

Does Ishiguro Dream of Electric Sheep?
Androids as a distinctive emergent phenomenon in Japan

by

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BA, Haifa University, 2012

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Supervisory Committee

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Abstract

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The Japanese robotics industry stands out in both its scale and its diversity of innovations. No other country has put so much effort in research and development of humanoid robots. This phenomenon has been widely discussed in academic scholarship, and cultural, religious and socio-economic influences are widely cited as contributing factors to the shaping of robotics in Japan. This work is focused on a specific and relatively new product of this industry: the robot in human image, the android. The main feature that separates androids from humanoid robots is external appearance, a design aspect that has no operational function. This work attempt to offer a holistic theory for the existence of an entire field of study dedicated to creating robots that look just like humans.

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Dedication

To Murphy,

For now, I win.

Chapter 1- Introduction

*“Let us make man in our image,
after our likeness...”*

-God (allegedly), book of Genesis 1:26

Passengers arriving in Japan’s Narita airport earlier this year were greeted and welcomed to the country by the instantly recognizable ASIMO, Honda’s most famous robot¹. The company offers some background information on the temporary attraction in Narita airport:

ASIMO is a bipedal humanoid robot Honda has been developing with a goal to develop robots that will coexist with and be useful to people.[...]The latest version of ASIMO, introduced in November 2011, features not only high physical capability that allows it to make not only various moves such as running, going up and down stairs and kicking a ball, but also an ability to recognize faces/voices of people and take action accordingly and autonomous behaviour control such as avoiding obstacles depending on the situation of the surroundings. (Honda Worldwide)

The Japanese robotics industry has been leading the world for decades. Japan has more industrial robots than any other country, and the same is true for service and entertainment robots as well. This earned Japan the nickname Robot Kingdom a few decades ago, and it seems that the country will not be losing this title in the foreseeable future.

¹ The demonstration took place during a week at the end of March and the beginning of April, 2016.

Countless books and papers in many languages were written about the Japanese robotics industry, how it came to be, and what makes it stand out. Almost all the research done on this topic, going back a few decades, recounts the socio-economic, religious, and cultural circumstances that helped create the Japanese robotics phenomenon. From early industrial robots to humanoid robots, like ASIMO, the innovation in robotics research and development in Japan keeps marching forward. The latest, and most radical, in the line of advanced robotics are certainly androids.

Androids are humanoid robots with human-like appearance. Instead of a shiny plastic or metal exterior, they have artificial skin, hair, noses, even eyelashes. On an evolutionary chart of robots, androids would certainly be the newest addition, preceded by humanoid robots. This generally leads to the perception that androids are the next level of development after humanoid robots. It is very common to look at technological progress in various fields in terms of 'evolution'. For instance, after the desktop computer was sufficiently functional, efforts began to create a compact and portable version. The laptop was a clear 'next step' in the evolution of the computer industry.

When applied to androids, this evolutionary analysis works only in a very narrow, linear, sense. From a chronological standpoint, it is accurate that androids were developed after humanoid robots. It is also true that android developers benefited from existing technologies that were used to build humanoid robots. However, this was not a conceptual evolution of an existing technology. Most technological advancements are at least partially based on the question: how can we make it even better? The large stationary computer was great, but a smaller, lighter one that is also portable, is better. The same does not apply to androids.

As fascinating as androids are, they are in no functional way ‘better’ than humanoid robots. And yet, they exist. As will be discussed at some length in the fifth chapter, building androids is a complicated and time consuming task. It is also very expensive. The Japanese government is involved in funding these projects, thus making androids harder to dismiss as a mere curiosity. The most interesting thing about androids is that they exist, even though the one attribute that separates them from humanoid robots, their external appearance, has absolutely no function.

If we take into account the years of research, the technological challenges, the support of top universities, as well as government funding, androids cannot be deemed a frivolous technology. Significant as well is the fact that Japan has very little competition in the field of android research. As previously mentioned, the academic literature on Japanese robotics is vast. As for androids, works from the past decade exploring the unique factors that shaped the Japanese robotics industry mostly regard them as an offshoot of the more established humanoid robots. These unique factors are undeniably applicable to androids, and yet, do not fully explain them.

A question that remains unanswered in existing literature is: why build human looking robots? If their design does not have any practical reasoning behind it, why do it, and how did Japan become the centre of this phenomenon?

This project attempts to offer a holistic reading of the creation and development of androids in Japan by employing a multidisciplinary approach. Insight from literary studies, religious studies, engineering, sociology, anthropology, and media studies, among others, are incorporated into what is hopefully a coherent perspective of the Japanese androids phenomenon. The project, naturally, relies heavily on research

conducted on the Japanese robotics industry, and the (until recently) uniquely Japanese phenomenon of humanoid robots. Later chapters explore the motivations and views of the leading android scientist, Dr. Hiroshi Ishiguro. His perspective is an essential factor in understanding how androids stepped from fiction into reality.

