

# Popular Science and Personal Endeavor in Early-Meiji Japan: The Case of *Hatsumei Kiji*

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## Abstract

During the late 1860s and early 1870s, many science books were translated into vernacular Japanese from Chinese and European languages. These works rendered science accessible to non-scholarly audiences, thereby opening up scientific knowledge for appropriation in various ways. This paper focuses on one work that drew together material from such translations to promote a particular message. The book in question, *Hatsumei Kiji (Accounts of Invention)*, was created by an Osaka-based merchant who adapted, supplemented and vernacularized scholarly translations to produce a work which aimed to persuade tradesmen that science promised a means of securing their future in the unsettled social and economic landscape of the early Meiji period. This paper examines the methods used by the book's author to hone his message and to render it accessible for his desired audience.

**Key words:** science popularization, translation, early-Meiji science, artisans

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## I. Introduction

Following the opening of treaty ports in 1859, among the first imports to Japan were science books written in, or translated into, Chinese by British and American protestant missionaries. These were of course not the first science books on Western science to arrive in Japan. There had long been a healthy trade in imported Dutch and Chinese science books, especially after the mid-eighteenth century when the Tokugawa Shogunate relaxed restrictions on the import of Dutch books.<sup>1</sup> However, what distinguishes these later imports from earlier arrivals was their degree of permeation into wider Japanese society. Whereas Dutch and Chinese books were circulated, copied and studied mainly among the scholarly classes, works by protestant missionaries went, through their multiple iterations and rewritings, so far as to reach even juvenile audiences in the early 1870s.

By the time the treaty ports were opened there was widespread feeling that *rangaku*

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<sup>1</sup> Grant K. Goodman, *Japan and the Dutch, 1600–1853* (Richmond: Curzon, 1999).

(Dutch studies) was becoming obsolete as a means of inquiry into Western science and many scholars now wanted to access books in languages such as English and French. As there were few outside of Shogunal institutions who could understand—much less translate—books in these languages, Chinese publications proved a valuable medium. These books initially arrived as gifts presented by foreign travellers to their Japanese hosts.<sup>2</sup> Notable among Chinese science books circulating in Japan during this period were *A Circle of Knowledge* (*Chikan Keimō*) by James Legge, *A New Book on Natural History* (*Hakubutsu Shinpen*) by Benjamin Hobson, and *An Introduction to Science* (*Kakubutsu Nyūmon*) by William Alexander Parsons (W.A.P.) Martin.<sup>3</sup>

These Chinese books followed varying trajectories in their new context. For example, Hobson's *A New Book on Natural History* was promptly reprinted by the *Bansho Shirabesho* (the Institute for the Study of Barbarian Books) and thus initially experienced the widest circulation. In time, all were reprinted, and thereafter subject to various modifications. These reprints often included *kunten* (reading markers) or explanatory prefaces added by Japanese scholars. Eventually, all were translated into Japanese—Hobson's in 1868, and Legge's and Martin's in 1870—before inevitably being revised or retranslated.<sup>4</sup> These translations found their way into the newly inaugurated school system in 1872: in its new curriculum, the Ministry of Education, assigned Japanese translations of *A New Book on Natural History* and *An Introduction to Science* as textbooks for upper elementary schools.<sup>5</sup> One must be careful not to overstate the importance of these books in the school system. The Ministry of Education's list provided suggestions rather than prescriptions; teachers had the freedom to introduce other textbooks, or even to translate or write their own. Moreover, as is well noted, in the early years of the supposedly mandatory school system attendance was low, especially in the more advanced levels of the system where the use of the works was suggested.<sup>6</sup> Thus, their actual use in the school system cannot necessarily be presumed to have been widespread. However, their adoption by the education system is a sign of how widely these works circulated in Japan and how integral they were to the study of science in

<sup>2</sup> Yatsumimi Toshifumi, "Bakumatsu Meijishoki ni torai shita Shizenshingakuteki Shizenkan: Hobuson 'Hakubutsu Shinpen' o chūshin ni," *Aoyama Gakuin Joshin Tanki Daigaku Sōgō Bunka Kenkyūjo Nenpō*, 4 (1996): 127–140. For further discussion on the import and circulation of these works see Nihon Gakushiin eds. *Meiji-zen Nihon Butsuri Kagakushi* (Tokyo: Nihon Gakujutsu Shinkōkai, 1964), Ch. 2 'Chūgokuyaku Rikagakusho no Yunyū to Honkoku, pp. 203–223.

<sup>3</sup> For more on these missionaries and others, see Paul Cohen, "Christian Missions and their Impact to 1900," in John K Fairbank, *The Cambridge History of China*, Vol. 10 Pt 1. (Cambridge: Cambridge University Press, 1978), pp. 543–90.

<sup>4</sup> These translations were typically in *kanbun kundoku* style. This translation approach adopted a slavish adherence to the Chinese original, but with the text rearranged according to Japanese syntactical order.

<sup>5</sup> Nihon Gakushiin eds. *Meiji-zen Nihon Butsuri Kagakushi*, op.cit., p. 226.

<sup>6</sup> For discussion of popular resistance to government education efforts, see Mikiso Hane, *Peasants, Rebels, Women, and Outcasts: The Underside of Modern Japan* (Lanham, Md.: Rowman & Littlefield, 2003).

Japan up to and including the early Meiji period.

