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The Role of Manga in the Diffusion of Technoscientific Information into the Modern Japanese Society

— Part 1: Science and Technology in Japanese Manga —

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I INTRODUCTION

Fifteen years ago, I visited the *Tezuka Osamu Manga Museum*, situated in Takarazuka (Western Japan). In the library, there is access to most of Tezuka's works, some of them in foreign editions. Even though he is known as the "God of manga" in Japan, I had never heard of him before, for his manga/animations were never broadcasted in Belgium, my home country. I therefore decided to spend an afternoon there, to read some of his graphic novels translated into French, and try to remedy this shortcoming of mine in Japanese popular culture.

Was it my major in science or my new interest in science popularization at that time, I cannot say, but something struck me as odd while reading his story *Buddha* (*Budda*, vol.1). In the midst of a panic scene — a dense swarm of locusts devouring everything in its path — appears a long quotation about locusts, an excerpt from the *Story-Book of Science* written by Jean-Henri Fabre, a French entomologist (see Appendix 1). Two pages later, another comment explains that such calamities hit Algeria various times. It was a surprise to encounter such a flagrant mix of genres, namely the graphic novel and the popular science ones. In bringing together allusions of unrelated countries, i.e., France and Algeria, in a narration supposedly taking place in India, these pieces of scientific information were obstructing the narrative flow in my mind. Puzzled by this "dissonance", I skimmed through some other books by Tezuka, and made sure that it was not a unique case. Indeed many passages of a pedagogical nature could be spotted in *Black Jack*, *Phoenix*, *Lost World*, and about a dozen more.

For this paper, I will therefore look further into the relationship between manga and science in Japan. One may ask why bother about the connection between an often disparaged visual art, and a respected source of knowledge, seemingly poles apart? It goes without saying that science and technology (S&T) are of the highest importance for modern societies, for example, to maintain or increase the economic margin of the country in creating more added value and wealth. It is therefore essential to pass on that knowledge and know-how to younger generations, which is the role of formal education. Parallel to this, non-formal education has developed in order to respond to adults' needs. Nothing is more natural if one considers how fast S&T develop. However, formal and non-formal education is not enough to preserve S&T societies. Indeed, this technoscientific proficiency would remain the privilege of a minority, leaving the rest of the social body much unaware of the

stakes. This situation would be harmful on two accounts: a modern social system cannot reproduce itself if the individuals are ignorant of science and technology (see Part 2, to be published); and S&T not “translated” into common language, may become the cause of major accidents. On this matter, the nuclear issue will also be contemplated later.

How to avoid these perils? Of course, it is important to attract enough young people into scientific careers to avoid a decline in the population of researchers. But, it is even more essential to educate citizens in such a way that they can participate in S&T-related societal debates. Put differently, people must be empowered to contribute to democracy, i.e., to be capable to consider new technologies & related risks. In short, S&T knowledge must be popularized.

On the other hand, as seen in the opening example, Japanese manga can be a vehicle for science publicization, even a powerful one. It has exerted (and still exerts) a strong influence on the Japanese, and especially on children. In 2008, almost 40% of all magazines and books published in Japan were manga; and, on average, Japanese teenagers read ten manga per month (Nippon, 2010, 24).

I will therefore examine how manga can integrate S&T into the Japanese society and culture.

The first step was to gather Japanese comics in which could be found representations of science & technology (*kagakugijutsu*, in Japanese), and/or scientific information. The list of the consulted manga is reported in Appendix 2 (Reference numbers in the main text and Appendices are given between square brackets). The second step consisted of classifying these works into categories. Three main families emerged: science fiction, pedagogic, and promotional works. Each one will be described in detail in this first part, keeping in mind that this categorization is probably not exhaustive, and boundaries not perfectly tight.

II SCIENCE FICTION MANGA

In people’s minds, science fiction (SF) is a literary genre spontaneously related to science. And Japanese are no exception: if they are asked about graphic novels they associate with “science”, they would often give titles of SF manga. In the following section, after defining “SF”, that category will be examined in more detail. Various representative comics will be explored, in search of artificial entities and fictional scientists, in order to see how they relate to each other, and to the society in general (government, military, business). These relations depicted in the manga are symbolic, in my opinion, of the position occupied by S&T in societies, first of all from the artist’s perspective, and possibly from the reader’s one. The general tone of the manga toward science and technology will also be evaluated: ‘Does S&T appear to be creating more problems in society than solving them?’

SF manga is often denigrated as a minor form of entertainment targeting children, and/or pure nonsense from a science perspective. However, one should give more consideration to this type of reading for two reasons: their number, and their impact in the long term:

First, in order to have an idea of their number, the Wikipedia *SF manga sakuhin* (Science Fiction

comics) category was consulted. One condition was required to include a work in our final list (to avoid mix-ups of genres with fantasy, horror, etc.): the narration should make use of at least one of the following features: 1. Science & technology development and repercussions, 2. Future of the human society, 3. Extraterrestrial creatures (e.g. Dufour, 2011, 12-14). From Figure 1, reporting the total number of SF stories running at each year (from 1947 to 2010), one can see that SF is still very present in Japanese popular culture today — eventhough they are competing harder with other genres and entertainment media, more numerous today than they were in the 1940s and 1950s.

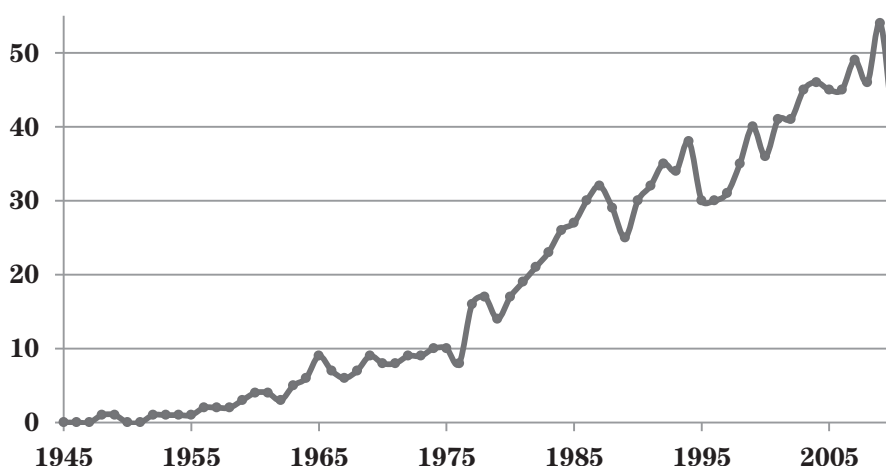


Figure 1. Total number of SF manga by year

Secondly, because of its visual nature, SF manga can have a powerful impact on young minds. It can capture young readers' imagination, and trigger their interest in science & technology, leading them later to a career in these fields. A famous example illustrating this point is *Astro Boy* (*Tetsuwan Atomu*), arguably one of the most representative Japanese SF manga. Drawn by Tezuka Osamu, the manga narrates a little robot's adventures, serialized in *the Shōnen magazine* between 1952 and 1968. In fact, his comic had social impact other than just child edification and delight:

(a) At the start of the 1950s, Japanese politicians, industrialists, and academics were engaged in a debate on the peaceful use of nuclear energy — especially after the *Atoms for Peace* speech delivered in 1953 by U.S. President Dwight D. Eisenhower. But, it is now acknowledged that the above stories of *Atomu*, fighting for peace and justice while feeding on atomic fuel, facilitated the Japanese nation accepting that energy — though it had caused the destruction of Hiroshima and Nagasaki, only a few years earlier (see Kōsaka & Motohama, 2006, 505).

(b) On the other hand, today's development in Japanese robotics can be partially explained by the success of that graphic novel. For example, roboticist Asada Minoru of Osaka University recognized Tezuka's comic influence on his career choice; and Professor Koike Yasuhiro of Keio University also chose to become a scientist because of *Astro Boy* (McCarthy, 2009, 255). More generally, during her fieldwork, Robertson (2010, 2) noticed that many Japanese robotics specialists have *Atomu* pictures or figurines in their laboratories, acknowledging that their research on sociable humanoid robots has been inspired by that fictional character.

Clearly, SF manga has affected the reader's perception of science, in particular about nuclear energy and robots. Let us now examine more concretely artificial entities and fictional scientists which populate major Japanese manga.

1. REPRESENTATIONS OF TECHNOLOGY

A. The Android (autonomous robot with anthropomorphic characteristics)

Obviously *Astro Boy* is our standard of comparison. He is a unique model created in 2003 by the director of the Ministry of Science himself, in a Japanese society where science & technology have become omnipresent, and in which mass-produced robots, tailored to the human's needs, are basically "servants" exploited by their employers. The nuclear-powered little robot however manifests human-like feelings, and fights for justice [S1, 6-22].

The second most famous robot in Japanese imagination is without doubt *Doraemon* (1969-1996) by Fujiko F. Fujio. The blue cat-robot is sent from the future to save Nobita, a clumsy and mindless boy, from becoming a failure in his life. In each episode, Doraemon takes out a technological device from his ventral pocket to assist Nobita in his daily predicaments. Invariably, these objects lead to further complications [S6, 13-18 or 331-364]. In the same vein, and drawn by the same team, the manga *The Strange Encyclopedia* (*Kiteretsu Daihyakka*, 1974-1977) stages a genius schoolboy named Kiteretsu, and his faithful robot helping him out to create more inventions, which result also in troubles [S8]. All *Doraemon* and *Kiteretsu Daihyakka* storylines have happy endings, but they tend to show that technology is not a panacea for humans: ethics and range of use should be thought through (of course the protagonists do not, for comical effects).

More recently, the manga *Chobits* (2000-2002) depicts the complex relationship between young men and humanoid-computers which take the shape of beautiful girls, hard to distinguish from real persons since their programs can emulate human feelings [S16].

Helpful and lovable robots like these appear as benign entities, images to be contrasted with Western representations in which the Machine is more than often portrayed as evil, deceitful, and dangerous for the human society (e.g. Hel in *Metropolis*, HAL in *2001*, Terminator). That dissimilarity may find its source in Shinto, the indigenous spirituality that teaches that all living and non-living beings — trees, rocks, dolls etc. — are inhabited by spirits called *kami*. Therefore, in the Japanese's imaginative world, anthropomorphic robots seem to belong to the natural world, and thus appear less threatening (see also Robertson 2010: 12-15).

B. The Mecha (super robot)

A few years after *Astro Boy*, *Gigantor* (*Tetsujin 28-gō*, 1956-1966) [S2] appeared as a precursor for a new breed of artificial beings: the giant robots. The huge machine belongs to a unit of metallic warriors developed during the war to protect imperial Japan. Completed after the end of the hostilities, it would become a tool for peace. However, *Gigantor* is operated by remote control, and obeys whoever, well- or ill-intentioned, is holding the controller. That lack of autonomy, contrary to Tezuka's creature, suggests that technology is essentially amoral, and the social consequences of its use depend exclusively on the users' purposes.

