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An Artificial Heart

Kosakai Fuboku

Introduction and Translation by Max Zimmerman

On the fifth anniversary of the establishment of the Kyoko Selden Memorial Translation Prize through the generosity of her colleagues, students, and friends, the Department of Asian Studies at Cornell University is pleased to announce the winners of the 2018 Prize.

In the category of "Unpublished Translator," the prize has been awarded to Max Zimmerman, of Nikkei America, for translating the short story, "An Artificial Heart" (Jinkō Shinzō, 1926) by Kosakai Fuboku. Zimmerman's text makes available in English for the first time the work by an acclaimed pioneer of science fiction in Japan. Zimmerman's meticulous and concise prose well captures the style of this breakthrough piece by Kosakai, a renowned researcher in physiology and serology, whose fictional account of the construction of an artificial heart anticipated the first successful heart transplant by almost sixty years.

This is the second of three prize-winning translations that will appear in the Asia-Pacific Journal

Kosakai Mitsuji (1890 – 1929) was a doctor, translator, and forgotten pioneer of Japanese science fiction under the name Fuboku. He grew up in a small town in modern day Aichi Prefecture and studied medicine at Tokyo Imperial University. He specialized in physiology and serology, becoming a world-renowned researcher in both fields. His achievements earned him trips to London, Paris, and the U.S. where he met early science fiction authors Conan Doyle and Edgar Allan Poe, who were major influences on his work.[1] Kosakai, however, frequently suffered from hemoptysis during his travels before eventually returning to Japan for good. The illness continued to impact his health, and he was forced to retire around 1921, which led to the start of his relatively brief career as an author. He would go on to write scientific essays as well as detective stories that helped popularize science fiction in Japan as a conduit for exploring new ideas and technologies, unlike the more speculative stories of many Western authors. But while Kosakai's works in the detective tradition fit a role well-defined by the genre, *An Artificial Heart* followed an entirely unexplored avenue of Japanese science fiction. Tatsumi Takatsuki, a professor of literature at Keio University, has called it "the first hardcore science fiction in Japan."[2] It has also been described as the first "pure science fiction" story in Japan.[3]

Kosakai Fuboku (Credit: Kanie Digital Museum)

Published in *Taishu Bungei* in 1926, *An Artificial Heart* is radical for its scientific realism, anticipating the eponymous device nearly sixty years before its first successful implant. The main character, a doctor modeled after Kosakai himself, believes he can create a utopia by inventing an artificial heart. He theorizes that it will extinguish the fear of disease – a preoccupation likely born from the terror of his own untreatable condition – since one could theoretically become immortal. He even proposes an artificial lung that would eliminate the need for food through nitrogen fixation, solving another of humanity's perennial concerns. The doctor completes the device only to realize that he has made a grave error. The device works, but only at the cost of what makes us human: emotion. Kosakai builds up the facade of scientific theory, only to tear it down with bitter experience.

An Artificial Heart is significant as one of Japan's first science fiction stories in the Western sense: "scientific fact mixed with prophetic vision," as Hugo Gernsback described the genre in 1926.[4] Tatsumi labeled the work "hardcore" because it uses contemporary knowledge and technologies of the time as tools for envisioning the near future, like the science fiction of America and Europe, in contrast to softer detective stories that lack such forward-looking ideas. The mercury heart and amoeba described in Kosakai's piece are actually experiment based; the James-Lange theory of emotion was essential to the development of modern psychology. Kosakai's conclusions are often wrong -- an artificial heart implant does not suppress emotion -- but they were nonetheless plausible, based on leading theories at the time. Even the most outlandish ideas, such as the potential for an artificial lung to end hunger, are loosely based on the knowledge of the day, however incomplete. This leap gives the author a format heretofore rarely seen in Japanese literature, through which he delves deeper into the ambivalences of science, technology, and modern thought as they spread throughout society. Though Kosakai is quite optimistic about science in his early writings, he seems to have realized later in life that it is chained by limitations, ethical quandaries, and unintended consequences. "Even though we ought to pay our utmost attention to the advancement of science," he wrote, "we should never think that science is omnipotent, or that science will allow us to achieve all our desires."[5] *An Artificial Heart* is a prophetic warning to readers against such arrogance.

The piece is also stylistically significant as an exemplar of how translation is, in author Mizumura Minae's words, "the very condition of modern Japanese literature."[6] The translator is confronted with the challenge of rendering a Japanese text whose words, format, and ideas have, in a sense, been adapted from European languages back into English. The story is told from the perspective of a journalist, a profession of western import, and much of the conversation in the first half of the story is medical in nature, with terms that only recently entered the Japanese lexicon from Europe, mainly Germany. It is easy to forget that the technical language with which Kosakai describes the mercury heart and other scientific phenomena is one with a relatively short history in Japan. Even the quotational format of the story would be impossible without the *genbun-itchi* movement, which married written Japanese to the colloquial tongue of Tokyo based on European novels.[7] Japanese authors produced these linguistic innovations so that scientific texts and Western literature could be properly translated and emulated. *An Artificial Heart* thus marks Japan's entrance into a once-exclusively European discourse, with Kosakai harnessing new techniques to craft a piece that would have been unthinkable in both subject and style less than a century earlier. “Japan has just emerged from the era of translation,” he wrote in 1929, the year of his death, “and whether we’ll reach a golden age [of science fiction] or not depends on whether a good writer appears.”[8] His successors -- authors as well as film directors, manga artists, and animators -- would live up to the challenge, transforming Japanese science fiction into the internationally renowned art form it is today.