In 1873, the following year, the Ministry of Education released another list of suggested textbooks. In this list, translations of Hobson's and Martin's works were replaced by some that were published by the Ministry itself, as well as a range of other commercially published vernacular (*zokubun*) works. This did not, however, mark the end of the road for these Chinese works. Rather, it signaled their even more widespread use under new guises. With their proliferation now so widespread, they were appropriated by a new generation of readers who interpreted them in new ways and adapted them for novel purposes. Many of these books were reworked in an innovative synthesis of material from various sources, which were themselves translations or vernacularizations, supplemented with original material. The Chinese books described above were often the basis for many of the new works that were to be their replacements and thus, in their afterlives, continued to be used to influence attitudes toward science well into the first decade of the Meiji era.

## 2. The Afterlife of *An Introduction to Science*

One work that drew on translations of such Chinese sources for a significant portion of its content was *Accounts of Invention* (*Hatsumei Kiji*), which drew much of its content from W.A.P. Martin's *An Introduction to Science*. It was among the books recommended by the Ministry of Education for use in schools in its revised list announced in 1873. Many of the science books published in that year were written in the hope that the Ministry of Education would recommend their use thereby guaranteeing their authors a financial windfall.<sup>7</sup> *Accounts of Invention* was, however, written with a different objective in mind. Unlike many other science books published at the time, *Accounts of Invention* was produced, not by someone from a scholarly background, but by an Osaka-based merchant. Its compiler, Azumai Ketsuzen, described himself as an "uneducated" bibliophile merchant.<sup>8</sup> Moreover, while most vernacular books on science during the early Meiji period aimed to educate the 'ignorant'—usually women and the less-literate peasantry—Azumai targeted a different readership. He honed his message to speak directly to those engaged in manual pursuits, such as artisans and lower-ranking samurai, for whom he felt that science held particular promise. In his preface he sets out his mission:

<sup>7</sup> Miyoshi Nobuhiro, *Kindai Nihon Sangyō Keimōsho no Kenkyū* (Tokyo: Kazama shobō, 1992), p. 633.

<sup>8</sup> Azumai described himself as bibliophile in the preface to *Hatsumei Kiji* (Osaka: Kajita Kizō, 1872), vol. 1, p. 2, while he pointed to his occupation and his relative lack of education in the preface to *Bankoku Hatsu* (Osaka: Morimoto Tasuke, 1876), p. 2. His assertions in both prefaces suggest, but by no means explicitly assert, that he may have been a bookseller. I would like to thank an anonymous reviewer for bringing Azumai's self-description in *Bankoku Hatsu* to my attention.

There is an old Chinese proverb that says, “In a journey of a hundred miles, at ninety, one is only halfway there.” How true this is! Next to me lives a *daiku* by the name of Katō Shūzō.<sup>9</sup> About [two years ago] he invented a human-powered machine for dredging riverbeds. He applied to the prefectural office and was immediately granted permission to manufacture it. And so he embarked on his business. At this point he had reached ninety miles but, alas, he ran into difficulties getting funding and without money, he was unable to achieve his goal. So he gave up. I found this hugely disappointing. I told him, “you can’t just give up like that,” but he responded that he had a family to support. To encourage him I told him about the examples of Western inventors. You may have a family, I told him, but invention has nothing to do with being rich or poor. It is said that the Western inventors Watt, Arkwright and Stephenson were all initially poor, but they paid no mind to this and in the end their reputation has carried on through the ages. [...] It is my wish that those like Katō would engage in learning and become proficient in techniques so that they can become successful inventors, just like those in the West. Then they will have completed their journey of one hundred miles.<sup>10</sup>

Azumai’s aim was thus to encourage his readers to turn their energies to producing new inventions, thereby securing a stable, even prosperous, future for themselves in the unsettled social and economic landscape of the early Meiji period. In 1871, the year before Azumai published this work, the Meiji government started dismantling the *mibunsei*—the putatively immutable Tokugawa-era social hierarchy, which ranked four classes in descending order as follows: samurai, farmers, artisan and merchants. Over the next few years samurai would see their stipends removed and would thus be required to earn their own keep. It was, as Gilbert Rozman describes it, a transition from “privilege conferred” to “position earned.”<sup>11</sup> The “common people” for their part, were now “allowed to pursue their own calling,” and were no longer tied to their hereditary trades and status.<sup>12</sup> This represented an opportunity for artisans, whether so designated by hereditary

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<sup>9</sup> *Daiku* is usually translated into English as ‘carpenter’. However, as Gregory Clancey notes, during the period under discussion here, *daiku* performed roles that, in Britain and the United States, were done by architects, general contractors, carpenters and masons. Designating the role as ‘carpenter’, he notes, “reduced *daiku* to only one of these positions—the least powerful one.” To avoid this reductionism, the term *daiku* is used here. Gregory Clancey, *Earthquake Nation: The Cultural Politics of Japanese Seismicity, 1868–1930* (Berkeley: University of California Press, 2006), p. 28.

<sup>10</sup> Azumai, *Hatsumei Kiji*, op.cit., pp. 1–2.

<sup>11</sup> Gilbert Rozman, “Social Change,” in Marius B. Jansen, ed., *The Cambridge History of Japan, Vol. 5: The Nineteenth Century* (Cambridge: Cambridge University Press, 1989): 499–568, p. 532.