But it is with *Mazinger Z* (1972-1974) by Nagai Go, that super robots started to be piloted from

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inside (their heads) [S7]. Nagai's series would give birth to the *meka* genre, in which huge robots or vehicles are taking center stage in the narration (*meka* is the Japanese abbreviation for the English word "mechanism"). It would also be the start to the "media mix" industry (anime, video, games, toys inspired by manga).

Metaphorically speaking, the human (pilot) is "closer" to the technology (robot), but they remain perfectly distinct: the mechanical protection is cocooning the human body, without altering its biology.

That condition is like a reminder of the Meiji Restoration (1868) catchphrase *Wakon-yōsai* (Japanese spirit and Western techniques). Indeed, after the "Black Ships" arrival at Uruga harbour (1853), Japanese leaders chose to import Western rationality and technology to counter Western countries' expansion, and avoid the fate of neighbouring Asian nations. Metaphorically speaking, the Japanese had to "wear" a technological "armour", inspired by foreign states that they were indeed opposing. At the same time, a "Japanese" identity (a "soul") worth being protected against Western aggression had to be invented. To that end, the Emperor was transformed into a divine descendant of Goddess Amaterasu, of whom all "Japanese" are the children, as well as into a symbol of modernization to which they should all contribute. This Janus-like opposition survived the Pacific War, with the Shōwa military technonationalism subsisting under a form of economic technonationalism (Gomasasca, 2002, 114; Van Drom, 2009). Here, technology appears therefore as a tool of resistance against otherness.

C. The Cyborg (organism that has enhanced abilities due to technology)

The cyborg will transcend the previous flesh-mineral separation. *8 Man* (1963-1966) is one of the oldest SF manga revolving around such an organism: detective Yokoda is assassinated but his life force is transferred by Dr. Tani into an android body [S3]. This is a precursor of *Robocop*.

One year later another famous series started, *Cyborg 009* (1964-1981) by Ishinomori Shōtarō, setting up nine humans kidnapped by an arms dealers' organization, and cybernetically enhanced to be able to engage in the next world war [S4].

In both cases, technology is providing superpowers that will be used, eventually, for justice or freedom.

But the archetypal work in this genre is *Ghost in the Shell* (*Kōkaku Kidōtai*, 1989-1997) [S14]. In 2029, the world is unified and communicating through a global network, recurrently attacked by hackers. "Major" Kusanagi, a member of a secret unit fighting cyber-criminality, is a human spirit in a humanoid shell. During her mission, she will meet the Puppet Master — an artificial intelligence which has emerged from the network — and will end coalescing with him. In showing the fusion between digital, mineral, and organic worlds, this work hints at the ultimate question of what is it to be human (Japanese?). Here, technology abolishes ontological partitions, and leads to philosophical questioning.

2. REPRESENTATIONS OF SCIENCE

To better understand the representation of science itself, fourteen "doctors" (scientists and physicians) have been selected and described in Appendix 3. Their inclusion in the data base rested

on three criteria: 1. Appearance in the first stories, 2. in a well-known graphic novel, 3. and for whom enough information is available to fill out the survey forms. These cards contain the character's appellation flanked by the manga reference and its starting year, his field of research, followed by his behaviour toward his colleagues and technology, toward his family if depicted, and more widely toward the society. The last item comments on the general context, in particular if "science" is represented as a neutral endeavour, a source of progress (utopia), or a cause for calamities (dystopia). On the other hand, each entry includes a scale running from "good" to "bad", in which one number is circled. These choices are obviously not perfectly objective, and may be subject to revision in a more complete survey.

A. Fictional scientists

Firstly, all the characters are male, and often have unkempt hair (70%), a lab coat (70%) and a necktie (40%). Titles (Dr., Pr., Doctor) are frequently added to their names (80%), which is the easiest way to recognize them as scientists or physicians.

Secondly, most of them are seen in their working places, often laboratories. 50% are doing research or development on their own, whereas the other half are working with colleagues respecting the group hierarchy.

This observation is in contrast to the stereotypes found in Western science fictive stories. For example, in movies, scientists are portrayed, in general, as people searching obsessively for scientific answers or technological applications, to the point of losing touch with their emotions and the society. Three types are identified by Perkowitz: the *nerd* and the *villain*, the former being amicably eccentric, including geniuses helpless in daily life; the latter comprising characters such as Rotwang (*Metropolis*) or Dr. Frankenstein, the typical *mad scientist*, driven to evil acts by their obsessions. The third type is the *hero*, who saves the world, sometimes even sacrificing himself (Perkowitz, 2010, 167-195). The *maverick* is a more recent genre: standing outside institutions of science, he prevents big business, government or military from diverting scientific or technological benefits for private interests (Frayling, 2006, 215).

Even though half of the characters in our list are displaying psychological disorders of some sort (Appendix 3: 1,5,7,9,10,11,12), very few are maverick, mad, or heroic for that matter. Therefore, these SF manga caricatures do not generate very negative or fearful images of scientists, except from the 1970s into the 1980s. It must be noted that this particular period was marked by the rising of a global awareness about ecological disasters (*Silent Spring* written by Rachel Carson had been translated into Japanese in 1964). In 1972, the book *Limits of Growth*, commissioned by the Club of Rome, also suggested that there were limits to progress brought about by science and technology, an impression reinforced by the oil crisis in 1973. At that time, most media companies in Japan had a specialist in pollution issues, and were supporting civil movements. On the other hand, media were closely following pollution related lawsuits, during which scientists were proving or disproving the causality between pollutants and diseases, depending on which side (the victims or the industries) they were on. By 1970, it became clear that experts could be manipulated by industries trying to delay or dilute the truth (Wakamatsu, 2006, 133-148). Science and technology appeared to be failing their promises for a brighter future.

B. Their fields of research

In considering what the representative scientific occupations are in manga, one can realize the main role attributed to science in Japanese imagination, around the time of the publication. The list shows an over-representation of “engineers” until the 1970s, a trend confirmed by Figures 2 and 3, based on data found in the Japanese website *Scientists appearing in manga (Manga ni tōjōsuru kagakusha)*.

These figures can be explained by the fact that, after the war, heavy industries and their engineers were at the heart of the economic development for the recovery of the country. On the other hand, we have seen that contamination issues, resulting from that industrialization, became flagrant around the 1970s, and technology was probably becoming more problematic in people’s

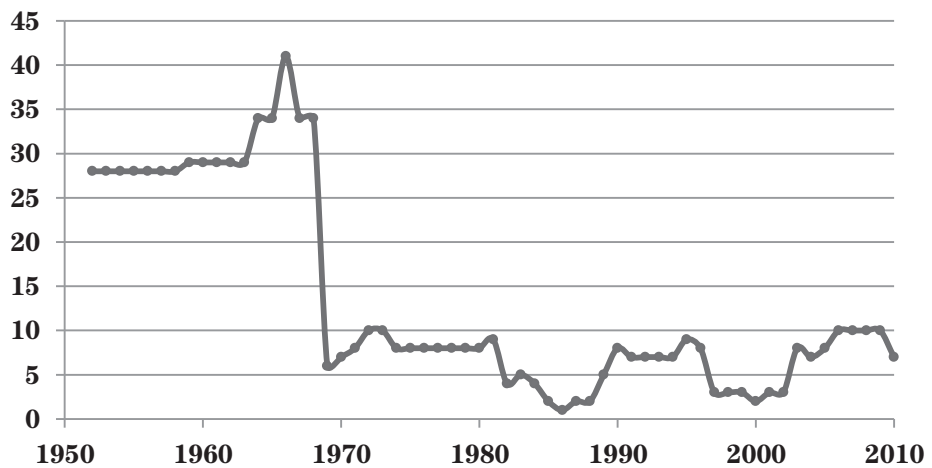


Figure 2. Total number of “engineers” in manga

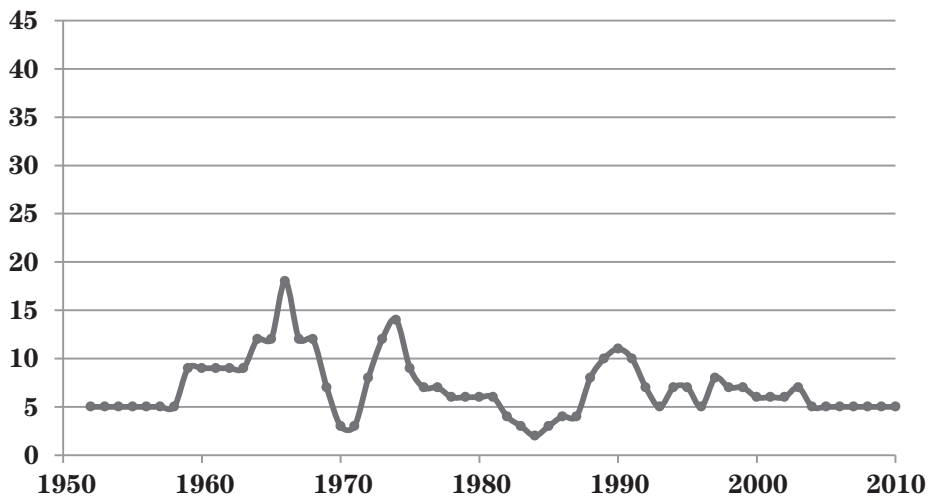


Figure 3. Total number of “non engineers” in manga

imaginary.

In fact, a detailed breakdown shows a general drop in the number of scientists in manga after the 70s, but also the emergence of various scientific professions, among which biologists and physicians tend to become the most numerous. The “medical manga” prototype is certainly *Black Jack* (*Burakku Jakku*, 1973–1978) by Tezuka [M3, and Appendix 3: 9]. In this series, the main protagonist is a young physician in possession of miraculous surgical skills, free of charge for the poor, but very costly for the pompous. Without a legal doctor’s license and despised by other colleagues, Black Jack perfectly personifies the *maverick* scientist.

Today’s representations are more true-to-life, suggesting that scientific literacy in Japan is better, and also that the readership has become increasingly demanding in terms of realism. For instance, in *Jin* (2000–2010), the brain surgeon Minakata, who has fallen back into Japan’s feudal past, shows convincing use of his medical knowledge despite the lack of modern instrumentation [M8]. Incidentally, this graphic novel gives the impression that the Edo period is harsher but happier than today’s Japan and all its technology. In *NachuN* (2006–2010), one can read the down-to-earth thoughts of a student about publishing in a scientific magazine, and about his hesitation to add the name of a professor who inspired him with the idea [M13, 15–16]. This is a common predicament for contemporary researchers.

Astronautics is another field more prominent these years with two series: *Planetes* (*Puranetesu*, 1999–2004), a story about a space crew salvaging space debris around the Earth and the Moon in the 2070s [S15]; and *Space Brothers* (*Uchū kyōdai*, since 2008), in which the two protagonists are pursuing their dream to become NASA astronauts, around 2025 [M14]. All characters are good fellows just fulfilling their missions.