An Artificial Heart

Kosakai Fuboku

Translated by Max Zimmerman

I

I initially conceived of the idea to invent an artificial heart in my first year of medical school, when I learned about the artificial amoeba and artificial heart during a general physiology lecture…

This is what the physiologist Doctor A recounted to me. At great cost, he attempted to invent an artificial heart -- that is, one made by human hands -- to replace the natural heart in an effort to save humanity from all disease, prolong life, and perhaps even revive the dead. He eventually completed his goal after overcoming a serious illness, only to mysteriously abandon his groundbreaking research like a worn pair of sandals after his wife’s death. I inquired several times about his reasoning, but he never spoke, only grinning in reply. During a visit to his office one day, however, I happened to mention that the inventor of artificial nitrogen fixation, Fritz Haber, would soon arrive in Japan. At this, despite his past silence, he cheerfully offered to tell me how he invented the artificial heart. I should inform the reader, by the way, that I am an arts and science reporter for S News.

…The artificial amoeba and artificial heart are made of inorganic materials that imitate the movements of an amoeba and heart. Both were devised as evidence that biological behavior is not extraordinary or miraculous but entirely explainable in mechanistic terms. Perhaps you have never seen an amoeba under a microscope, but it is a single cell organism composed of a semifluid protoplasm and nucleus. The protoplasm can take many forms, absorb nutrients, and change position. Observers are often reminded of a slug creeping along a fence or the slowly growing nose of a goblin when they watch it move. Potassium dichromate crystals gradually dissolve when steeped in a glass petri dish filled with twenty percent nitric acid solution and a globule of mercury. When the dissolved crystal touches the mercury in the center, the drop will start to move like an organism and appear as if a silver spider is wiggling its legs in and out. The mercury moves like an amoeba when carefully observed, otherwise known as the artificial amoeba.

Next is the artificial heart. Needless to say, the heart rhythmically alternates between two actions, diastole and systole, and mercury is able to precisely imitate this movement as well. First, put a ten percent nitric acid solution into a watch-glass with a pinch of potassium dichromate and a globule of mercury in the center. If the mercury’s surface is lightly touched with an iron needle, it will promptly start to move like a frog’s heart, getting bigger and smaller in a rhythmic fashion comparable to diastolic and systolic action.

But how is it that this globule moves like an organism? The answer is a physical property called surface tension, which manifests when a foreign object touches the surface of a liquid. Within the liquid, particles are acted upon by equal forces of attraction all around it. On the surface, however, the particles on the inside are pulled by the liquid while those on the outside are pulled by the foreign substance. Oil expands on top of water when spilled because it has a weaker surface tension, and mercury takes a spherical shape when dropped into water because its surface tension is stronger. Now suppose that you strengthen or weaken the tension where the water touches the mercury; the weaker section will shrink less compared to the stronger section, thus warping the mercury. If we relate this to our artificial amoeba, the surface tension of the mercury is weakened when the potassium dichromate touches the mercury in the nitric acid solution, reacting to create a substance called mercury chromate. Although the drop changes shape as a result, the mercury regains its original surface tension since the mercury chromate easily dissolves in nitric acid. The mercury naturally returns to its original shape as well, making it appear to the observer as though the globule has moved. The potassium dichromate and mercury will touch again the next moment and repeat this cycle of reaction and dissolution, so that the mercury continuously moves like an amoeba.

In the case of the artificial heart, contact electricity is generated when the iron pin touches the mercury due to the presence of the nitric acid solution. The electricity is then transmitted to the metal and liquid, producing positive hydrogen ions through electrolysis that are attracted to the negatively charged particles on the mercury's surface. This strengthens the mercury's surface tension, causing it to contract. The contraction then separates the mercury from the iron pin and returns the globule to its original size, at which point the drop touches the pin, generates electricity and shrinks again. The motion repeats rhythmically such that it appears to be moving like a heart.

II

I'm certain my lengthy explanation of these matters seems dull, but I have discussed them in such detail because they are the source of my inspiration. Of course, the artificial heart that I invented was fundamentally different from the one just described. As part of that gradual discussion in medical school, we students were repeatedly lectured that all biological phenomena, no matter how complex, could be explained in purely mechanical terms, just like the artificial amoeba or artificial heart. It was drilled into my head that the forces of physics and chemistry could satisfactorily explain all life without presupposing the existence of some mysterious power. Looking back on it now, even if mercury behaves like an amoeba, it is ultimately only mercury and not an amoeba. Nor could it ever be a heart. But I was obstinate in my youth and became a fanatical follower of this positivistic philosophy, this so-called mechanism

If mechanism is the theory that all biological phenomena can be explained in purely mechanical terms, then 'vitalism' is the idea that biological phenomena can be understood only through some supernatural force that the physical sciences cannot measure. These two views have sown the seeds of academic controversy for centuries, exchanging victories and defeats in a debate that rages even to this day.