<sup>12</sup> The third clause of the Charter Oath, pronounced in 1868, stated “the common people, no less than the civil and military officials, shall each be allowed to pursue their own calling so that there be no discontent.” Rozman, “Social Change,” *ibid.*, p. 525.

status, or whether they be lower-ranked samurai who, because of their relative penury, had to supplement their stipends by engaging in artisanal occupations. Azumai believed that, with their technical nous, these groups were well placed to play a central role in Japan's anticipated industrialization.

It was not only the societal landscape that was subject to such upheaval. At this time the professionalization of science—or more correctly, technology—had started in earnest.<sup>13</sup> The Meiji government sought to cultivate its own cadre of scientists and engineers through its various technical institutions and departments. However, despite the pronouncements of the government, these positions were overwhelmingly dominated by those of inherited privilege. Azumai targeted those largely shut out from such elite institutions—those such as tradesmen working with a variety of materials, and perhaps merchants who wanted to invest in tradesmen's activities. Azumai's work demonstrates his belief that, although tradesmen might not have been au courant with latest Western technologies, their underlying skills meant that they were the ones who could most easily transition to the new materials and technologies of the age, if only they persevered against the odds.<sup>14</sup>

Azumai's perspective was perhaps colored by his status as a merchant in Osaka: during the Edo period Osaka was transformed from a military city into a commercial hub dominated by merchants, who made up ninety-five percent of its population. Because of its exceptional demographic character, the effects of the class hierarchy and the expectations that this entailed were less palpable. Osaka became a center for both western and Chinese studies where even merchants and artisans could engage in scholarly pursuits.<sup>15</sup> The idea that artisans as well as merchants could play a prominent role in Japan's industrialization would thus have seemed more evident in an environment such as this.

Azumai sought to give his readers the tools, both technological and psychological, to enable them to turn their attention to the new technologies of the age. As the most iconic

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<sup>13</sup> As studies of modern Japanese industrial development have underscored, the Meiji government was less interested in developing science than in promoting the adoption of Western technologies. See, for example, David G. Wittner, *Technology and the Culture of Progress in Meiji Japan* (London: Routledge, 2008) and Tessa Morris-Suzuki, *The Technological Transformation of Japan* (Cambridge: Cambridge University Press, 1994). The distinction between science and technology was not an issue for Azumai. Notably, the subtitle to *Hatsumeï Kiji* was *Nisshin Kyūri* (new 'science'). *Kyūri*, literally 'the investigation of principles', had currency in the early Meiji period as shorthand for both 'science' and 'technology based on scientific principles.'

<sup>14</sup> Azumai was indeed correct that tradesmen would be well placed to engage in Japan's technological transformation. Some *daiku*, for example, took leading roles in railroad construction at the Ministry of Public Works. Some also gained knowledge in Western style building practices as sites in Yokosuka and Yokohama. Clancey, *Earthquake Nation*, op.cit., p. 34. Other tradesmen who previously made guns switched to making bicycles. Suzuki Jun, *Shingijutsu no Shakaiishi* (Tokyo: Chūō Kōron Shinsha, 1999).

<sup>15</sup> Tetsuo Najita, *Visions of Virtue in Tokugawa Japan: The Kaitokudo Merchant Academy of Osaka* (Honolulu, University of Hawai'i Press, 1997).

of these modern technologies was the steam engine, Azumai would narrate the ascendance of steam in Britain. His book would tell the life stories of those responsible for the development of steam technology, seeking to underscore parallels between these inventors in Britain and artisans in Japan. To give his readers the most up-to-date information on steam technology Azumai turned to *The Steam Engine (Jōki Kikaisho)*, a textbook for steamship engine operators, published by the Numazu Military Academy in 1869.<sup>16</sup> *The Steam Engine* is likely a translation of a Dutch work. Its source remains unclear, but it is believed to be the first major translation in Japan on the steam engine.<sup>17</sup> Although it was translated by and for technical specialists at the military academy, as we can glean from the fact that Osaka-based Azumai was able to obtain a copy, it circulated well beyond the bounds of the institution.

Bringing W.A.P. Martin's *An Introduction to Science* and the Numazu Military Academy's *The Steam Engine* together was an endeavor that required considerable ingenuity. The result would need to go beyond a mere cobbling together of the two sources. Both texts would need to be modified to meet the conventions of the vernacular genre to which Azumai's less sophisticated audience were accustomed. Martin's catechetical style, a method transposed from theology and which embodied the hierarchical relationship between master and student, would need to be remodeled to reflect the more equitable relationship between Azumai and his readers. Moreover, illustrations would need to play a more central role. In both *An Introduction to Science* and *The Steam Engine* images were largely incidental to the text and were presented separately. In the former, all illustrations were presented at the beginning of the text work, and in *The Steam Engine* they were appended as a 4 *chō* (7 page) booklet at its end. This modus operandi was alien to more vernacular forms and to the *daiku hinagata* and *kikujutsu-sho* genre of *daiku* technical literature, where text appeared alongside and subordinate to illustrations. In light of the considerably enhanced role that imagery would need to play in his work, Azumai collaborated with the artist Shōkōsai Chōei, who not only modified many of the illustrations from the two sources, but added several of his own. There was also the matter of terminology. *The Steam Engine* brimmed with technical neologisms that would have been incomprehensible to all beyond a small circle of scholars. Azumai needed to make these foreign technical terms comprehensible to his peers by drawing on vernacular language.