C. Their worlds

While the society described in *Astro Boy* is slightly utopian — at least S&T are not being a source of major problems — technology and war themes became prominent in later comics throughout the 1970s. It is enough to recall that Gigantor had been created to take part in the Pacific War, or that Ishinomori’s cyborgs were initially designed to wage war in the future. Moreover, Mazinger Z, and later giant robots, are *meka* devised to crush enemies. In the same vein, we cannot pass over in silence the rebirth of the imperial navy battleship Yamato into a spaceship, saving the Earth from utter destruction (*Uchū Senkan Yamato*, 1974–1975) [S9]. Perhaps the contents of these manga reflect the fact that the Japanese, in the middle of a period of high economic growth, were regaining their confidence, but also that they were healing from the war by “re-experiencing” their trauma through alternative stories.

By the 1980s, SF worlds ended at the mercy of technological powers and irresponsible scientists, and turned rather dystopian. Two well-known graphical novels led the trend: *Nausicaä of the Valley of the Wind* (*Kaze no Tani no Naushika*, 1982–1984), in which surviving humans are living near a forest contaminated by an industrial civilization extinct long ago [S12]; and *Akira* (1982–1990), the cyberpunk story of two orphans fighting each other, with nuclear-bombed Tokyo as the backdrop, 38 years after the end of the Third World War [S13]. It must be noted that the Cold War tensions and conflicts were reawakening between 1979 and 1985, and the spectre of nuclear annihilation was

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again feeding people's anxiety. In his masterpiece *Phoenix* (*Hinotori*, 1967-1988), Tezuka had already condemned, as early as in 1969, the autodestructive behaviour of humans who fail to understand that all things are interrelated [S5].

From the 1990s, *Ghost in the Shell* would lead the way to Japanese post-cyberpunk genre: S&T themselves are less called into question or subject to social criticism. However, the "identity" issue remains prevailing through emerging themes such as computers, and the osmosis between real and virtual worlds.

Since year 2000, many SF manga universes have become very realistic: hospital and surgical interventions in *Jin*, tasks in space in *Planetes*, or astronaut's training in *Space Brothers* are very convincing details; but the focus of these narratives is on the protagonists' daily life and feelings rather than on technology used, which is perfectly integrated into the society. On the other hand, one witnesses a coalescence between SF and fantasy genres. *Fullmetal Alchemist* (*Hagane no renkinjutsushi*, 2001-2010) is but one illustration. This is a mix of philosopher's stone, mass conservation law, full-armored knight ("cyborg"), and steampunk ingredients, with a hint of humour [M9]. Another interesting example is *Mushishi* (1999-2008) in which the natural world built on strings, black holes, and wormholes (i.e. modern concepts of quantum physics and cosmology) is blended with the supernatural realm of the *mushi* [M7] (Dufayet, 2009, 115-126).

3. SCIENTIFIC INFORMATION

Let us turn to the scientific contents found in the SF manga consulted for this study. A common feature is the presence of realistic depictions, in particular of space-related subjects: lunar craters in *Astro Boy* [S1,166], Sputnik in *Cyborg 009* [S4,6], Saturn in *Galaxy Express 999* (*Ginga tetsudō 999*, 1977-1987) [S11,114], outer space activities in *Planetes* [S15], or comets in *Phoenix* [S5,63-66], to name but a few examples. However, what is said about these objects in the manga may be erroneous, or obviously out of date. The human body or surgical operations also can be depicted with a striking realism in *Black Jack* [M3,24,83] (Tezuka held a medical degree from Osaka University), or in *Jin* [M8,3-9].

Another feature is a better integration of the information into the story, compared to the introductory example about locusts and the French entomologist Fabre. In children-oriented manga, explanations are often given in a teacher-to-pupils fashion, which reinforce the reality effect of what is explained [S1,30-32; S4,25]. In these works, elementary science can be used for comical effects or for the narrative progression. For instance, in *Astro Boy*, the artist makes use of principles such as the expansion of water near freezing point, the water absorption by polyester, or the persistence of vision [S1 vol.1, 216; S1 vol.2, 26,161].

In more recent adult-oriented manga, the scientific information is precise, and merged into the story — except for *Ghost in the Shell*, in which one finds countless factoids about biotechnology and mechatronics, as well as about the socio-political background of the story.

On the other hand, the scientific method itself is indirectly presented in *Gigantor* [S2,52-60], and more diffusely in detective stories such as *Case Closed* (*Meitantei Conan*, since 1994) [M6] or *Pluto* (*Purūtou*, 2003-2009) [M10]. It is worth noting that for Hirai Tarō (1894-1965), one of the founders of Japanese mystery fiction, detective stories contain the "real scientific spirit" since knowledge in

physics and chemistry are often exploited, but above all because the arrangement of the plot is based on logical reasoning, as in Sherlock Holmes' adventures (Mizuno, 2009, 159-160).

In conclusion, SF manga (SFM) appear as a rich source of S&T representations. An evolution in the SF themes could be perceived: from a predominance of robots and engineers in the war's aftermath, subjects diversified after the 1970s. Today's themes to be found in this category are generally related to "medicine" and "space".

Besides, science and technology in SFM are depicted as being trustworthy overall. Since this literature has a probable subconscious and lasting effect on children's minds, this may explain why Japanese society has shown so little resistance to, or has not been very critical of technology in general.

In Part 2 (to be published), I will indeed argue that SFM played an important role in re-integrating the idea of S&T in the postwar civil society of Japan.

III EDUCATION AND INFORMATION MANGA

It goes without saying that there is more effective literature than *SF* comics for children to learn about scientific matters. Pedagogical manga is one of these tools since it introduces science and technology knowledge in a more systematic fashion, and hopefully with fewer errors than in SF works.

1. HISTORICAL CONTEXT

A. Education manga (*gakushū manga*)

The potential of manga as a tool to reach children was recognized in the 1920s. Indeed educational magazines were quick to exploit that form of art. For example, *First-Year School Pupils (Shōgaku Ichinensei)*, launched by Shōgakukan in 1925, contains a few pages devoted to manga such as *Doraemon* (since 1969). Since editors follow the curriculum guidelines issued by the Ministry of Education, these magazines are trusted by parents and teachers. In this way, pupils are exposed to manga "grammar" from an early age.

One of the oldest examples of a full-fledged *Educational manga* (*gakushū manga*) is Aki Reiji's *Study Manga (Benkyō Manga, 1910)*, but it is the *Himitsu — secret — Series* (edited by Gakushū-kenkyūsha since 1972) which became a representative in this category [E1]. Classified as child literature, these works found their way into school and local libraries from between the mid-1960s and the 1970s. About thirty years later, in 1998, the State finally approved the introduction of that media in the classroom, marking a change in academic attitude toward manga. Indeed the curriculum guidelines for the fine art section of the second and third years of lower secondary school state that "children must be able to express themselves through media such as manga, illustrations, photographs, videos, computer graphics and so on." As a consequence, the teaching of manga "grammar" was introduced in school textbooks as well (Yoshimura, 2009, 158-160, 161).

Today, there are too many to list, but for the sake of illustration, in elementary astronomy alone, one can find: *The Faraway Universe 1 / The Blue Planet · Earth* [E5]; *Wonders of the Universe and the Gravitation* [E15] with Conan as the main protagonist; or *The Wonders of the Universe* [E16] with

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Doraemon as a guide.

In this way, manga have been recognized as a precious tool to communicate knowledge, with “natural sciences” being one of the earliest subjects to be developed, along with “history” [E1].

B. Information manga (*jōhō manga*)

Around the time librarians were stocking their shelves with educational manga, an adult genre materialized in general magazines for salarymen, i.e., “instructive” manga (*kyōyō manga*) staging characters learning about wine, cuisine, etc. (Ito, 2008, 42). Obviously, readers started to expect accurate descriptions and correct information. For example, the manga *Oishinbo A la Carte* stories [M4] are sometimes built on current affairs (in relation to food or recipes). Since the artist expresses views about social issues, he must be ready to back them up with data (Akita, 2008, 165). Nowadays one can find an impressive number of manga dealing with themes as diverse as leisure, politics, philosophy, or the tax system, to cite but a few, and even entertainment manga can abound in interesting factoids about art dealing [M5], oenology [M11], micro-organisms [M12], etc.

But the real forerunner of adult-oriented educational manga or *informational manga* (*jōhō manga*) is Ishinomori Shōtarō’s *Japan Inc.* (*Nihon Keizai Nyūmon*), serialized in the Japan Economic Journal (*Nikkei Shimbun*) between 1986 and 1988. The paperback volume (*tankōbon*) sold a million copies, demonstrating that grown-ups were ready to consider that that form of art could be a valuable source of information as well.

Today, one can find “manga textbooks” of physics [E11], genetics [E17], mathematics [E21] and so on, in bookstores and libraries. *Manga Guide to Quantum Mechanics* [E14], or *Manga Guide to Statistics* [E6] are but a few specimens of a very long list of comics which are sometimes recommended readings at universities. These last two are part of the collection *Manga Guide (Manga de Wakaru)* edited by Ohmsha, one of Japan’s oldest scientific and technical book publishers. The series is even translated into English, suggesting that Western countries may be ready to teach abstract subjects through manga.

C. Manga at the university

This change of status from a “bad-taste” reading to a useful cultural media opened the universities’ doors to all manga. Two private university libraries in the Kansai region kindly allowed access to their data, including the number of manga-related books bought each year (entertainment manga + educational & informational manga + books on manga). The relevant periods are 1970/5 to 2010/9 for Kinki University, and 1976/12 to 2010/9 for Hannan University. The evolution curves are presented in Fig.4 and Fig.5 respectively. An increase can be spotted in both graphs from around the 1990s — and common peaks are also observed around 2000 and 2005–2006. One also notes that Hannan University acquired manga in greater numbers and at a faster pace. They even set up a special section “VISUAL” in their library, bringing together Tezuka’s works, how-to books, manga on Japanese classics or history, etc. According to the chief librarian, the goal of their policy is not only to help students to learn quickly the basics they are supposed to know before entering the university, but also to arouse their curiosity in subjects they ignore.