To give a tentative history, it scarcely needs to be said that primitive humans believed their lives were governed by some mystical power. These were people unable to think deeply about objects even if they could sense them, so it was only natural they believed that spiritual forces dominated their lives. As human knowledge advanced, however, people began to debate life and thought itself in particular. I will give an example from the West since the development of scientific thought in Japan is extremely recent, and it is difficult to know the thinking of bygone eras. The Greeks, roughly two thousand and seven or eight hundred years ago, were quite serious in their meditations on life. A group of people emerged at this time known as natural philosophers, who contemplated the creation of the universe and humanity, relating the formation of all things to the arrangement of four basic elements -- earth, water, air, and fire -- and thus establishing the theory of mechanism.

Later in Greece, however, a new group of philosophers led by Plato and Aristotle emerged. As a result of their thorough inquiries into humanity, they concluded that mental phenomena were unexplainable in mechanistic terms since mind was separate from body, and body was subordinate to mind. Vitalism saw light once more and eventually took on religious nuance with the rise of Christianity, swaying people's minds for over a millennium.

The sixteenth century ushered in the Renaissance and the advent of early scientists. Mechanism would carry the day again as the field of human anatomy progressed. At the same time, more radical disciplines known as iatrophysics and iatrochemistry tried to explain all biological phenomena in physical and chemical terms.

In the eighteenth century, however, the prominent biologist Albrecht von Haller championed the old vitalism once more, noting that certain phenomena were particular to living beings and absent in inorganic matter. A contemporary cast of leading philosophers also advocated for vitalism, and the theory reached the height of its prosperity in the first half of the nineteenth century.

But startling leaps in the natural sciences during the second half of that century -- like Darwin's theory of evolution and cell theory -- resurrected and refined mechanistic thought, which dominates to this day. Even so, some prestigious biologists like Emil du Bois-Reymond, who passed away recently, have still leaned toward vitalism.

And so the competing prominence of vitalism and mechanism ebbed and flowed. Even individual philosophers were occasionally convinced to switch allegiances. I, like my colleagues, was a fervent proponent of mechanism from my college days up until the completion of the artificial heart, when I abandoned both my beliefs and my research upon witnessing the results of my invention.

III

Now, as a firm believer in the mechanist theory put forward in those lectures on the artificial amoeba and artificial heart, I wondered whether it was possible to artificially construct a human or animal heart to replace the original after demonstrating these two phenomena in my second year. I learned in physiology class that the heart was nothing more than a kind of pump and that no other organ was as important, despite its simple role. A person cannot be considered dead as long as the heart is still pumping, even if they lose consciousness. I then thought that, perhaps, if you could transplant an artificial heart when the natural one stops beating and then apply an outside energy source to create the pumping action, sending blood throughout the body, the deceased could be revived. Theoretically, they might attain everlasting life in some circumstances. The idea behind the artificial heart is straightforward: Deoxygenated blood from the venae cavae enters the pump and is sent to the aorta through a valve. Since an electric motor is all that is required to move the valve, and electricity will never run dry as long as geomagnetism exists, such a person could live until the Earth itself became extinct. Such were the fantasies I dreamed up.

Above all, it was the dizzying array of cardiological theories that made me long for an artificial heart. Details may be the essence of academia, but I felt it quiet onerous to be lectured about so many theories in my college days. Although listening to academic debate is highly interesting on occasion, it is unbearable once several arguments pile up. Since disciplines like physiology can be considered an assembly of knowledge, I believed that reducing those theories would not only help humankind master physiology but might also simplify life itself.

You may already be aware, but there are two explanations for the origin of the heartbeat. The first says that stimulation of the heart muscles produces the beat, while the other says that it is stimulation of nerves inside the muscle. There is little doubt that the beat comes from within the heart itself since it pumps as usual even when removed from the body under the right conditions, but it is still unclear whether that power comes from the muscles or the nerves within them. Throngs of researchers have studied a wide assortment of animal hearts to determine which theory is correct -- some have even sacrificed their precious lives to this work -- but a satisfactory explanation has not yet surfaced. Although one scholar paraded a proof of the neural theory based on his study of rare animal hearts like that of the horseshoe crab, it has yet to gain acceptance from this often narrow-minded community of scholars.

That's when it came to me. Regardless of which theory is correct, these tiresome debates exist only because the heart itself exists. The dawn of an artificial heart would turn both arguments to dust. Since electricity powers the motor, all existing theories would be consolidated into a single "electrical theory." There would also be no room for anybody to spew competing theories. How gratifying it would be! You could call it the rashness of youth, but I was lost in such shallow thoughts. After careful consideration, however, if God created our bodies, then the uproar over muscles or nerves may appear even more comical to His eyes than mine, which fantasized about an electrical theory of the heart. In any case, I could no longer bear the burden of cramming various theories into my head, wanting only to finish inventing an artificial heart as soon as possible after graduating from university.