<sup>16</sup> The Numazu Military Academy was established in Shizuoka by the Tokugawa house after its Shogunate had been deposed. Many mathematicians and military scientists trained there, later becoming teachers throughout the country. See Higuchi Takehiko, *Numazu Heigakkō no Kenkyū* (Tokyo: Yoshikawa Kōbunkan, 2007).

<sup>17</sup> Marginalia in a copy of the work held by the National Diet Library describes *The Steam Engine* as "a translation of a foreign work" (*gaikoku sho yori honyaku taru mono*) without specifying the language or source of the original. However, the inclusion of Dutch glossing suggests a Dutch work as its source. Anon., *Jōki Kikaisho* (Numazu: Kaigun gakkō, 1869).

These various modifications made by Azumai to transform the two texts into a single work suitable for his new audience are the focus henceforward in this paper. First, this paper explores how Azumai appropriated the Victorian genre of heroic biography in service of his aim of encouraging tradesmen to learn about the steam engine. Thereafter, it looks at its illustrations and terminology, examining how Azumai modified these to make them relevant to his target audience. In doing so, this paper demonstrates that Azumai's innovative synthesis resulted in work that is arguably greater than the sum of its parts. It also demonstrates how, in an era of heady excitement at elite levels about the potential of science to transform Japan into a prosperous state, science was not seen by all as being narrowly related to nation-building, but was perceived instead as a means of personal advancement and of securing a stable future for one's own family.

### 3. Adapting Heroic Victorian Biography for Early-Meiji Tradesmen

As indicated in his preface, Azumai considered the lives of James Watt, Richard Arkwright and Stephenson as particularly instructive for his readers. Azumai was less interested in these engineers as individuals than as models that would illustrate his message that inventiveness was determined, not by social status, but by the extent of one's ambition and perseverance. For this reason, Azumai's biographies all follow a similar narrative arc: the crushing poverty into which his subjects are born is emphasized, as is their unstinting desire to overcome their material circumstances through hard work and study. While his protagonists encounter setbacks and opposition along the way, they persevere to invent epoch-defining technologies. Ultimately, as a reward for their efforts their reputations are greatly enhanced and, importantly, they accumulate great wealth. To give one example, an abbreviated version of George Stephenson's biography as it appears in *Accounts of Invention* could be narrated as thus:

*Stephenson was born to an impoverished engine operator. So poor was his father that the children had to work to ensure survival of the family, and so young George was sent to work as a farmhand to tend cattle (Figure 1, panel A). Because of this, he was unable to go to school. Having matured without the ability to write, or even to read his own name, Stephenson decided to enrol in night school (panel B). He worked throughout the day and studied at night, meaning that there was little time for rest. Eventually, he married at the age of 21 and two years later had a son. However, shortly thereafter his wife fell ill and died so Stephenson was left to raise his son on his own (panel C). This misfortune motivated Stephenson to work even harder. Using his newfound literacy skills, he read books on machinery and used this knowledge to improve machines in the coal mine where he now worked. Stephenson's diligence*



Figure 1. Illustrations of George Stephenson's biography in *Accounts of Invention*. Panels A to F from left to right starting at the top right hand corner. Courtesy of The National Diet Library.

resulted in promotion, such that he was able to obtain a salary of “300 yen” by the time he was 31 years old, which lifted him and his son out of poverty. The knowledge he gained from his study and application enabled him to try his hand at making a steam locomotive (panel D). The one that he eventually created was superior to those created by professional engineers. Thereafter, Stephenson embarked on a project to revolutionize the railways (panel E). Although he encountered opposition from those who doubted its feasibility, he was able to persuade detractors through rational, public debate. Ultimately, he was successful and his technology was adopted widely leading to increased prosperity for the nation. With his reputation secured, he was able to live out his final days in comfort in a luxurious mountain villa (panel F).



Much of this biography of George Stephenson may strike the contemporary reader as familiar. Indeed, Azumai's knowledge of Stephenson was almost certainly gleaned from the same source that we derive much of our own knowledge of the railway pioneer: Samuel Smiles' *Lives of the Engineers* (1861) and *Self-Help* (1859).<sup>18</sup> In these works, the British author Smiles presented biographies of 'self-made' men of lowly birth who were able to surmount their circumstances through diligent work and perseverance. Smiles' *Self-Help* was translated into Japanese in 1871 by Nakamura Keiu (Masanao) as *Saigoku Risshi Hen* (*Western Success Stories*). It is difficult to overstate the influence of this work in Japan. Earl Kinmonth, for example, notes: "commonly and quite correctly, *Saigoku Risshi Hen* is described as one of the 'holy books' (*seisho*) of the Meiji era."<sup>19</sup> Smiles' message that one should not be judged by rank or wealth, but by the ability of their achievements to advance civilization found official endorsement in Japan, and Nakamura's translation was distributed by the government to the public and used in lectures given to the Meiji emperor.<sup>20</sup> Nakamura's terse, erudite style limited its readership to those with only the highest levels of literacy, but its message was widely disseminated in various other formats, notably as illustrated single-sheet prints produced by the Ministry of Education for use in schools.<sup>21</sup>

Azumai's *Accounts of Invention* was yet another, albeit unofficial, way in which this message was passed on to a wider audience. However, although *Accounts of Invention* shares the same source as *Western Success Stories*, there are discernable differences in which aspects of Smiles' work are given prominence. As Kinmonth has pointed out, in *Western Success Stories*, which targeted a samurai readership, Nakamura muted Smiles' emphasis on the lowly birth of his protagonists while amplifying the link between the success of Smiles' subjects and national prosperity. In Nakamura's translation, references to national prosperity are inserted where no such mention was made in Smiles' work.<sup>22</sup> This emphasis on the relationship between character and national esteem is what accounted for its appeal among government educators who promoted Nakamura's work so widely.