In this connection, a spectacular example of how well manga have been adopted by higher

education is the fact that they have become a subject taught at universities, not only as a range of art techniques or as business content, but also as an art worthy of theoretical research. The Kyoto Seika University is without doubt the leader in that field by establishing a Faculty of Manga (2006), and graduate schools of Manga (Master in 2010 and Doctorate in 2012), a first in Japan. More precisely, manga research has led to a tight collaboration between the Seika University's *International Manga Research Center* (Kokusai Manga Kenkyū Sentā), the *Kyoto International Manga Museum* (Kokusai Manga Myūjiamu), and Kyoto City (see SEIKA). Moreover, the *Japanese Society for Studies in Cartoons and Comics* (Nihon Manga Gakkai) was created in 2001, currently

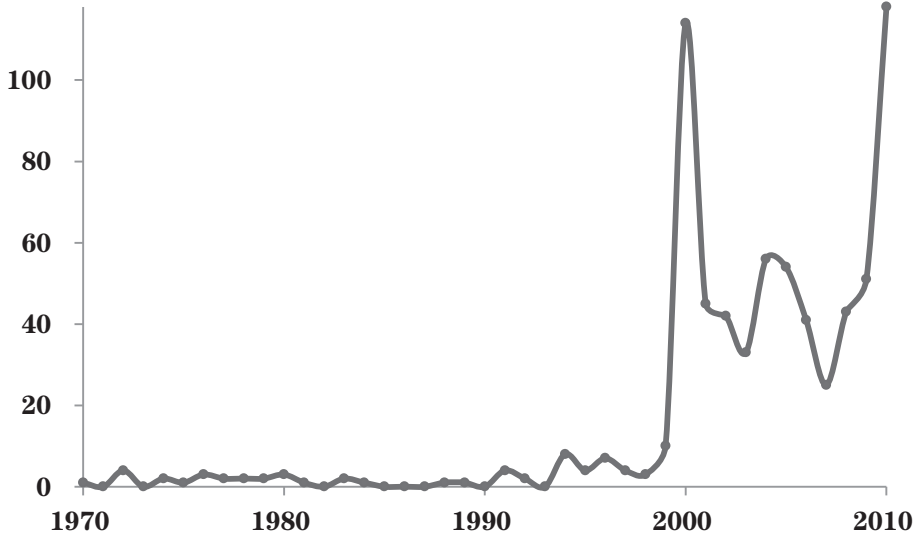


Figure 4. Number of manga related book entries in Kinki University library (Main Campus)

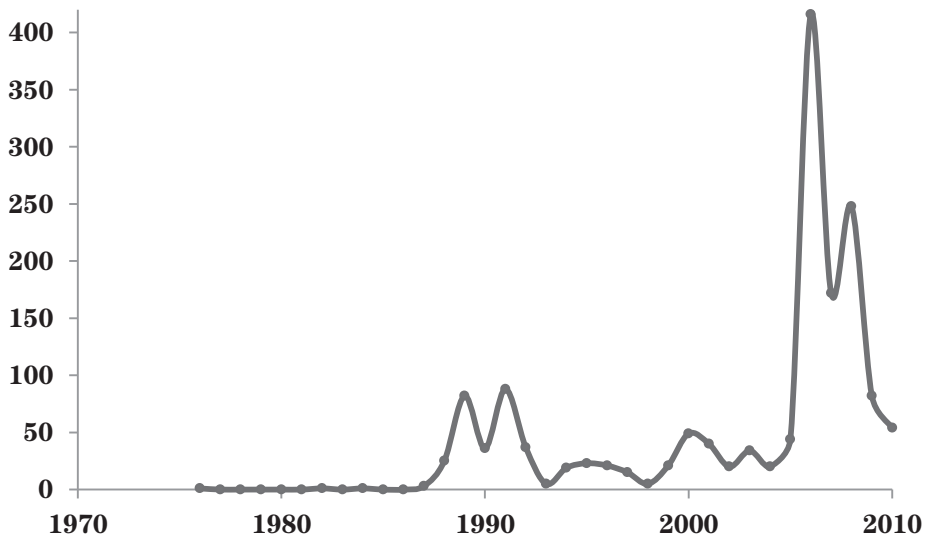


Figure 5. Number of manga related book entries in Hannan University library

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with over 440 members (see MANGA SOCIETY).

2. PEDAGOGICAL QUALITIES

The characteristics of educational and informational manga presented below are based on the analysis of two books from the representative collections previously mentioned: the *Himitsu series*, and the *Manga Guides* [E1, E8].

A. Objectives and legitimacy

These tomes come in book forms of 140 and 230 pages respectively, and the editorial teams include one supervisor knowledgeable in covered fields: a member of the Japan Meteorological Agency for *100 Secrets about the Weather*, and a professor emeritus, Ph.D. in physics, for *Universe*. This is obviously a safeguard against errors, and also a source of legitimacy.

Interestingly, the team of the child orientated manga [E1] felt nevertheless compelled to add a notice at the back to justify the selected format, a precaution suggesting that, in 1975, teachers and parents were probably still skeptical about the pedagogic qualities of comics. Their argument goes like this:

Why the manga form? When you buy a book for your child, (s)he often reads the first few pages before giving it up all together. Why is that so? Today, our children used to watching television and reading manga magazines, dislike books which contain mainly prose. They tend to read for a shorter span of time. Is there any way to get them to read until the last page? Each year we propose a volume based on textbooks edited by Gakken: *Science from the first to the sixth year*. The manga format assures that they are enjoyable and, moreover, easy to understand. [...] Of course, some people may have a negative attitude towards manga, but is there any meaning to offering even a good book to your child, if (s)he does not read it after all?

Other authorizations are printed on the same page: a recommendation by the National Congress of Parents and Teachers Associations of Japan; and a poll showing that 87% of the children want to read manga to learn, and 96% of the parents want their offspring to read them.

By contrast, there is no explicit justification to be found in the book *Universe* (2008). However, the development team of Ohmsha Editions kindly answered my queries about their reasons for publishing their *Guides*:

These years, facing a general decline in the motivation to learn (a distaste toward difficult technical books), this series is the product of our quest for a more enjoyable method to learn. Technically speaking, this is an “educational manga” for adults. [...]

More precisely, our target readers are men of between 20 and 40 years old, who are not eager to read standard textbooks but who want nevertheless to get some knowledge easily.

From a means of remedying a child's lack of interest in reading, manga has become a media to counteract the young people's disinterest in science.

Beyond these intentions, what are the pedagogical advantages of comics?

B. Texts & illustrations networks

It is well known among educators that, in pedagogical settings, combinations of texts and images are more effective than pure texts. Why is that? Paivio (2007) argues in his dual coding theory that thinking involves the activity of two distinct cognitive subsystems, a verbal one and a non-verbal one, specialized respectively in linguistic, and nonlinguistic matters. While they can function independently or cooperatively, depending on the task under way, the memorization of words or events is a combination of verbal and nonverbal memory codes, the latter contributing more to the combined effect. Therefore, imagery in educational settings helps learners to build up their long term memories that constitute knowledge (Paivio, 2007, 12-15, 433-444). Tamada (2008) mentioned two other studies confirming the previous conclusion: Larkin & Simon (1987) showed that drawings were more efficient than sentences for explaining a pulley use, for example, in physics laboratory experiments; and Gyselinck & Tardieu (1999) demonstrated that the reader's general understanding is increased by adding graphs which make explicit the causality relations structuring the text.

Since comics are sets of pictorials, or other images, juxtaposed in deliberate sequences, and include speech bubbles or captions (McCloud, 1994, 20-21), they appear as natural media for teaching and learning. But beyond that intrinsic structure, a deeper level can be found in educational and informational manga: entire parts of comics are combined with other types of documents. In the *Himitsu series* book, sections are often composed of comics completed by illustrations and/or photographs (see Appendix 4).

The *Manga Series* volumes show an even richer structure. In *Universe*, the story manga (58%) is truncated into blocks, alternating with 1. text chunks (34%) expounding astronomical subjects — sometimes supported by charts and mathematical formulae — and 2. pure dialogue pieces (8%) in which protagonists exchange views about the theme under discussion (see Appendix 4). Further, color pictures of planets of our Solar System complete the book. In a minor sampling of five people—knowing little or nothing about cosmology—one could check that this type of make-up fosters reading motivation. Three university male students and two mature women were given the book (230 pages) for a week, along with one requirement: to stop altogether the reading if they felt bored or lost. According to the questionnaires they filled in later, they all completed the reading, and agreed that the manga narrative helped them to keep going through the volume. Moreover, they showed an interest in learning more about that subject (in regular books, or in manga format).

C. Contextualization of knowledge

On the other hand, the educational and informational manga most often stage a “teacher” — a professor, a scientist, a father, etc. — bringing some enlightenment to “learners” of the target reader's age, and placed in academic situations — in classrooms and schools — or in daily life. More concretely, the *Himitsu* volumes often feature a boy who is curious but a bit of a scatterbrain, and a girl who is generally practical, assisting the professor, or calling the boy to order. Funny secondary characters also add comical effects to these stories. In *Universe*, five protagonists (3 high school girls, including an American exchange student, one male freshman, and one professor of astrophysics) are

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conceiving a play for an arts festival, about an odyssey to the “edge” of the universe. Besides this contextualization, the protagonists follow Japanese sociolinguistic rules of interaction, and numerous Japanese cultural elements are present (a young thunder god in *100 Secrets about the Weather*, or the *Tale of the Bamboo Cutter*, a 10th century Japanese folktale, in *Universe*), enhancing the concretization effect. Readers can thus easily identify themselves with one of the characters, and become part of the depicted world. They look at the scientific content from a subjective viewpoint, and the manga can achieve a greater impact on their learning process than would have a neutral and objective transmission of information (Morita, 2009, 100-103).

Alongside this socio-cultural contextualization, the exchanges between characters fulfill another important function in creating different levels of enunciation, i.e., a “polyphony” as defined by the Russian scholar Mikhail Bakhtin (1895-1975). To him, all thinking processes are underlain by continuous dialogues, external or internal, with real or virtual partners. Therefore the act of thinking means to “listen” to as many “voices” as possible (Suzuki & Kato, 2009). To explain complex topics, some of the dialogues in *Universe* are even reduced to “talking heads” lines (see Appendix 4).

Finally, the scientific content is embedded into narrative devices, creating the motivation to complete the reading. The facts are also easier to remember than if they were just chunks of information strung together. In fact, a narrative form gives every element a logical place in the world, rendering it understandable (Habermas, 1987, 136).

D. Humour

Another important ingredient in the learning process is humour. For instance, Delgatto showed that “celebration of carnival” and the “grotesque”, other concepts from Bakhtin’s theories, are useful in pedagogical settings by promoting joy and laughter (Delgatto, 2011, 12-15, 22-24). Making fun of the “teacher” in the story is to be related to the “carnival”, which represents a temporary escape from hierarchies; and distortions in physical appearance, to the “grotesque” which corresponds to a degradation of what is considered spiritual to something mundane and common (Bakhtin, 1984, 19). Intuitively, this last concept shares deep ramifications with the “dream-work”, a concept elaborated by Sigmund Freud (1856-1939), which is the transformation of latent thoughts into deformed contents in dreams, that is to say, into images (see also DW; Tisseron, 2000).

3. SCIENTISTS’ REPRESENTATIONS AND SCIENTIFIC KNOWLEDGE

But what about the representations of S&T in this genre? Scientists are shown more in their educational role than in their research function. Even though they seem more “normal” than in SF manga, some of the stereotypes identified in the previous chapter are still spotted: male, wearing a lab coat, and often with a disorganized hair style. In informational manga, they may appear cooler, and faculty professors are given as reliable sources of information. Still, the representation remains blind to one crucial aspect of the contemporary scientists’ reality, i.e., their membership to a community whose main driver is the publication of academic articles (e.g. Fujigaki, 2003, 13-30). Even in biographies of famous scientists, as in Einstein’s [E3], they appear more like heroes, with so few of the common human’s failings, often sacrificing their normal life for the sake of science and/or the people.