IV

During clinical instruction in my third year, I became acutely aware of modern medicine's powerlessness and realized that we were learning no more than an accumulation of theories far removed from practice. A well-defined medical theory should lead to a clear treatment, but if it is disputed or vague, the treatment will naturally be half-baked as well. Of the vast multitude of diseases, the number effectively treated with medication can be counted on one hand. Drugs are simply administered for so-called peace of mind, while the patient waits on the body to heal itself. When the patient's condition turns critical, as you know, they receive a camphor injection irrespective of their affliction. One hundred thousand or so die each year in Japan alone, and the majority is sent off with camphor as a parting gift. It goes without saying that camphor is a cardiac stimulant, a drug that improves heart function. The ultimate medicine, in other words, is one that strengthens the heart. Regardless of whether the disease is acute or chronic, the patient can keep living as long as a constant power source preserves heart function while the condition either subsides or remains. Horrific illnesses like the plague and cholera ultimately kill by attacking the heart. Rather than pour energy into studying the bacteria that give rise to these diseases, medical scientists should make the heart as strong as steel -- no, they should take the next step and create an artificial heart made of steel. It would eliminate the need to research each disease and add to the medical literature. There would be no reason to fear disease if only the artificial heart was completed. Thinking about the accomplishments of men like Louis Pasteur, Robert Koch, and Paul Ehrlich not only filled me with gratitude but also regret that these geniuses did not apply their gifts to the invention of an artificial heart. Numerous people have left their mark on medical history, but I am certain that an artificial heart would already exist if they had fully applied themselves to its invention, and that mankind would have built a utopia long ago. The greatest fault in the development of human civilization is that people make things unnecessarily complicated. We appear to enjoy wandering in agony through a maze of our own design. People naturally lose sight of the forest for the trees as matters become more complex. So, like Rousseau, I called for a return to nature. But rather than revert to a natural state, I believe Rousseau is telling us to revisit the roots and forget the leaves. I was eager to invent an artificial heart as quickly as possible and return to the roots of medicine.

The complexity of advanced civilization, along with medicine's obsession over trivial detail, have bred a dreaded illness that needs no introduction: pulmonary tuberculosis. Mycobacterium tuberculosis has difficulty growing on its own and only proliferates in humans when the conditions are ripe. You could view pulmonary tuberculosis as a kind of divine irony, since it so happens that the development of civilization basically fostered an ideal environment for the disease. As proof, modern medicine has no power over tuberculosis and is far from having any influence, watching helplessly from the sidelines while the disease rages on. Such an illness may be precious fertile ground for doctors, but it is nothing but a plague for patients.

Anyone who has tried their hand at medicine has thought about a cure for tuberculosis, including myself. I realized, however, that the invention of an artificial heart would instantly provide a solution. I said earlier that an artificial heart would be a panacea, and pulmonary tuberculosis is obviously no exception -- although the lungs have a special connection with the artificial heart that I shall explain next.

Needless to say, the main function of the lungs is to exchange gas in the blood. Venous blood that has circulated throughout the body is sent from the heart to the lungs, where the carbon dioxide is removed. Oxygen taken from the air then forms arterial blood that is returned to the heart and circulated throughout the body. The lungs would soon become obsolete if assisted by a device that absorbs and emits carbon dioxide from the blood while simultaneously oxygenating it. The patient would then be pain-free no matter how severe the infection. The issue of tuberculosis would thus be solved in an instant. This so-called artificial lung would be attached to the artificial heart, an extremely simple surgery. You could say it kills two birds with one stone.

I expect that liberating the lungs from their job of swapping gases will produce an unusual phenomenon. People may be able to significantly reduce their food intake should the lungs no longer need to perform their function. The artificial heart would therefore not only save humanity from the suffering of disease but also from hunger in some cases. I fantasized about all of humanity living off of nothing but the mist, like mountain hermits.

Perhaps other scholars have given thought to the invention of an artificial heart, but I believe I am the first to suppose that humans could curtail their food intake by freeing the lungs from their role, so I decided to mention it here.

V

I had long been suspicious about the abundance of nitrogen in the atmosphere. Although nitrogen actually makes up eighty percent of the air, it is thought to be of no benefit to human life, a dangerous proposition for teleologists. But I was certain that nitrogen, like oxygen, serves some purpose for human existence. No matter how I racked my brain, I found it absurd that every bit of oxygen is needed for human life but that nitrogen, at quadruple the level of oxygen, was uselessly flowing in and out of our bodies. What is absurd, I thought, is human ignorance toward nitrogen's value.

As you are no doubt aware, the chemical building block of the body's most vital structures is protein, which is formed from compounds that center around nitrogen. Humans, therefore, cannot live for even a single day without nitrogen compounds. Although we generally ingest these compounds through food, I once believed that God committed a grave blunder by not allowing humans to harness atmospheric nitrogen, despite its indispensable nature to our bodies. I soon reached the conclusion, however, that God made no such error; He did give humans the ability to utilize free nitrogen, but we had failed to realize it. Perhaps the word God does not appeal to you, but I believe that it is more comprehensible than Creator or something like that, so please bear with me.

So, on which organ did God bestow the ability to harness free nitrogen? The lungs, naturally, since they are an endlessly revolving door of the stuff. Although the skin may handle some nitrogen, just as it uses oxygen in a process known as cutaneous respiration, I thought that the lungs should mainly process nitrogen just as they do oxygen.

Did you know that certain bacteria in the ground are able to process nitrogen? They have the power to convert free nitrogen into other compounds, in other words. Isn't it unlikely that the cells of humans, the most advanced animals, would be deprived of this miraculous power granted to the lowest organisms like bacteria? Thus I hypothesized that our lung cells were also given the ability to fixate nitrogen like soil bacteria.

I am sure that the alveoli are so busy with their vital work of gas exchange that there is naturally no time for nitrogen fixation, which is unnecessary anyway since these essential compounds to our survival are supplied from food. If a state of hunger were induced through fasting, however, nitrogen fixation in the lungs would surely flourish as they try to take charge of the body's nutrition in place of the digestive tract. This must be the reason humans can live for several weeks on nothing but water. The most plausible explanation for why those who fast can subsist so long is that they starve until forced into bed rest, which allows the nitrogen fixation process to flourish since less gas exchange is needed in repose. The deterioration of nitrogen fixation activity from pulmonary tuberculosis is probably the reason why its victims become so emaciated that they require protein supplements.