In contrast, Azumai emphasized the social mobility and wealth accrued by the inventors he profiled. This is not to suggest that Azumai overlooked the contributions inventors could make to national prosperity. Indeed, his work includes copious reference to and illustrations of palatial rail stations in London, bustling ports, and railways

<sup>18</sup> The sections on George Stephenson that appeared in the *Lives of the Engineers* were a revision of material that previously appeared in *The Life of George Stephenson* (1857). Henry Petroski, "Lives of the Engineers," *American Scientist*, 92 (2004): 410–414, p. 412.

<sup>19</sup> Earl H. Kinmonth, "Nakamura Keiu and Samuel Smiles: A Victorian Confucian and a Confucian Victorian," *The American Historical Review*, 85(3), (1980): 535–556, p. 536.

<sup>20</sup> *ibid.*, p. 549.

<sup>21</sup> Examples of these can be seen at: <http://www.tulips.tsukuba.ac.jp/lib/ja/collection/rare-kyoiku-nishikie>.

<sup>22</sup> Kinmonth, "Nakamura Keiu and Samuel Smiles," *op.cit.*, pp. 545–546.

brimming with goods destined for export. However, these merely provided the backdrop to the feats of the figures profiled. More than collective prosperity, what was foregrounded was individual achievement. Notably, the one clear deviation between Azumai's narrative of the life of George Stephenson and that of Samuel Smiles (and Nakamura Keiu) comes at the end of the protagonist's life. Stephenson, we already know, achieved great recognition during his lifetime. His luxurious retirement villa, perched on a hillside overlooking a resplendent valley is, however, an invention of Azumai and his illustrator, Shōkōsai.

#### 4. Illustrating *Accounts of Invention*

Although imagery was an important feature in most popular science books produced during the early Meiji period, their illustrators remain largely unknown. In the case of *Accounts of Invention*, however, the name of its illustrator, Shōkōsai Chōei, appears on the work's frontispiece alongside that of its compiler Azumai Ketsuzen. This reflects the special import of illustrations in this work. Other than *Accounts of Invention*, the only other extant work by Shōkōsai Chōei is the triptych print, *The Bustling Higashiori Iron Bridge in Naniwa*. This work gives some insight into the themes of interest to Shōkōsai. The Higashiori Iron Bridge (Kōrai bashi) depicted in the print was, when it was constructed in 1870, the first iron bridge in Osaka and only the second one in Japan. Shōkōsai's triptych is filled with depictions of the brand-new material trappings of urban life in the early Meiji period and suggests a fascination, a delight even, with creating a visual record of the transformation of the urban landscape. The bridge is adorned with tall gas-powered lamps and is traversed by pedestrians holding western-style umbrellas. The tall chimneystacks in the background are suggestive of the new steam-powered machinery being adopted in factories, while in the foreground a steam-powered boat moves along the river. It is unlikely that the scene, as represented by Shōkōsai, existed at the time. In all probability, Shōkōsai was creating an imagined landscape that amalgamated many of the various technologies he had seen, heard, or read about in various sources.

The images Shōkōsai contributed to *Accounts of Invention* are of three types. First are those that can be traced back to W.A.P. Martin's *An Introduction to Science*. Second, there are those, such as the ones shown in Figure 1 to illustrate George Stephenson's life, that are original illustrations by Shōkōsai. Finally, there are the images taken from *The Steam Engine*, the book translated at the Numazu Military Academy. These required more modification than those taken from *An Introduction to Science*. It was not only the technical vocabulary produced at the Numazu Military Academy that had to be vernacularized. Images, too, needed to fit the conventions of vernacular literature to ensure its comprehensibility and usefulness for its new audience.

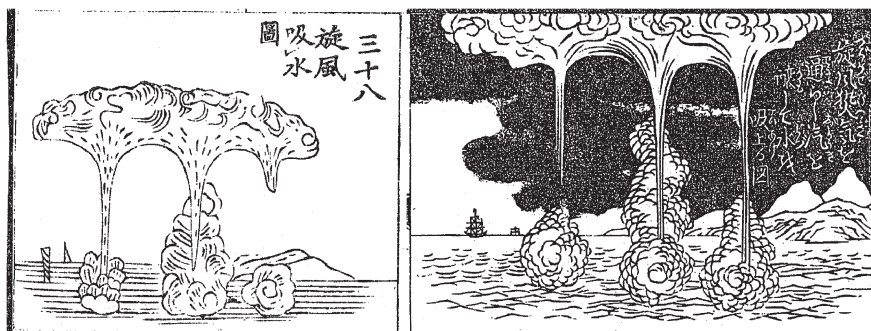


Figure 2. Illustrations showing evaporation of water from the sea into the atmosphere from *An Introduction to Science* (left) and *Accounts of Invention* (right). Courtesy of The National Diet Library.