On the other hand, the scientific knowledge presented in this genre is generally settled at the manga publication time: few, if any, controversial topics are included; neither are researches in progress. The manga about the weather does not mention any societal problems such as the global warming (but it was edited in 1975). Interestingly, recent Korean *manhwa* for children, translated into Japanese, do touch on that issue, and on what to do to survive related calamities [E19].

The development team of Ohmsha Editions also select domains for their collection on the basis of the stability criterion: they favour subjects that do not change much with time, or which are universal (Uzu Hiroshi, private communication). Yet, *Universe* gives an account of some topics still unsettled to this day: dark matter, dark energy, Weakly Interacting Massive Particles, and so on, which are found in popular science magazines (as *Newton*).

Finally, information can take various forms, from phenomena's personification (raindrops or wind speaking like humans) to drawings and pictures, to technical graphs and mathematical formulae. This shows the deeply dialogic nature (as defined by Bakhtin) or the rich intertextuality (the French equivalent) of pedagogical manga, i.e., the presence of a continual dialogue with other works of science and other researchers (hint from Suzuki & Kato, 2009).

In conclusion, education and information manga (EIM) enjoy several advantages to teach S&T to children, and adults: they are 1. Supervised by specialists; 2. Better designed than SF manga for pedagogical purposes; 3. Built on dialogism and narrative form; 3. keeping the reader's motivation high through the networking of texts & illustrations; and 4. the presence of humour, of course, is an important ingredient to facilitate the learning process.

In Part 2 (to be published), we will see that EIM is the closest category to the usual science popularization, i.e., a tool to integrate scientific and technological knowledge into the culture.

IV PRACTICAL AND FUNCTIONAL MANGA

Representations of science and technology can be found in a third kind of manga that I call "promotional" manga. They are product advertisements or explanatory brochures commissioned by clients. Unlike their entertainment and pedagogical counterparts, these rarely find their way into libraries or book shops, and are so integrated into the social life that people and researchers tend to overlook them. For that reason, they are sometimes nicknamed "invisible manga" (Fujimoto, 2007).

1. HISTORICAL CONTEXT

A. Practical manga (*jitsuyō manga*)

The pioneer in the field is held to be Okazaki Mitsuru who created the company Trend-Pro, in 1988, specializing in the promotion of manga for companies (Schodt, 1996, 295). The number of clients grew from 50 to 100 in the first two years, but the orders from corporations dropped when the Japanese economy bubble collapsed. This was balanced by an increase in commissions from public offices, such as Chiba prefecture and its Environment White Paper — handed out to children in prefectural primary and intermediate schools; or from the Environment Agency's for its White Papers, from the start of the 90s to about year 2000. Around the same period, the Bank of Japan

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ordered an introductory manga on money matters, also handed out to school pupils. Today, they produce manuals and booklets for IT companies, financial bodies, manufacturers, and publishers such as Ohmsha (see OKAZAKI). It is interesting to notice that since 2005, the Ministry of Defense has been publishing its White Papers in a graphical novel format — the last one depicting the Self Defense Forces activities in Tōhoku devastated regions after the 3.11 earthquake and tsunami (see MANGA-DOF).

This state and business investment in manga from the middle of the 1980s unveiled the urgency for these institutions to find new means of communication with society. Indeed from that time, large enterprises and national institutions were searching for a means to diffuse new social and cultural values, and with a view to having social bodies cohere better. In this way, manga have become a tool for the business and political worlds to pass on their ideologies to employees and youngsters. On the other hand, manga productions, which were in need of readers (baby boomers had grown up), exploited that official legitimization in restricting themselves to officially ‘respectable’ or ‘cultured’ themes, while censoring ‘bad manga’ from their publications. Editorial committees therefore began to give their preference to artists with similar political orientation, and so the manga media from left-wingists (critical of the system) turned towards being more conservatist (Kinsella,1999).

B. Business Promotion Bureau of Kyoto Seika University

From around 2005, a new type of production made its appearance. We have seen above how active Kyoto Seika University (KSU) was in manga studies, but one department remains to be described: the Business Promotion Bureau (Jigyō suishin shitsu), founded in 2004. This office is entrusted with 50 to 60 orders each year of educational materials, informative booklets, publicity/PR documents, for private companies or the Kyoto prefecture government, to be drawn by manga artists graduated from KSU.

Manager Kurotobi Keiko points out that features unique to the office are not only the collaboration with the Manga Faculty itself, but also the access to other Faculties’ networks and know-how made available by Seika University, and exploited notably for the production of technical manga (SANGAKUKAN, 2009). The artist can therefore get out of her/his field, and even the university. For example, before the drawing of *The Leading Town in Cosmology*, which is a story about the Kamioka Observatory and the 2002 Physics Nobel Prize winner Koshihara Masatoshi [P1], *mangaka* had to interview specialists about elementary subatomic particles, and to go to Gifu prefecture to see neutrino detectors with their own eyes. The manga was ordered as a commemorative booklet for local children to be proud of their town’s achievements in science and technology.

In this way, the Bureau gives preference to products that play an educational or social role — and tend to reject purely commercial or erotic manga — since those are a “brand” of KSU (Kurotobi Keiko, interview, 2010).

C. Functional manga (*kinō manga*)

2010 can be considered as the starting year for *functional manga* (*kinō manga*), with the launch of the *Asbestos Manga Project*, a joint research project between the Graduate School of Humanities of Kobe University — in charge of information-gathering about silicate minerals and related illnesses —

and the KSU's Graduate School of Manga — responsible for the presentation.

Unlike practical manga, functional ones are not constrained by commissioner's intentions, but are rather designed to present and convey information as freely as possible. Moreover, the covered topics are more challenging than in other categories: explanation of societal issues, presentation of research findings, introduction of medical treatments, etc. In short, the "function", advocated by Takemiya Keiko, means the role that manga could play in society, for instance in calling the public's attention to certain dangers (Ogawa & Tsuru, 2011).

But what exactly are the functions of this category?

2. FUNCTIONAL QUALITIES

Most of the manga considered in this section were provided by the Business Promotion Bureau of KSU, probably causing some distortion in our analysis. However, I think that the following instances show interesting applications of manga in various sectors.

A. Role in traditional industries

Manga brochures or leaflets about traditional products can be found in Kyoto shops, or are distributed in schools. The goal is not so much to sell merchandise, than to place the item in Japanese history, to describe its manufacturing process, to show its characteristics, and to inspire the reader with new uses in everyday life. In short, these manga partly contribute to the survival of local craft industries, for example the Kyoto traditional paperboard [P17], or fan [P18]. The *Legend of Nuridon* (see NURIDON), another case, helped to boost sales in traditional lacquer ware, in Niigata prefecture (Fujimoto, 2007).

Other graphical novels praise the *monodzukuri* or skilled manufacture, a critical asset for Japanese modern industries and new technologies [P3, P8, P9].

B. Role in hospitals

Manga can also be useful in the medical world. First it must be said that doctors find drawings more practical than photographs for their work or conferences. The reason resides in the fact that photos show everything, even inessential details. In addition, the crucial sections are often saturated in blood which reflects the light and blurs the picture. On the contrary, sketches bring out shapes and arrangements distinctly, and ignore secondary elements.

Secondly, manga can help surgeons to carry out informed consent, i.e., to help patients or families to take a decision based upon a clear understanding of the facts, implications, and consequences. For instance, the Kyoto Prefecture Medical University ordered manga, placed at hospital reception desks, about subarachnoid and cerebral haemorrhages (see SANGAKUKAN).

Indeed, a patient who arrives at the emergency room is still in shock, and has difficulty comprehending the situation, all the more if the surgeon expounds his/her case with medical terms. A manga may prove useful: family members can take it back home to read it calmly, and later speak with their afflicted relative about the sickness, surgical options, and rehabilitation. Also, drawings somehow cushion the shock since they are less dreadful than photos. Obvious constraints are in order: the content should be easy to understand, readable in one shot, and dramatization should be

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kept to a minimum (Kurotobi Keiko, interview, 2010).

C. Role in knowledge clusters

Finally, in reaction against disaffection towards science, manga [P10, P11, P12, P13, P14] have been commissioned by Kyoto City, and handed out to local school pupils, to arouse the children's curiosity about — and to encourage vocations in state-of-the-art research carried out in Kyoto. The subjects can be complex, like the femtosecond laser, but manga are so appealing that schoolboys and girls grasp them and read them without feeling daunted by the content. Needless to say, these graphical novels cannot be a substitute for academic courses. They can however trigger an interest in sciences or engineering (Kurotobi Keiko, interview, 2010).

In fact, in order to revitalize local economies, the Japan Ministry of Education, Culture, Sport, Science & Technology is establishing knowledge clusters, i.e., systems combining advanced research conducted by universities, and unique technologies owned by manufacturers, aiming at creating new products. Among them, the *Kyoto Environmental Nanotechnology Cluster* will address issues in global environment and medical treatments, with the help of nano S&T (see KENC).

3. SCIENCE AND TECHNOLOGY REPRESENTATIONS

Intended for young people, technoscientific information in practical manga are partly similar to those found in educational ones: 1. Engineers and physicians play the same role: tutors or models (see covers in Appendix 5), living in a rather utopian society; and 2. Both categories share the feature of being edited under the direction of a specialist in the studied field.

Some differences nevertheless need to be underlined:

First, about the sort of knowledge encountered in practical graphical novels. Often the provided information is not yet definitive: research is still in progress or yet to be conducted, such as in the brochures for the Kyoto knowledge cluster.

Secondly, being promotional devices for companies, these manga also tend to show science as a tool at the service of technology and industrial developments, i.e., producing goods for consumers. In other words, science is scaled down to its applications and commercial spin-offs. For example, *Next Generation Semiconductor Materials* [P12, cover page] gives the impression that research in nanosciences is carried out to produce better parts and materials for home appliances and cars (to be less resource-wasting and more energy-efficient).

Thirdly, narratives frequently conclude with young characters deciding to dedicate their lives to research in the depicted field, and ensure a radiant future for the society. Of course the goal of these manga is to convince the readers of the significance of scientific explorations. However, S&T should not be presented as a sure source of progress and happiness, especially today, after the nuclear accident at Fukushima (11 March 2011). Technology is a source of risks and uncertainties that must be evaluated and controlled. Nothing of the kind is suggested here about nanotechnologies, and too little about nuclear energy production [P7, 38].

In the same vein, the atmosphere in medical manga is convivial and well-behaved. In *Handbook on Clinical trials* [P16], for instance, the reader is guided by a cute nurse kindly encouraging him/her to

volunteer for clinical trials of new medicines. For youngsters, it is probably natural to trust that lovely character without much questioning, but again risks should have been touched upon and not avoided.

On the contrary, technoscientific information found in functional graphical novels is presented in a less biased way; their contents can even be close to what you can read in newspapers or academic articles. *Asbestos* (2012) [P20] is one of the most recent illustrations. Composed of nine parts drawn by different *mangaka*, the book relates the lives of various victims of asbestos-related diseases, and it states clearly where responsibility resides. In Appendix 6, three examples are given: 1. Two graphs showing asbestos importations in the UK and Japan between 1930 and 2002, and an estimation of the number of patients until 2035; 2. Regulations about asbestos, as well as the address of a webpage for more information. 3. A description of asbestos facts in the world and in Japan between 1985 and 1995, in which one learns that the Japanese government was too slow to act (the source is added); or that the Great Hanshin earthquake (1995) was the cause of asbestos being released into the air.