The lungs would certainly be able to devote all their energy to nitrogen fixation should they no longer have to exchange gases. If the body receives all of its nourishment through nitrogen fixation, would it not eliminate the need to ingest protein as food? Some have calculated that people require two grams of protein daily for every kilogram they weigh. I suspect that much nutrient can be easily created if each lung cell is devoted to nitrogen fixation. Humans could thus greatly curtail their food intake if an artificial lung, attached to an artificial heart, takes on the role of gas exchange. With further research, humanity might even be able to live entirely without food one day. So I dreamed, working to graduate university even a day earlier to purse the invention of an artificial heart.

VI

I found work in a medical laboratory after graduation and commenced my research with permission from the director. My wife and I -- circumstance had me marry while I was still a student -- were allowed to sleep in a university classroom to avoid time lost to our commute. My wife also took great interest in my research and worked as my assistant. We toiled from dawn till dusk. Although we were surrounded by the city, the vast campus' silent nights were lonesome; light from the gas lamps bounced off the high ceilings. But we were filled with immeasurable happiness whenever we smiled at each other, our eyes glistening with hope, surrounded by laboratory animals. I would often stay up all night when an experiment failed to go as planned, working in a foul mood. How hard my wife tried to lift my spirits in those moments as she kept vigil with me! It was her encouragement that rescued me from nearly sinking into the depths of despair as I failed time and again. I probably would have been unable to complete the artificial heart without her. She died young, however, and is no longer with us. It is because of her death that I was compelled to abandon the invention for which we had labored years to complete. What a strange fate. My chest flutters even now when I am reminded of those painful, happy moments.

Oh, excuse me, I seem to have gone off on a tangent. Now, once I began working on the artificial heart, I realized that it was not as simple as I had imagined in my student days. I reasoned that even if someone had conceived of inventing an artificial heart, they probably left no written record because they could not turn their idea into reality.

Rather than experiment with the lab's ready abundance of frogs, which were too small to test an artificial heart, I chose to experiment with rabbits. Oh, how many did I send to their graves? Although each was under anesthesia, I am filled with guilt in retrospect, regardless of my intention to save humanity. The world often mistakes scientists for heartless people; indeed, some are brutal enough to find fascination in the killing of laboratory animals, but we are not all necessarily that way. I actually thought of abandoning several trials because I could no longer bear the rabbits' suffering.

The procedure begins with fastening the rabbit belly to a special table, applying anesthetic, and opening the cardiac region of the rib cage. Then the pericardium is cut, and the pump is installed in place of the heart. But the surgery is easier said than done. I initially cut out the heart to replace it with the pump but failed to do so because of intense hemorrhaging. So I decided to leave the heart in place and attach fairly long tubes between the pump and main arteries.

I originally decided to put my plan for an artificial lung aside and research only the artificial heart, but realized that it would be easier to devise them together, since joining the pumps to the pulmonary arteries and veins alone involved much effort. Since the heart has four chambers, an artificial heart -- the pump -- must naturally have four as well. Including an artificial lung, however, makes it much simpler: Only one chamber is needed, with a valve separating the upper and lower sections.

At first, I made the pump out of thick glass walls and the valve out of a firm rubber to observe blood flow. I later changed both to steel, which proved to be more suitable to an artificial heart than glass.

Before turning to the pump's structure, I will explain the theory of the artificial heart first. It is actually quite simple. All that needs to be done is remove carbon dioxide from venous blood delivered by the venae cavae and then send oxygenated blood to the aorta, which only requires connection to an oxygen delivery line. Removing the carbon dioxide, however, was rather troublesome. The tricky part is not the carbon dioxide removal itself but instantly doing so in large quantities. Although some gas can be extracted by strong negative pressure generated with a device attached to the chamber where venous blood enters, total removal is highly problematic due to quick circulation. Then, after much consideration, I thought it possible to break through this barrier by reducing the blood's carbon dioxide content. It would then be enough to accelerate the flow of heavily oxygenated blood. I supposed that speeding up the movement of the valve three or four fold would be sufficient. Testing indeed confirmed that the carbon dioxide content was greatly reduced, and the issue was resolved with relative ease.

Next, decarbonized blood from the artificial lung is directly connected to the venae cavae and forced into the pump through the valve, where a tube delivers oxygen. The arterial blood is then sent to the aorta. You might be thinking that an integrated artificial heart-lung device would be quite bulky, but we were able to shrink the volume to about one and a half times the size of our laboratory animals' hearts by using steel. I failed to mention that the valve was powered by an electric motor, of course, and that I later used electricity to generate the negative pressure for carbon dioxide removal as well.

It may sound as if the experiments proceeded with great ease, but it was no simple task to improve the tests up to this point. In those days, my wife and I would often literally forget to eat and sleep. Even with the device complete, attaching it to a rabbit's venae cavae and aorta was next to impossible. We first used catgut fiber to suture the steel pipes with the vessels, but the metal was inflexible so we put a hard rubber tube in between. The rabbits often bled to death still since the sutures frequently ruptured from uneven pressure.