Images from W.A.P. Martin's work and from other Chinese science books made their way, in modified form, into many popular science textbooks of the early Meiji period. Many of these images recur because they provided a visual template for describing key theoretical concepts. One that tends to reappear, and which can be found in *Accounts of Invention*, explains one segment of the meteorological cycle (Figure 2). That the illustration in *An Introduction to Science* is the basis for the one appearing in *Accounts of Invention* can hardly be disputed. Even the two ships to the right are reproduced, as well as the islands in the background to the left, although Shōkōsai's illustrations are more detailed and stylized.

The majority of the illustrations that appear in *Accounts of Invention* are original works by Shōkōsai or ones that he subjected to considerable modification. In some cases, these images are products of Shōkōsai's attempts to provide his readers with scenes that are described, but not illustrated, in the work's sources. These are often tinged with humor and are suggestive of the imagery that tends to appear in the vernacular *gesaku* literary form of light fiction. Take, for example, the illustration that accompanies the following text describing the method for determining the unit of horsepower. This text is from *The Steam Engine*, which is copied almost verbatim in *Accounts of Invention*:

In the British capital of London, Watt (personal name) determined this method by measuring the work of a strong, healthy horse over one minute and comparing it with the work of a machine over one minute. At this time, he decided that one horsepower was the power [required] to lift a mass of 33,000 kin (British unit of mass) a height of one fuuto (British unit of length) in one minute. This is called the Watt horsepower.<sup>23</sup>

<sup>23</sup> Anon., *Jōki Kikaisho*, op. cit., vol. 4, p. 15.

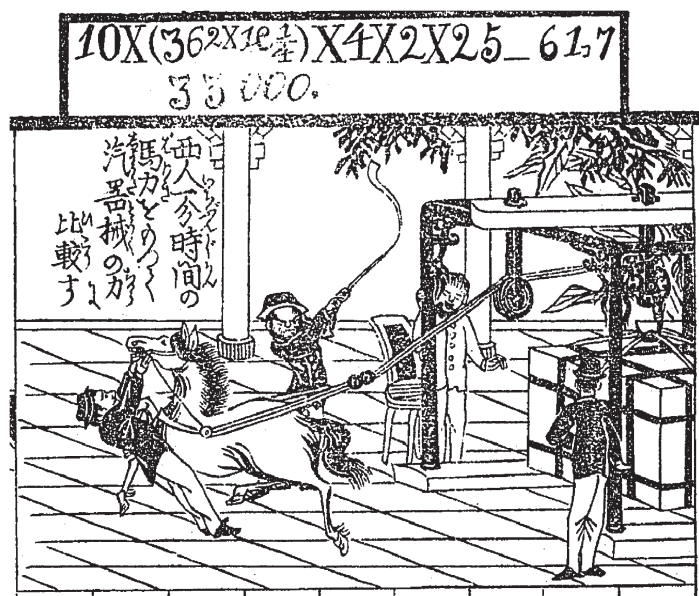


Figure 3. Illustration in *Accounts of Invention* that accompanies text describing how James Watt determined the value of one horsepower.

$$\frac{10 \times \left( 36^2 \times R \frac{1}{4} \right) \times 4 \times 2 \times 25}{33,000} = 61.7$$

The text and equation above appear without an image in *The Steam Engine*, and although Azumai renders the text with only minor modifications, which will be discussed later, an illustration (Figure 3) is added. The illustration shows four men in what the reader is expected to interpret as typically western attire, and is captioned “westerners comparing the power of a machine to the power of a horse over one minute.” Above the scene is an equation that at first glance appears undecipherable, but which is in fact a botched attempt to render the equation that that appears in *The Steam Engine* (this equation does not appear outside of the illustration in *Accounts of Invention*). The illegibility of the equation would not have undermined the explanations provided by Azumai. As we will see, *daiku* had their own metrics and system of calculation, so the equation itself was of little value and was thus almost entirely decorative.

Some of the seemingly original illustrations by Shōkōsai are undoubtedly influenced by visual tropes in circulation at the time, or inspired by images he encountered in western texts. Although *The Lives of the Engineers* was not translated into Japanese, this and other works by Smiles, circulated in Japan at the time owing to Smiles’ reputation. A bibliophile merchant would surely have no difficulty obtaining a copy. Among the several illustrations that share considerable elements from *The Lives of the Engineers*, is the one shown in Figure 4, which illustrates, according to its caption, “a steam locomotive emerging from a tunnel onto an elevated track.”

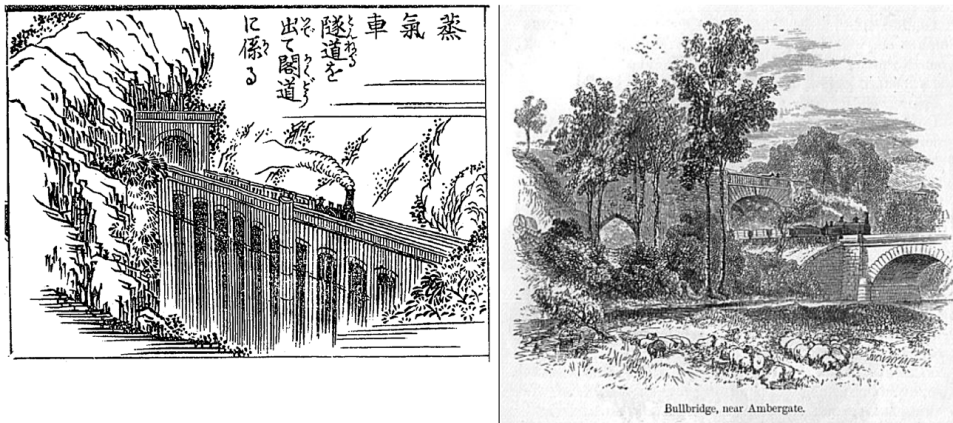


Figure 4. Illustrations of a steam locomotive emerging from a tunnel onto an elevated track appear in in *Accounts of Invention* (left) and *Lives of the Engineers* (right). Courtesy of the National Diet Library.