Clearly, in this last category, tragic testimonies are balanced by more objective data.

V PARTIAL CONCLUSIONS

Let us conclude here the first part. We have come across three types of manga depicting science and technology: *science fiction manga*, as entertainment works, *educational & informational manga*, as pedagogical works, and *practical & functional manga*, as promotional works. They will be named *S-T manga* hereafter (see Table 1).

We have noted that these graphical novel's functions have diversified with time. From an art mainly entertaining, it developed early as a tool to fight children's loss of interest in reading (educational manga), and later to combat young people's disaffection in science (informational manga). More recently, practical manga are playing a role in local industries' survival, in hospitals conducting informed consent, or in knowledge clusters trying to ensure the next generation of researchers. Finally, the functional manga, the newest type, is devised to heighten public awareness of certain societal problems.

So, considering the fact that entertainment works are becoming global, one can conclude that there is an opposite trend of manga becoming tools for local communities.

To interpret the evolutions identified in this first part, one needs to have a better grasp of what science popularization means to society. This is my goal in Part 2.

TABLE 1. Science – Technology manga

	<i>Science fiction manga</i>		<i>Pedagogic manga</i>		<i>Promotional manga</i>	
	Mixed	Pure	Educational	Informational	Practical	Functional
Function of knowledge	Entertainment		Knowledge for knowledge		Knowledge for action	
Nature of knowledge	Factoids		Basic	Higher level	PR of enterprises and organizations	Specialized information for the general public
Expert image	<i>Mad scientist</i>		Teacher		Researcher	
World	Dystopian		Neutral		Utopian	Realistic
Example	<i>Fullmetal Alchemist</i>	<i>Astro Boy</i>	<i>Himitsu series</i>	<i>Manga Guides</i>	Brochures of Kyoto City	<i>Asbestos</i>

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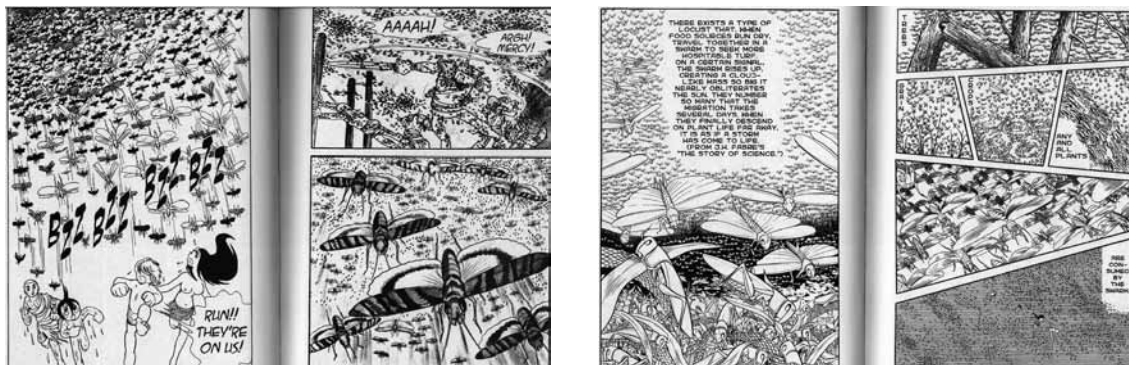
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APPENDIX 1 : EXTRACT FROM TEZUKA'S BUDDHA



[Vertical Inc, Kapilavastu, 2006, pp.112-115]

APPENDIX 2 : CONSULTED MANGA WITH SCIENCE & TECHNOLOGY

Science Fiction Manga				
n.	Title	Author · Supervisor Writer · Manga · Composition · Editor	Press / Magazine	Years
S1	Tetsuwan Atomu (Astro Boy)	Tezuka Osamu (A)	Young Magazine (Akita Shoten)	1952-1968
S2	Tetsujin 28-gō (Gigantor)	Yokoyama Mitsuteru (A)	Kōbunsha (Ushio Press)	1956-1966
S3	Eito Man (8 Man)	Hirai Kazumasa (W) Kuwata Jirō (M)	Kōdansha / Young Magazine (MSS Vol.435)	1963-1966
S4	Saibōgu Zero Zero Nain (Cyborg 009)	Ishinomori Shōtarō (A)	Akita Shoten	1964-1981
S5	Hinotori No.9 / uchū · seimei hen (Phoenix / Universe and Life compilation)	Tezuka Osamu (A)	COM	1967-1988
S6	Doraemon	Fujiko F. Fujio (W,A)	Shogakukan	1969-1996
S7	Majingā Zetto (Mazinger Z)	Nagai Go (A)	Shūeisha Kōdansha	1972-1974
S8	Kiteretsu Daihyakka (The Strange Encyclopedia)	Fujiko F. Fujio (W,A)	Shogakukan	1974-1977
S9	Uchū Senkan Yamato (Space Battleship Yamato)	Leiji Matsumoto (A)	Adventure King	1974-1975
S10	Shōnen SF Tanpen 1 (Short SF Stories)	Fujiko F. Fujio (W,A)	Shogakukan	1975-1979
S11	Ginga Tetsudō Surī Nain (Galaxy Express 999)	Leiji Matsumoto (A)	Shogakukan	1977-1987

S12	Kaze no Tani no Naushika (Nausicaä of the Valley of the Wind)	Miyazaki Hayao (A)	Tokuma Shoten	1982-1994
S13	Akira	Otomo Katsuhiro (A)	Kōdansha / Young Magazine	1982-1990
S14	Kōkaku Kidōtai (Ghost in the Shell)	Shirow Masamune (A)	Kōdansha / Young Magazine	1989-1997
S15	Puranetesu (Planetes)	Yukimura Makoto (A)	Kōdansha / Morning	1999-2004
S16	Chobittsu (Chobits)	Clamp (W,A)	Kōdansha / Young Magazine	2000-2002
S17	Kopperion (Coppelion)	Inoue Tomonori (A)	Kōdansha / Weekly Young Magazine	2008 on-going

General Manga				
n.	Title (in English) [theme]	Author · Supervisor Writer · Manga · Composition · Editor	Press / Magazine	Years
M1	Budda (Buddha) [historical manga?]	Tezuka Osamu (A)	Ushio / Shōnen Manga Magazine	1972-1983
M2	Hadashi no Gen (Barefoot Gen) [atomic bomb]	Nakazawa Keiji (A)	Shūeisha / Weekly Shōnen Jump	1973-1985
M3	Burakku Jakku (Black Jack) [medical manga]	Tezuka Osamu (A)	Akita Shoten / Weekly Shōnen Champion	1973-1978
M4	Oishinbo (Oishinbo A la Carte) [cuisine manga]	Kariya Tetsu (W) Hanasaki Akira (M)	Shōgakukan / Big Comic Spirits	1983-on-going
M5	Gyarari feiku (Gallery Fake) [art]	Hosono Fujihiko (A)	Shōgakukan / Big Comic Spirits	1992-2005
M6	Meitantei Conan (Case Closed) [detective story]	Aoyama Gōshō (A)	Shogakukan / Weekly Shōnen Sunday	1994-on-going
M7	Mushishi [Modern physics?]	Urushibara Yūki (A)	Kōdansha / Afternoon	1999-2008
M8	Jin [medical manga]	Murakami Motoka (A)	Shūeisha / Super Jump	2000-2010
M9	Hagane no Renkinjutsushi (Fullmetal Alchemist) [steampunk]	Arakawa Hiromu (A)	Square Enix / Monthly Shōnen Gangan	2001-2010
M10	Purūtou (Pluto) [detective story]	Urasawa Naoki et al.	Shōgakukan/ Big Comic Original	2003-2009
M11	Kami no shizuku (The Drops of God) [wine]	Agi Tadashi (W) Okimoto Shū (M)	Kōdansha / Weekly Morning	2004 on-going
M12	Moyashimon (Tales of Agriculture)	Ishikawa Masayuki (A)	Kōdansha / Evening	2004 on-going
M13	NachuN [hard marine SF]	Tsuru Daisaku (A)	Kōdansha / Afternoon	2006-2010
M14	Uchū Kyōdai (Space Brothers) [space manga]	Koyama Chūya (A)	Kōdansha / Morning	2008-on-going

M15	Kūsō kagaku X (Fanciful Physics X) Lesson I	Saxyun (A)	ASCII Media Works · The Nonsense of Wonder Series	2010
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Education and Information Manga				
n.	Title (in English)	Author · Supervisor Writer · Manga · Composition · Editor	Press / Series name	Year
E1	Tenki 100 no himitsu (100 Secrets about the Weather)	Shimizu Noritaka (S/meteo) et al.	Gakken / Gakken Manga · Secret Series/ (PTA recommended)	1975
E2	Manga seiza jiten (Manga Dictionary of the Constellations)	Saitō Kuniharu (S) et al.	Gakken / Gakken Manga · Dictionary Series/ (PTA recommended)	1989
E3	Ainshutain (Einstein)	Takeuchi Hitoshi (S/sc) et al.	Shueisha / Gakushū Manga · World Biographies	1992
E4	Manga saiensu (Manga Science)	Asari Yoshitō (A)	Gakushū Kenkyūsha	2002
E5	Harukana uchū 1 / Midori no hoshi · Chikyū (The Faraway Universe 1 / The Blue Planet · Earth)	Tuboi Kō (A)	Asahi Shimbun / Science Manga	2003
E6	Manga de wakuu · tōkeigaku (Manga Guide to Statistics) [English version available]	Shin Takahashi (A/ techn. writer) Trend-Pro (M)	Ohmsha	2004
E7	Uchū no sabaibaru 1 (To Survive in Outer Space)	Hong Jae-Cheol (W)/ Lee Tae-Ho (M)	Asahi Shimbun / Kagakuru Book · Science Manga Survival Series	2008
E8	Manga de wakuu · uchū (Manga Guide to the Universe)	Kawabata Kiyoshi (S/Phys. Ph.D) et al.	Ohmsha	2008
E9	Manten gakushū manga · seibutsu chikyū uchū (Perfect Educational Manga · Life Earth Universe)	Hamaguchi Ichiro (S/teach.) et al.	Gakken	2008
E10	Manga de wakuu yo no naka no shikumi · sō nan da! Shakai hen (Manga Guide to <i>How Works the World</i> · I Understand Now! The Social Section)	none	DeAgostini	2008-2010
E11	Manga · Butsuri ni tsuyokunaru (Manga / Be Stronger in Physics)	Sekiguchi Tomohiko (W) / Suzuki Miso (M)	Kōdansha / Blue Backs	2009
E12	Manga · chūgaku · rika (Manga / Lower Secondary School / Science lessons)	Tsutsui Chinatsu (M) et al.	Gakken Education	2009
E13	Gendai moe eisei zukan (Today's Illustrated Guide of Pretty Satellites)	Shikishima Fugen (A) et al.	Sansai Books	2009
E14	Manga de wakuu · ryōshirikigaku (Manga Guide to Quantum Mechanics)	Kawabata Kiyoshi (S/Phys. Ph.D) et al.	Ohmsha	2009
E15	Uchū to jūryoku no fushigi (Wonders of the Universe and Gravitation)	Aoyama Gōshō (W) et al.	Shōgakukan / Gakushū-manga Series · Science Konan	2010