Blood clots should be regarded as a particularly unfortunate surgical phenomenon. Blood immediately coagulates outside the vein, as you know, but if even a miniscule clot were to enter circulation, it would result in the embolism of smaller capillaries and turn the entire system gangrenous. We had no choice but to somehow prevent the clotting. I decided to perform the surgery using a substance called hirudin, which I extracted from frogs' mouths, to prevent coagulation. But even if the surgery were successful, clotting would often occur on the inside of the rubber tube where it was connected to the major vessels. After numerous failures, I finally discovered that speeding up the valve's movements would prevent coagulation, so I was able to overcome this difficulty by completing my plan for an artificial lung.

Another unfortunate phenomenon of note was pus caused by bacteria. Purulence can be avoided as long as all instruments are sterilized and the surgery is performed in an aseptic environment, since rabbit blood is perfectly capable of killing bacteria. Ultimately, however, the most important factor is finishing the operation quickly. Performing the surgery in the shortest time possible is crucial for eliminating pus and every other adverse occurrence. Fortunately, after some time, I became efficient enough to complete the entire operation in just ten minutes, though not without sacrificing scores of rabbits. While the operation consisted only of subtly opening the rib cage, attaching the artificial heart, and closing the chest, I felt a subtle sense of pride in being able to finish so fast. It goes without saying that the apparatus itself protruded outside the body. It would be best to place it inside the chest, but that proved impossible given the device as described. Surely you are thinking that a steel heart would need to be oiled from time to time, but this was of no concern since blood, thankfully, contains some fat.

I trust you can understand our jubilation after finally completing the artificial heart. Embracing each other, my wife and were delirious with delight as we watched the motor buzz like the wings of a horsefly dancing around tree leaves on a balmy autumn day. The valve moved with dizzying speed as the rabbit, still bound to the table, but awoken from the anesthesia for five, then ten hours, continued to live unfazed. Although the sounds from the motor, carbon dioxide removal, and oxygen supply might have been unpleasant to the animal, I imagine that it would have shared our joy at conquering the first hurdle -- creating a device that no one had been able to perfect since humans first walked the Earth -- and that it would be sincerely grateful should further research make resurrection possible by fixing an artificial heart to the dead. That second step should have been relatively easy to complete now that the first was mastered. We embarked on this research before long, only to run into an entirely unforeseen obstacle shortly thereafter.

VII

It is often said that clouds tend to follow sunshine, but everything soon fell off the rails. One night, a week after the first breakthrough, I suddenly began to cough up blood.

It had been a year and a half since my wife and I moved into the classroom. Although I had developed a light cough about six months earlier and might have been running a slight fever at the time, I was so engrossed in my work that I had not given it a moment's notice. I pushed myself until the curse of fatigue set in, forcing me to temporarily halt our research. You could call it youthful indiscretion, but I was at fault for charging ahead single-mindedly rather than working patiently. Thankfully, my health recovered, but I realized then that the largest jobs should be done without haste.

The laboratory director strongly recommended that I seek hospital care after I first coughed up blood, but I had no desire to leave the confines of my lab, so our lodging became the sickroom where my wife nursed me. I coughed up about ten grams of blood at first and immediately called a friend who worked as an internist to examine me while I was still in bed. He injected a hemostatic drug to stop the bleeding and admonished me to rest, so I lay on my back, still as rock.

I would often awake suddenly in the dead of night to an itchy tingling in my chest. Each time I believed it was over, I would start to cough loudly and hack up warm pools of blood. As I coughed, my wife would bring me a cup that quickly turned crimson before her very eyes. Shocked, she would then bring me a washbasin that I would place to the left of my bed before spitting up more blood, the exceptional force causing some of it to gush out my nose and splatter down my face. My chest would begin to sound like an aggravated bees' nest and then rumble like thunder soon after. The basin was half full before long, and I wondered if I would spew up every drop of blood in my body at that rate. The white sheets were covered in bloodstains large and small. My wife's hands trembled as she held the basin. I was lost in a sort of pensive fog as I heaved blood, the gas lamp hissing in the still night.

The hemoptysis fortunately stopped, but I find myself somewhat unable to describe the imprint it left on my mind. I was quite clear-headed for a time but soon fell back into a fleeting daze, after which I was struck by an intense wave of anxiety.

Fear. Unbearable fear. I was struck by a fear I had never felt in my life. It was, of course, the fear that I would begin to vomit blood again. Perhaps it was the fear of dying. For some reason, however, I believed it to be a fear that even surpassed death. The thought kept me awake at night. I was too scared to sleep. I would lie awake, stiff as a board, certain that I would start to cough blood again if I dozed off. There was no way to repair the ruptured vessels in my lungs. All the doctor could do was watch in silence. The hemostatic drugs had no effect. I resigned myself to the damage… the horror. I had never considered a patient's fear before, even when I examined them. It was then that I first understood that a doctor who has never fallen ill is unqualified to treat patients. I even felt that it would not faze me to spit up blood if someone would just relieve me of my anxiety over it. That is when I came to the realization that medicine's greatest mission was not the treatment of disease but eradicating the fear of sickness.

I begged my wife to give me a morphine injection, hoping that it might alleviate the anxiety that kept me up at night. She administered a fairly large shot, believing the prescribed amount insufficient to calm my unease. Within an hour, my terror vanished completely, and I was suddenly in the midst of a cozy dream. Have you ever taken morphine or read Confessions of an English Opium-Eater by Thomas De Quincey? Either way, morphine pulls the user into a pleasant world somewhere between waking and sleeping. There is no fear there -- only a paradise that transcends time and space.