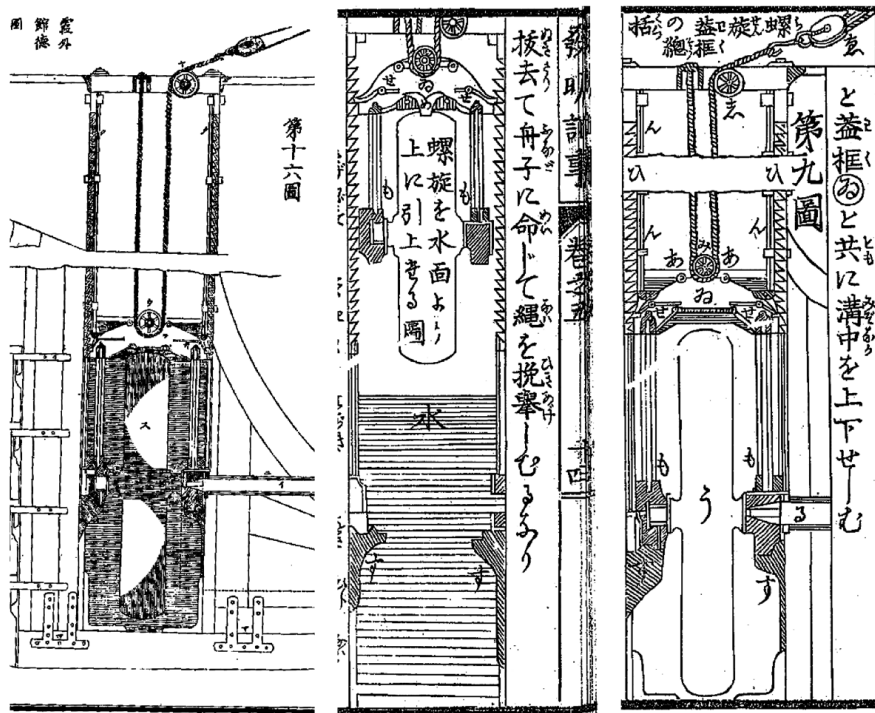


Figure 5. Images from *The Steam Engine* (left) and *Accounts of Invention* (center and right) showing the operation of the screw propulsion mechanism of a steam-powered ship. The image in the center has been added by the illustrator to demonstrate how the screw is lifted out of the water. Courtesy of the National Diet Library.

The third type of illustration added were those adapted from *The Steam Engine*. In *The Steam Engine*, the images were presented in an appendix separately from the text, and with no captions or explanations. To adapt them for his new readership, Azumai ensured that these were placed within the text that made direct reference to the machinery

in the drawings. To aid comprehensibility, Shōkōsai atomized the images to ‘zoom in’ to specific parts of the machinery so that the reader could better comprehend their operation. Then, he supplemented these illustrations by showing changes in the position of elements of the machinery depending on its operation and appended captions within the images to provide further explanation. For example, the illustration at the center of Figure 5, which shows the operation of the screw propulsion mechanism on a steam-powered ship, has been added to show the position of the screw when it is elevated out of the water, and a caption has been added to indicate this. In this way, Azumai and Shōkōsai transfer the explicatory burden onto the image from the text, by having them interact productively.

### 5. Terminology: From Technical to the Vernacular

Stylistically, *The Steam Engine* would not have presented much of a challenge to Azumai’s readers, but its terminology would have presented a considerable barrier to comprehension. As one of the first large-scale translations of a work on the steam engine in Japanese, it necessarily contained a considerable number of technical neologisms. As was the custom for more scholarly translations in the late-Edo and early-Meiji periods, these neologisms were glossed in the language of the original work. In this case, *The Steam Engine* was glossed in both Dutch (the likely language of the source), and English, reflecting the growing importance of English as a language of technology at the time.

To enable to reader to comprehend these neologisms *The Steam Engine* is full of in-text annotations, and each chapter contains a glossary that explains the pronunciations and meanings of these new, unfamiliar terms. Thus, the reader needed to flip back and forth from text to glossary to decipher the meaning of each passage of text. Azumai’s text avoided this inconvenience. Indeed, the ‘readability’ (specifically, the ‘read aloud’-ability) of *Accounts of Invention* is one reason that it appealed to the Ministry of Education educators who recommended its use in elementary schools.<sup>24</sup> To make the work accessible Azumai modified the terminology to make their definitions intuitive. He was less concerned about how well the technical terminology reflected the meaning of the original Dutch text than about what his readers would find comprehensible. The following text—Azumai’s version of the text in *The Steam Engine* describing Watt’s calculation of horsepower—illustrates his strategy:

In the British capital of London, a person by the name of Watt determined this method by measuring the work of a strong, healthy horse over one minute and comparing it with the work of a machine over one minute (one sixtieth of half

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<sup>24</sup> Pupils were expected to read out excerpts of the text during lessons. This would be followed by discussion of the meaning of the text. Nihon Gakushiin eds. *Meiji-zen Nihon Butsuri Kagakushi*, p. 225.

of a Japanese hour).<sup>25</sup> At this time, he decided that one horsepower was the power to lift something weighing 3,960 *kanme* a height of about one *shaku* in one minute. This is the actual measurement of horsepower.