E16	Uchū no fushigi (The Wonders of the Universe)	Fujiko.F. Fujio (M) et al.	Shōgakukan / Doraemon Science World	2010
E17	Menekigaku ga wakaru (Guide to Immunology)	Natsu Midori (W)/ Shin Emon (M)	Gijutsuhyōron / First Book	2010
E18	Manga de wakaru shinryō naika (Manga Guide to Psychosomatic Medicine)	Yūki Yū (W/ med.)/ Sō (M)	Shōnengahō / Young King Comics	2010
E19	Ijōkishō no sabaibaru 1 (To Survive Dangerous Weather)	Gomdori co. (W)/ Han Hyun-Dong (M)	Asahi Shimbun / Kagakuru Book · Science Manga Survival Series	2010
E20	Jintai no sabaibaru 1 (The Survival of the body)	Gomdori co. (W)/ Han Hyun-Dong (M)	Asahi Shimbun / Kagakuru Book · Science Manga Survival Series	2010
E21	Manga de wakaru bibun sekibun (Manga Guide to Differential & Integral calculus)	Ishiyama Taira (A) et al.	Softbank Creative	2011
E22	Hayabusa Love Kōza (Lessons on Hayabusa Love)	(Lecturers)	Tokuma Shoten / COMIC Ryū Henshūbu · Hen	2011
E23	Ikarosu kun no daikōkai (The Long Journey of Little Icaros)	Sawada Hirotaka (S/W) et al.	JAXA (Japan Aerospace Exploration Agency)	2011

Practical and Functional Manga				
n.	Title (in English) [theme, if not clear]	Author · Supervisor Writer · Manga · Composition · Editor	Press / Series name	Year
P1	Uchūkagaku · Saisentan no machi · Hokuto Kamioka (The Leading Town in Cosmology - Hokuto Kamioka)	Kyoto Seika University (KSU) Fine Arts Faculty Manga Section (M)/ Takemiya Keiko (S)	Gifu Prefecture Kamioka Town	2004
P2	Manga · ibunka tenaraichō (Manga - Handbook of Foreign Culture)	Culture Agency Culture Division Japanese Section (E)	Kyoto International Manga Museum	2007
P3	Kyoto monodzukuri retsuden · Shigoto mo asobi mo [omoshiro okashiku] : Horiba Masao (Biographies of Kyoto Manufacturers · Work and Pleasure must be "Fun and Amusing"): Horiba Masao	KSU · Business Promotion Bureau (BPB) (S) et al.	Kyoto Foundation · Advanced Technology Research Center	2008
P4	Yoshi! Mō "kami" de nayamanai (All Right! Don't worry any more about your "hair"!)	KSU · BPB (S)/ Kojima Eiyū (M)	Biotech Ltd.	2009
P5	Maga de miru Kyoto no kyōiku to gakuseifuku no ayumi (A Manga Guide on the History of Education and School Uniforms in Kyoto)	KSU · BPB (S)/ Enoki Akiyoshi (M)	Muratadō Ltd.	2009
P6	Manga Makuranosōshi (The Manga Pillow Book)	Kyoto Prefecture (S) KSU · BPB (E) et al.	Kyoto Culture Environment Division Cultural Arts Bureau	2009
P7	Manga de wakaru chikyū ondanka bōshi no torikumi (Manga Guide to Measures against Global Warming)	KSU · BPB (S)/ Takahashi Reika (M)	Kansai Electricity Ltd.	2010


P8	Manga de miru monodzukuri no sekai (Manga Guide to the World of Goods Manufacturing)	KSU · BPB (S)	Association for the Advancement of Kyoto Prefecture	2010
P9	Atarashii koto ni chalenji shitsuduketa otoko (The Man Who Continuously Took on New Challenges)	KSU · BPB (S) et al.	OMRON Ltd.	2010
P10	Femutobiyō rēzā (Femtosecond Laser)	KSU · BPB (E) et al.	Kyoto City / Discover Kyoto Advanced Science and Technology with Manga	2010
P11	Iryōyō maikuromashin (Micromachines for Medical Treatment)	KSU · BPB (E) et al.	Kyoto City / Discover Kyoto Advanced Science and Technology with Manga	2010
P12	Jisedai no handōtai zairyō (Next Generation Semiconductor Materials)	KSU · BPB (E) et al.	Kyoto City / Discover Kyoto Advanced Science and Technology with Manga	2010
P13	Mizutte eien no mono? (Is Water Everlasting?) [Purification of water]	KSU · BPB (E) et al.	Kyoto City / Discover Kyoto Advanced Science and Technology with Manga	2010
P14	Iryō ni kakumei wo (Revolution in Medical Treatment)	KSU · BPB (E) et al.	Kyoto City / Discover Kyoto Advanced Science and Technology with Manga	2010
P15	Mitoko, ittoko, tokotoko Kansai (Let's visit, Let's go, Kansai Pitter-Patter) [Kansai Sightseeing]	Mogura (A)	JTB Publishing	2011
P16	Manga de wakaru jiken handobukku (Manga Handbook on Clinical trials)	KSU · BPB (S) / Takahashi Reika (M)	InCROM Ltd.	[none]
P17	Kyoto · Shikishi monogatari (The Story of Square Pieces of Colored Paperboard in Kyoto)	KSU · BPB (S) / Nakasora Tomomi (M)	Kyoto Square Colored Paper Cooperative	[none]
P18	Yoku wakaru kyōsensū · kyōuchiwa (Guide of the folding fan and round fan of Kyoto)	KSU · BPB (S)	Kyoto Fan Cooperative	[none]
P19	Manga Genpatsu Rettō (The Archipelago of Nuclear Plants, Manga)	Shibano Tetsuo (A) et al.	Ōtsuki Shoten	2011 (1989)
P20	Ishi no wata (Asbestos)	Takemiya Keiko (S) / Matsuda Tsuyoshi (S)	Kamogawa	2012

APPENDIX 3 : SCIENTISTS & PHYSICIANS IN SF MANGA


1.

	<p>Name (Manga): Dr. Temma ([S1 Vol.1, p.17], 1952) Speciality: Director of the Ministry of Science (engineer) Role: He built <i>Atomu</i> out of sorrow, to replace his only son killed in a car accident. Few appearances.</p>
<i>Relationship with colleagues, and/or "technology"</i>	He sells his creation to a circus when he realizes that "it" will never age like a normal boy. (Good) 2 1 0 (-1) -2 (Bad)
<i>Relationship with family</i>	He is sorrowful when he learns about his son's death. (Good) 2 (1) 0 -1 -2 (Bad)
<i>Relationship with society</i>	Selfish and mentally instable, he is a "mad scientist". (Good) 2 1 0 (-1) -2 (Bad)
<i>General context</i>	Beginning of 21 st century; science and technology are omnipresent; mass-produced robots are serving humans (Utopia) 2 (1) 0 -1 -2 (Dystopia)


2.

	<p>Name (Manga): Dr. Ochanomizu ([S1 Vol.1, p.109], 1952) Speciality: Director of the Ministry of Science (engineer) Role: He bought back <i>Atomu</i> from the circus, and teaches him about human values.</p>
<i>Relationship with colleagues, and/or "technology"</i>	He is always helpful to <i>Atomu</i> ; often works in group, or takes part in scientific meetings. (Good) (2) 1 0 -1 -2 (Bad)
<i>Relationship with family</i>	He has no family, but becomes <i>Atomu's</i> spiritual father; creates for him two parents, a sister Uran, and a brother Cobalt. (Good) 2 (1) 0 -1 -2 (Bad)
<i>Relationship with society</i>	He is sentimental, sincere, and very smart. (Good) (2) 1 0 -1 -2 (Bad)
<i>General context</i>	Beginning of 21 st century; science and technology are omnipresent; mass-produced robots are serving humans (Utopia) 2 (1) 0 -1 -2 (Dystopia)


3.

	<p>Name (Manga): Dr. Shikishima ([S2 Vol.1, p.60], 1956) Speciality: Robotics engineer Role: He develops the super robot Tetsujin 28-go during the Pacific War for the Japanese army, but completed in 1955.</p>
<i>Relationship with colleagues, and/or "technology"</i>	He is a team leader. The creation of robots is a process made of trials and errors, sometimes requiring bold decisions. (Good) (2) 1 0 -1 -2 (Bad)
<i>Relationship with family</i>	He's married and has a boy (Tetsuō), the best friend of Shōtarō, the hero of the story. He regards him like a son. (Good) (2) 1 0 -1 -2 (Bad)
<i>Relationship with society</i>	In general, he is a mild-mannered person, and acts with composure. With a gun, he can become an action man. (Good) (2) 1 0 -1 -2 (Bad)
<i>General context</i>	Japan, from 1955 to 1964; Fights against secret societies, mad scientists, robots rampaging around. (Utopia) 2 1 0 (-1) -2 (Dystopia)


4.

	<p>Name (Manga): Dr. Tani ([S3 Vol.1, p.90], 1963) Speciality: Robotics engineer Role: Creator of 8 Man.</p>
<i>Relationship with colleagues, and/or "technology"</i>	He works alone, in a secret laboratory. He did research in US, and is a cyborg himself. (Good) 2 1 (0) -1 -2 (Bad)
<i>Relationship with family</i>	No information on his family. He cares for 8 Man. (Good) 2 1 (0) -1 -2 (Bad)
<i>Relationship with society</i>	He stole the robot he was working on in the US, because he did not want "it" to be used as a weapon. 8 Man, his creation, is a superhero fighting for justice. (Good) (2) 1 0 -1 -2 (Bad)
<i>General context</i>	That time Japan. Fighting against gangsters, a mad scientist (Dr. Daemon), a cyborg (007). (Utopia) 2 1 0 (-1) -2 (Dystopia)


5.

	<p>Name (Manga): Dr. Whisky ([S4 Vol.1, p.13], 1964) Speciality: Brain surgeon (Russian) Role: One of the kidnapped scientists that built the 9 cyborg warriors from unwilling people. Few appearances.</p>
<i>Relationship with colleagues, and/or "technology"</i>	Worked alone, in a team later. (Good) 2 1 0 (-1) -2 (Bad)
<i>Relationship with family</i>	Experimenting on his own child, against mother's will (Good) 2 1 0 -1 (-2) (Bad)
<i>Relationship with society</i>	Dedicated to his work; not interested in the society (Good) 2 1 0 (-1) -2 (Bad)
<i>General context</i>	Development of arms of destruction in preparation of a new World War; Scientists kidnapped and forced to work for an evil organization; but cyborgs fight against that project. (Utopia) 2 1 0 (-1) -2 (Dystopia)


6.