I heard the sound of a horsefly buzzing near my ear when I came to. Still puzzled, I heard the gushing of water as I focused my ears. I thought my wife and I were walking through a park, enjoying the waterfall's sounds while soaking up the autumn sun to our hearts' content. Upon further reflection, however, I realized that I was still in bed. I looked to my side in confusion to find a rapidly spinning motor, a negative pressure generator, and an oxygen supply device.

The artificial heart! That's it -- I've been attached to the artificial heart! How pleasant! It knows no terror! It alone can erase the fear of disease and deliver us to heaven! What a serene world!

Just as I felt at ease, I began to cough violently before spitting up blood again. I plunged from heaven into hell. I was simply under the illusion that the rumbling in my chest was a motor, and the morphine merely made me mistake that noise for the carefree utopia of the artificial heart. Although the coughing stopped after three cups of blood, I was once again seized by an acute panic -- the morphine had worn off.

I longed for the artificial heart as I stared at the ceiling from my bed. I became certain that it would save us from our dread of disease, just as I had dreamed. My original intent was to save humanity from death and prolong life. I realized, however, that I must complete this device even if only to save people from that fear, for my illness taught me a terror even greater than death.

I then remembered the James-Lange theory of emotion from a psychology lecture I had attended years earlier. It states, for example, that we feel afraid because of various expressions that occur when startled. In layman's terms, our hair does not stand on end and our faces do not turn pale because we are scared, but we feel scared because our hair stands on end and our faces turn pale -- a radically mechanistic theory. Despite my sickness, I still had unwavering faith in mechanism, and I realized that the James-Lange theory masterfully explains why the artificial heart should eliminate anxiety. Our heartbeat slows when we are scared and stops in intense moments. That is, we become frightened because the heartbeat slows or stops. I am certain that the perpetual, unceasing beat of an artificial heart renders fright impossible. The thought made me want to get back on my feet as quickly as possible to start the second phase of my research. The hemoptysis thankfully stopped after the fifth bout, and my recovery proceeded smoothly. After about six weeks of rest I was able to work again. Although the friend who examined me firmly recommended that I recuperate in the countryside, I turned a deaf ear and set about working again with my like-minded wife. My greatest regret, however, is that I did not heed his advice, less for my own sake than for my wife. Her lungs were already considerably infected while she nursed me, but she was equally stubborn and revealed not the slightest sign of her condition.

VIII

The second phase of our research -- resuscitating a dead animal with an artificial heart -- was not as difficult as expected. I first applied various poisons to kill the rabbits and waited until their last breath. Then I immediately cut open their rib cages and attached the artificial hearts. I learned that the rabbits regain consciousness if the surgery is performed within five minutes of dying, but anything longer than that did not work. I had never hoped for anything like reviving a frigid corpse, not even in my dreams. Joy filled the lab after having brought back the first dead rabbit with extreme ease, but it was accompanied by an intense feeling of hollowness. It would be one thing if that was all there was to the process, but I had sacrificed many rabbits to reach this point. It was rather difficult to choose a poison. I could not wait for the rabbits to die naturally, so their deaths had to be artificially induced. This was quite cumbersome, however, because poison changes the properties of the blood. It was therefore necessary to test as many toxins as possible, which involved a good deal of work, since I would be successful after one trial and fail after another.

My purpose was to rescue humanity from fear, after all, so I needed to hook the artificial heart up to a person after succeeding with rabbits. Ever since coughing up blood, I thought, without a moment to reflect on anything else, that paradise would be possible if only I liberated humanity from its anxiety. A world without fear! Wouldn't that be a delightful place? The next step was to test the artificial heart on a larger animal, like a dog. The procedure for dogs is exactly the same, except that a bigger pump is needed. Unlike rabbits, however, an exorbitant amount of electricity is required. I tried to resuscitate only dead dogs, of course, and discovered that resuscitation is possible within ten minutes of death. In short, I learned that the artificial heart could be attached to larger animals with less haste. This was probably due to differences in blood clotting, which occurs faster in smaller animals. Blood coagulates after death, as you know, and an artificial heart is useless once it does. I then performed tests on sheep of comparable weight to humans, hypothesizing that there would be even more time to attach the artificial heart since they were larger than the dogs I had used. Sure enough, I was able to revive the sheep even after fifteen minutes. A human was all that was left. But who would believe that as I pondered a way to start human trials, the first subject would be my assistant, my wife, my Fusako.

One day, Fusako suddenly fainted in the lab. I lifted her onto our bed and gave her some red rice wine. She came to soon after, but her forehead was burning. Not surprisingly, the thermometer said she had a 41.5°C fever. I immediately prepared an ice bag to cool her down and had my friend, the internist, make a house call. I shudder even now when I recall the moment he informed me of her disease. My friend said it was a classic case of miliary tuberculosis. Miliary tuberculosis! That was nothing other than a death sentence. Fusako had endured the infection for so long that her fate was sealed. Yet even in my immense grief, I saw a glimmer of hope. That, of course, was the hope that I could save my wife with the artificial heart.

Fusako quickly understood her fate from our expressions.

"I can't be cured?" she asked as my friend left.

I shook my head in silence for lack of a better answer.

"I understand perfectly. I'm not the least bit scared to die, though." Her voice was brimming with hope.