Immediately, one can notice that there is less glossing in this version than the one that appears in *The Steam Engine* (see section 4, ‘Illustrating *Accounts of Invention*’, above). This is achieved by converting metrics to those used by artisans. The (British) imperial units of pounds and feet, are presented as *kanme* and *shaku*, respectively.<sup>26</sup> This type of conversion was typical in the early Meiji period. As Gregory Clancey has shown, building plans drawn by foreigners in treaty ports were often redrawn by *daiku* with mensuration in *shaku*.<sup>27</sup> The only unit that is explained with glossing is that of time (minute). This was necessary because until 1871, the year before the publication of this book the variable hours system had been used in Japan, and the newly introduced fixed hours system did not enjoy widespread currency.<sup>28</sup>

For other neologisms, Azumai decided to gloss these in the vernacular. This was not simply a matter of choosing Japanese ‘equivalents’—in many cases these did not exist—but of finding a vernacular term that would act as a bridge to understanding. Azumai kept the kanji compounds as they appeared in *The Steam Engine* but glossed them with vernacular terms that already existed. Therefore, whereas the Sino-Japanese term *kikan* was used to designate the (steam) engine in the more technical texts, this was glossed with the reading *karakuri* in *Accounts of Invention*. The term *karakuri* had a much wider semantic field, as it could be used to describe any mechanized device, regardless of how it was powered. Nevertheless, it had currency as a term to describe a machine designed to fulfill a specific function. Similarly, instead of the cryptic ‘*undō*’ to describe the concept of work, Azumai explained the term using the much more evocative *hataraki chikara* ‘the power [required to carry out] work.’ A few of the many instances of vernacular glossing in *Accounts of Invention* can be seen in Table 1:

Azumai also used phonetic glossing educationally, taking advantage of its versatility to introduce his readership to the more technical reading of this terminology. For example, after initially rendering ‘engine’ as *karakuri*, later in the text he switches the glossing to *kikan*—the same term used in *The Steam Engine*. Similarly, while ‘work’ is

<sup>25</sup> This glossing actually appears earlier in the text but is included here for illustrative purposes.

<sup>26</sup> These were metrics specific to the *daiku* profession. Although other professions, such as tatami makers used *shaku* to denote length, the actual length of a *shaku* would vary between professions. Mark Ravina, ‘Japanese State Making in a Global Context,’ in Richard Boyd and Tak-Wing Ngo (eds) *State Making in Asia* (London, Routledge, 2006).

<sup>27</sup> Clancey, *Earthquake Nation*, op.cit., p. 35.

<sup>28</sup> Implications of the shift from the variable hours system to the fixed hours system on time-keeping practices in modern Japan are discussed in Hashimoto Takehiko and Kuriyama Shigehisa, eds., *Chikoku no Tanjō: Kindai Nihon ni okeru Jikan Ishiki no Keisei* (Tokyo: Sangensha, 2001).

Table 1. Some examples of terms glossed in Sino–Japanese in *The Steam Engine* that were given a vernacular glossing in *Accounts of Invention*

Term (translation)	<i>The Steam Engine</i> Numazu Military Academy	<i>Accounts of Invention</i> Azumai Ketsuzen
機関 (engine)	<i>kikan</i>	<i>karakuri</i>
運動 (work)	<i>undō</i>	<i>hataraki chikara</i>
水銀 (mercury)	<i>suigin</i>	<i>mizukane</i>
紡績機械 (textile spinning machine)	<i>bōseki kikai</i>	<i>ito tsumugi kikai</i>

first glossed as *hataraki chikara*, it becomes *undō* later in the work. In a sense then, Azumai aimed at a similar effect as the glossaries provided in the Numazu Military Academy publication—that of educating his readership about the ‘correct’ reading and meaning of the term. Where he differs in his strategy; Azumai aimed to accomplish this in a less intrusive way that met the expectations of the genres to which his readers were accustomed.

## 6. Conclusion

The historian Maeda Ai has described the early Meiji period as an “unsettled marketplace of communicative possibilities.”<sup>29</sup> By this he referred to the new means of expression that emerged from the simultaneous emergence of new information, new formats, and new imagined futures. Maeda was speaking of literary possibilities, but as this paper has shown, science too was opened up to new modes of communication during this period. As science emerged from the confines of the scholarly class into the less predictable realm of the public sphere, readers imbued it with new meanings. For Azumai, science represented an opportunity for technically-skilled manual workers to forge a new, more esteemed, role for themselves. Azumai Ketsuzen’s *Accounts of Invention* is but one manifestation of this afterlife of scholarly books in the public sphere. There are others. Indeed, each popular science book of the early Meiji period will tell its own story of how new readers encountered and perceived the value of science. These books are thus rich repositories of information about the relationship between science and society in early Meiji Japan and deserve wider study.

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<sup>29</sup> Maeda Ai, *Text and the City: Essays on Japanese Modernity* (Durham: Duke University Press, 2004), p. 229.