is situated on a mountain far from urban interference, changing agricultural land-use patterns can impact the quality of mulberry and thus his silkworm’s health since they feed on this plant nearly exclusively. Xu’s methodology involves a comparative inquiry of rearing silkworms in different indoor climates in the U.S., Germany, and Shanghai. See also <https://www.mpiwg-berlin.mpg.de/page/silkworm-project>.

<sup>13</sup> Paola Antonelli *et al.*, *The Neri Oxman Material Ecology Catalogue* (New York: The Museum of Modern Art, 2020).

<sup>14</sup> Charles Kostelnick, “Supra-Textual Design: The Visual Rhetoric of Whole Documents,” *Technical Communication Quarterly* 5, no. 1 (January 1, 1996): 9-33, [https://doi.org/10.1207/s15427625tcq0501\\_2](https://doi.org/10.1207/s15427625tcq0501_2).

<sup>15</sup> The prototype was exhibited at the “Making and Doing” exhibition of the *Society for the Social Studies of Science* Annual Meeting in 2017.

<sup>16</sup> Mikamo Mitsutaro, *Shōchin Gankagaku* (Tokyo: Tōhōdō, 1901).

<sup>17</sup> Shosaku Seo and Kōmoto Jūjirō, *Jitsuyō Gankagaku* (Tokyo: Seikōdō Shoten, 1891), pp. 40-43.

<sup>18</sup> Harold E. Henkes, *History of Ophthalmology 5: Sub Auspiciis Academiae Ophthalmologicae Internationalis* (Dordrecht: Springer Netherlands, 1993), pp. 104-105; Hoi-eun Kim, *Doctors of Empire: Medical and Cultural Encounters between Imperial Germany and Meiji Japan* (University of Toronto Press, 2014).

<sup>19</sup> Mikamo Mitsutaro, “Gankenseikei kowaza,” *Chūgai Iji Shimpō*. 396 (1896): 9-13; Y. Shirakabe *et al.*, “The Double-Eyelid Operation in Japan: Its Evolution as Related to Cultural Changes,” *Annals of Plastic Surgery* 15, no. 3 (September 1985): 224-41; S. Sergile and Kazuo Obata, “Mikamo’s Double Eyelid Operation: The Advent of Japanese Aesthetic Surgery,” 1997, <https://doi.org/10.1097/00006534-199703000-00008>.

<sup>20</sup> Mikamo Mitsutaro, “Gankenseikei kowaza,” *Chūgai Iji Shimpō*. 396 (1896): 9-13.

<sup>21</sup> Michael Bulmer, *Francis Galton: Pioneer of Heredity and Biometry* (Johns Hopkins University Press, 2003).

<sup>22</sup> Mikamo Mitsutaro, “Gankenseikei kowaza,” *Chūgai Iji Shimpō*. 396 (1896): 9-13. My translations.

<sup>23</sup> Mikamo Mitsutaro, *Shōchin Gankagaku* (Tokyo: Tōhōdō, 1901).

<sup>24</sup> Hayashi Makoto, "Mikami shi hō ni yoru futaemabuta keiseishujutsu 4rei ni tsuite," *Nihon Ganka Kiyō* (Folia ophthalmologica Japonica) 44, no. 9 (September 1950): 38-39.

<sup>25</sup> The motivation for such studies likely also connects to a larger interest in heredity, race, and biological anthropology and defining Japaneseness. See Tessa Morris-Suzuki, "Debating racial science in wartime Japan," In *Beyond Joseph Needham: Science, Technology, and Medicine in East and Southeast Asia*. Morris Low, ed. Special issue, *Osiris* 13 (1999):354-375; Jennifer Robertson, "Japan's First Cyborg? Miss Nippon, Eugenics and Wartime Technologies of Beauty, Body and Blood," *Body & Society* 7, no. 1 (March 1, 2001): 1-34, <https://doi.org/10.1177/1357034X01007001001>.

<sup>26</sup> N.A. 1934. "Dochiraga ōi? Hitoemabuta to futaemabuta. Futaemabuta ni naritai hito wa?" *Yomiuri Shinbun*. June 21.

<sup>27</sup> Hashimoto Kazumichi. "Biyō seikei," *Kango Kanri* (2009). 19 (11): 1004-5; S. Sergile and Kazuo Obata, "Mikamo's Double Eyelid Operation," Samuel M. Lam, "Mikamo's Double-Eyelid Blepharoplasty and the Westernization of Japan," *Archives of Facial Plastic Surgery* 4, no. 3 (July 1, 2002): 201-2.

<sup>28</sup> For further discussion of the relationship between young women and girls and silk cocoons as expressed in the context of literature, film, and media in Japanese, see Anne McKnight, "The Poetics of Cocoons," in Lisa Onaga and Anne McKnight, eds., *Re-visioning Silk Through Ama-mi-Ōshima* (Singapore: KHL Printing Co., Ltd., 2017), 16-17.

<sup>29</sup> Ryosuke Fujita *et al.*, "Efficient Production of Recombinant SARS-CoV-2 Spike Protein Using the Baculovirus-Silkworm System," *Biochemical and Biophysical Research Communications* 529, no. 2 (August 20, 2020): 257-62, <https://doi.org/10.1016/j.bbrc.2020.06.020>.