"Huh?" I said, staring at her in surprise.

"We have the artificial heart. When I die, please hook it up to me. I will surely be brought back to life."

"Don't say such sad things. You need to be more optimistic."

"No, it is you who should be more optimistic. We have performed so many tests, but it is all for nothing without human trials. I decided that, even if I were healthy now, after the rabbit trials I would end my life so that you could experiment with my body."

I grabbed her hand instinctively and kissed her lips.

"So you will do it? Oh, are you happy? Up to now, we have performed tests only on rabbits and dogs, so no one can say what it is like to live with an artificial heart. I want to experience it for myself. I trust it will be the carefree world you described. The thought makes me want to take my last breath soon. So when do you think I will die?"

My grief grew.

"Well, we can try," I said.

"Not if you aren't ready. It would be a shame if the procedure were not done in time. Go prepare! Quickly!"

That's right! If there was no hope of saving her, then fulfilling my wife's final wish was the least I could do for her. Determined, I began to ready the artificial heart in those moments when I was not tending to my wife. Yet my mood was vaguely dark, for we had always made the preparations together.

IX

The morning after the arrangements were complete, my wife's condition worsened. My friend came running over. Fusako asked everyone to leave except him and the lab director. She told them of her plan to test the artificial heart upon her passing, requesting their word that they would not cause me any legal trouble. The director's eyes glistened with tears.

She then had them leave as well and asked me to show her the artificial heart. When I placed it in my hand to show her, she smiled as she let out her last gasp and quietly departed.

Pulling myself together, I announced her death to those outside the room, asked that no one enter during the procedure and immediately began operating.

I still can't forget the touch of my scalpel on her chest. I promptly opened her rib cage and attached the artificial heart. The procedure began nine minutes after death and finished thirty minutes later.

I flipped the switch with my bloodstained hands. The whir of the motor could be heard as it began to spin. One minute, two minutes, three minutes. I gazed at my wife's eyes as I checked her pulse. It was impossible to track her heart rate since the valve moves two hundred and fifty times per minute, but I could feel the blood circulating smoothly.

Five minutes! Her eyelids fluttered slightly while the color returned to her lips. I nearly screamed in exhilaration, for that was the first sign of life in dogs and sheep as well.

Seven minutes! Both eyes began to rotate back and forth. I held back a burst of joy as I observed her.

Nine minutes! She began to move her lips and stared into space, eyes wide open.

Eleven minutes! Her vision focused on me.

Thirteen minutes! She let out a sigh.

"Fusako!" I exclaimed. "Do you know what's happened!? You've come back to life!"

But she did not so much as crack a smile.

"Fusako! The artificial heart works. Aren't you happy?"

"I am glad," she said in a toneless voice.

"You're happy? Me too. You've been given a new life."

"Oh, dear!" she said, her face still wearing the expression of a mask. "I just said I was glad, but I could never be happy."

Caught off guard, I kissed her suddenly.

"Oh, forgive me. I don't feel even the slightest longing for this world."

I was paralyzed.

"I'm sorry. I couldn't laugh if I wanted to, or be happy if I tried. Living like this is meaningless!"

Can you imagine my despair? I plunged my face into her bed.

"Dear! This won't do! Remove the artificial heart immediately. There is no feeling in death or rebirth."

Two years of research, shattered by these few words. In my obsession with eradicating fear, I failed to recognize that the artificial heart would also erase other emotions like pleasure. The remorse! The shame! She could not even feel such things. The artificial heart led to nothing but an artificial life.

Without hesitation, I flicked the switch that stops the motor.
My story seems to have run unexpectedly long. Although my bitter experience may demonstrate the James-Lange theory, I have found mechanism to be an unsatisfactory explanation ever since that day, as it ultimately destroys people's hopes. Perhaps humanity has something to live for precisely because there is fear, sickness, and death.

So, upon Fusako's death, I entirely abandoned my research on the artificial heart. I would like to continue researching the lungs' ability to perform nitrogen fixation, though. But haste will only invite blunders, so I plan to proceed with great patience.

Well, I've divulged my life's story at your mention that Doctor Haber, the inventor of artificial nitrogen fixation, is coming to Japan. I have to laugh when I hear myself say this, but at the end of the day, it is probably far more comforting if we biologists stick to tinkering with artificial hearts made of mercury.

Max Zimmerman grew up in New York City where he went to the Bronx High School of Science before heading upstate to pursue a major in Asian Studies at Cornell University. He now works as a news translator for the Nikkei Asian Review. When not reading, Max can usually be found running in Central Park.

Notes

[1] "The World of Detective Author Kosakai Fuboku," Kanie Digital Museum

[2] Takayuki Tatsumi, "Japanese and Asian Science Fiction," in *A Companion to Science Fiction*, ed. David Seed (Malden, MA: Blackwell Publishing, 2005) 327.
[3] "About Kosakai Fuboku," KanieTown
[4] "Definitions of SF," The Encyclopedia of Science Fiction.
[5] Sari Kuwana, *Murder Most Modern: Detective Fiction and Japanese Culture* (Minneapolis: University of Minnesota Press, 2008), 124.
[6] Mizumura Minae, "On Translation".
[7] *Genbun-itchi* literally means "unification of spoken and written language."
[8] Mark Silver, *Purloined Letters: Cultural Borrowing and Japanese Crime Literature, 1868-1937* (Honolulu: University of Hawaii Press: 2008), 172.