	<p>Name (Manga): Dr. Isaac Gilmore ([S4 Vol.1, p.79], 1964) Speciality: Scientist Role: One of the kidnapped scientists; He assisted in the 9 cyborgs' escaping</p>
<i>Relationship with colleagues, and/or "technology"</i>	Does not want other scientists to be hurt; Helping cyborgs (Good) (2) 1 0 -1 -2 (Bad)
<i>Relationship with family</i>	No information on his family. He cares for the cyborgs. (Good) 2 1 (0) -1 -2 (Bad)
<i>Relationship with society</i>	He understands that his colleagues have been tricked, and asks for forgiveness. (Good) 2 (1) 0 -1 -2 (Bad)
<i>General context</i>	New World War in preparation, with new technology; Abducted scientists working for an evil corporation (Utopia) 2 1 0 (-1) -2 (Dystopia)


7.

	Name (Manga): Dr. Kabuto Jūzō ([S7 Vol.1, p.8], 1972) Speciality: Inventor (engineer) Role: Built the super robot Mazinger Z
<i>Relationship with colleagues, and/or "technology"</i>	Works alone in a secret laboratory; Created the meka to protect Japan (Good) 2 1 ① -1 -2 (Bad)
<i>Relationship with family</i>	Lives with his two grandsons, but dies at the beginning of the story, after entrusting the machine to one of them, Kōji. (Good) 2 ① 0 -1 -2 (Bad)
<i>Relationship with society</i>	Megalomaniac tendency; Says to Kōji that he can be equal to the gods, and control the world; slightly mad scientist (Good) 2 1 0 ① -2 (Bad)
<i>General context</i>	That time Japan; Technology to conquer Japan, and the world, intense local destructions (Utopia) 2 1 0 ① -2 (Dystopia)


8.

	Name (Manga): Pr. Yumi Yanosuke ([S7 Vol.1, p.85], 1972) Speciality: Head of the Photon Power Labs (professor of mechanics) Role: Built Aphrodi A, helping when Mazinger Z is deadlocked
<i>Relationship with colleagues, and/or "technology"</i>	Team leader; he advises Mazinger Z and Aphrodi A to complete their missions: (Good) ② 1 0 -1 -2 (Bad)
<i>Relationship with family</i>	He has a daughter, Sayaka, the pilot of Aphrodi A. He cares for her; always in his laboratory (Good) 2 ① 0 -1 -2 (Bad)
<i>Relationship with society</i>	Serious, sense of responsibility, conscious of funds invested in robot development (Good) ② 1 0 -1 -2 (Bad)
<i>General context</i>	That time Japan; Technology to conquer Japan, and the world, intense local destruction (Utopia) 2 1 0 ① -2 (Dystopia)


9.

	Name (Manga): Black Jack ([M3 Vol.1, p.9], 1973) Speciality: Surgeon Role: Main character
<i>Relationship with colleagues, and/or "technology"</i>	Works alone most of the time, or is helped by Pinoko; He has miraculous skill in performing operations. (Good) 2 1 ① -1 -2 (Bad)
<i>Relationship with family</i>	He has lost his parents; living with Pinoko, a little girl incapable of growing, in a house isolated by the sea. (Good) 2 ① 0 -1 -2 (Bad)
<i>Relationship with society</i>	He caters to outlaws as well, and charges a great deal of money for his operations. (Good) 2 1 0 ① -2 (Bad)
<i>General context</i>	That time Japan; ambiguous world (Utopia) 2 1 0 ① -2 (Dystopia)


10.

	Name (Manga): Pr. Sado Sakezō ([S9 Vol.1, p.43], 1974) Speciality: Yamato battleship surgeon Role: To ease the tension in the manga through comical situations
<i>Relationship with colleagues, and/or "technology"</i>	Only scientist on board the Yamato; Former veterinary surgeon (Good) 2 1 ① -1 -2 (Bad)
<i>Relationship with family</i>	No information (Good) 2 1 ① -1 -2 (Bad)
<i>Relationship with society</i>	good humored but can be earnest; always gives advice (Good) ② 1 0 -1 -2 (Bad)
<i>General context</i>	Year 2199; Earth's surface is inhabitable because of radioactive meteorites sent by an alien race; it remains one year before the end of humanity (Utopia) 2 1 0 -1 ② (Dystopia)


11.

	Name (Manga): "father of Yūko" ([S10 Vol.1, p.109], 1976) Speciality: Cellular genetics, former university professor. Role: Main character
<i>Relationship with colleagues, and/or "technology"</i>	His research is misunderstood by his colleagues; knowledge can be used for private ends (Good) 2 1 0 ① -2 (Bad)
<i>Relationship with family</i>	His daughter Yūko just died, and he is deeply sad about it; tries to keep her spirit alive (Good) 2 ① 0 -1 -2 (Bad)
<i>Relationship with society</i>	He is using other kids' bodies to keep his daughter "alive"; mad scientist (Good) 2 1 0 -1 ② (Bad)
<i>General context</i>	That time Japan (Utopia) 2 1 ① -1 -2 (Dystopia)


12.

	Name (Manga): Doctor (Ōnishi) ([S13 Vol.1, p.121], 1982) Speciality: Head scientist of a secret psychic research project Role: Colonel (Shikishima) 's scientific advisor
<i>Relationship with colleagues, and/or "technology"</i>	Team leader; "sorcerer's apprentice" in trying to control unknown forces (Good) 2 1 0 ① -2 (Bad)
<i>Relationship with family</i>	No information (Good) 2 1 ① -1 -2 (Bad)
<i>Relationship with society</i>	His curiosity and negligence are responsible for Tetsuo's destructive power; experimentation on children (Good) 2 1 0 -1 ② (Bad)
<i>General context</i>	Neo-Tokyo, 2019, post-apocalyptic city; cyberpunk genre; Science is under the thumb of the military (Utopia) 2 1 0 -1 ② (Dystopia)

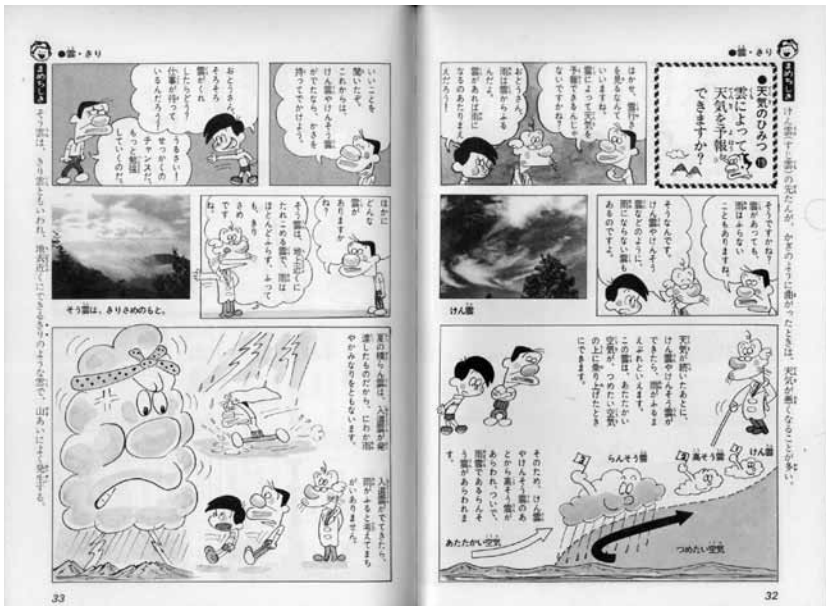
13.

	Name (Manga): Agasa Hiroshi (M6 Vol.1, p.120, 1994) Speciality: Genius inventor Role: technical support for Conan's investigations
Relationship with colleagues, and/or "technology"	Working alone; creates devices for Conan Edogawa (Good) 2 ① 0 -1 -2 (Bad)
Relationship with family	No information; he cares for Conan, and Miyano Shiho (Good) ② 1 0 -1 -2 (Bad)
Relationship with society	Absent-minded professor; Indirectly helps for investigations (Good) 2 ① 0 -1 -2 (Bad)
General context	That time Japan; detective stories (Utopia) 2 1 ① -1 -2 (Dystopia)

14.

	Name (Manga): Minakata Jin (M8 Vol.1, p.18, 2000) Speciality: Brain surgeon Role: Main character
Relationship with colleagues, and/or "technology"	Working in team; skilled surgeon (Good) ② 1 0 -1 -2 (Bad)
Relationship with family	Single. Dropped by his girlfriend. (Good) 2 1 ① -1 -2 (Bad)
Relationship with society	Helpful; Saves people with diseases or injuries (Good) ② 1 0 -1 -2 (Bad)
General context	Present-day Japan AND end of Edo period (Timeslip); Use of contemporary medical knowledge around the 1860s (Utopia) 2 ① 0 -1 -2 (Dystopia)

APPENDIX 4 : EDUCATIONAL AND INFORMATIONAL MANGA (Extracts)



100 Secrets about the Weather [E1, pp.32-33]
Can you predict the weather by looking at the clouds?



Manga Guide to UNIVERSE [E8, p.46]
About the size of the Moon, Earth and the Sun



Manga Guide to UNIVERSE [E8, p.54]
About the revolution of Earth around the Sun, and Galileo

APPENDIX 5 : COVER PAGES OF PRACTICAL MANGA



[P14, P10, P13, P12]

APPENDIX 6 : DATA FROM "ASBESTOS", A FUNCTIONAL MANGA

1. **石の結**

石の結

1950 35 45 55 65 75 85 95 2000 02

日本の 世界の

1950 35 45 55 65 75 85 95 2000 02

2. **日本の動き**

1985年 片断性シメカのカ
持込による
「静かなる暗殺事件」
1fasbestos
（産業用）発行
（産業用）発行

1987年 「学校ハニック」
BANAN
（子供向け）発行

1988年 大塚和由が
内閣府に
「石の結」を提出

1989年 特定初めに石綿指定
敷地指定における
大塚1号あり
10本の指定禁止
（大塚1号指定禁止）

1995年 三井物産大塚
含有製品
製造・輸入・供給
使用禁止

1990年代 欧州連合で
アスベスト使用全面禁止に
決定

1995年 オルネクスが
被害者による運動の始まり

3. **世界の動き**

1982年 英国アスベスト規制強化
代わり
トクメック
「Eco-King」放映
ジョンズ・マンビル社
アスベスト

1984年 ノルウェー
アスベスト使用全面禁止

1986年 石綿禁止に付る
安全な管理が禁止が争点

1987年 米国
「Eco-King」放映
ジョンズ・マンビル社
アスベスト

1988年 米国
「Eco-King」放映
ジョンズ・マンビル社
アスベスト

1989年 米国
「Eco-King」放映
ジョンズ・マンビル社
アスベスト

1990年代 欧州連合で
アスベスト使用全面禁止に
決定

1995年 オルネクスが
被害者による運動の始まり

[P20] (1.= p.40 / 2.=p.126 / 3.=pp.118-119)

(2013年11月29日掲載決定)