Conceptually, this project approaches androids as an emergent phenomenon. This very unique technology is created by, or emerges from, interactions and intersections of many factors and influences. The following chapters of this work explore this network of influences.

Our relationship with technology throughout history has been complicated. There are many ways and methods to analyse its development and impact. Do we control it, does it control us, or is it something in between? A very short story from more than half a century ago illustrates this point. The plot of *Answer*, written in 1954 by Fredric Brown, begins at a point in time, far in the future, when the final touches are being made to a massive project “that would connect, all at once, all of the monster computing machines of all the populated planets in the universe--ninety-six billion planets--into the supercircuit that would connect them all into the one supercalculator, one cybernetics machine that would combine all the knowledge of all the galaxies.” Shortly after, as the story goes, when the preparations were completed, the main switch was thrown, and “there was a mighty hum, the surge of power from ninety-six billion planets.” The story ends after the first question is presented to the super-computer:

"It shall be a question that no single cybernetics machine has been able to answer." He turned to face the machine. "Is there a God?" The mighty voice answered without hesitation, without the clicking of single relay. "Yes, now

there is a God." Sudden fear flashed on [his face]. He leaped to grab the switch. A bolt of lightning from the cloudless sky struck him down and fused the switch shut. (Brown 23)

This very short story is probably more relevant now that it was at the time it was written. Advances and developments in Artificial Intelligence draw some criticism, and occasional ominous warnings that if our human-built AI will become advanced enough, we will lose control. *Answer* perfectly captures what detractors would call the potential price of human curiosity, pursued at all costs. Although particularly fitting when discussing AI, the story raises larger questions regarding technology, its ability to change our societies, and our ability to steer its progress into beneficial avenues.

The second chapter broadly deals with these issues. It briefly reviews three popular approaches to the social study of technology: the deterministic approach, social construction, and actor network. The latter part of the chapter examines some of the perceptions and fears often associated with advanced technologies. How we think about technology, and how technology makes us feel, are important contextual considerations for the following chapters.

ASIMO, the friendly humanoid robot mentioned above, has long been Honda's best ambassador, and occasionally seems to represent Japan as well. One such instance from 2003, as described on the company's website:

ASIMO visited the Czech Republic [...] attending a dinner in Prague [...] and excellently fulfilling the role of goodwill ambassador of Robots. [...] One of the purposes of ASIMO visiting the Czech Republic was to assist in deepening relationships between Japan and the Czech people. [...] ASIMO then visited

Prague and met the Czech Prime Minister Vladimir Spidla at dinner, accompanying Japanese Premier Junichiro Koizumi as the 'Goodwill Ambassador for Robots'. ASIMO greeted guests at the dinner in Czech, and proposed a toast with a champagne glass in hand. There was a smile on everyone's face and a round of applause broke out when ASIMO announced 'I am still a child and therefore I cannot drink this'. (Honda Worldwide II)

No trip to Prague by a robot can be complete, of course, without a visit to the statue of the man who came up with the work 'robot', Karel Čapek, and pay his respects.

The third chapter explores both ASIMO and Čapek at some length. The first part of the chapter reviews the history of robotics, mainly in Japan: from centuries old traditional crafts, through the invention of the word 'robot', to modern times. The second part of this chapter discusses various social, religious, cultural, and demographic factors that contributed to Japan becoming the 'Robot Kingdom'. Before the discussion moves to androids in a later chapter, the history of robotics in Japan provides for a better understanding of the environment and circumstances behind their creation.

The fourth chapter offers a more nuanced view of the religious, cultural and spiritual landscape in Japan. The first part explores the concepts of nature, animism and mimesis, and how they shaped an environment that contributes to the Japanese society's views of technology. The second part of this chapter focuses on technological interpretations of abstract concepts, such as technological animism and bio-memetics.

Franz Kafka's thought provoking work *The Metamorphosis* explores what happens when a man wakes up one morning and subsequently discovers that he was transformed into an insect. In 2014 the story was adapted for the theatre stage, with some

alterations. Instead of waking up as a bug, the protagonist wakes up to discover that he is now an android. This play, called *La Metamorphose version Androïde* is another product of the cooperation between Japan's most famous roboticist, and its most famous playwright (Tanaka).

The fifth chapter will further discuss the roboticist, the playwright, and the intersection of theatre and engineering. At the centre of this chapter are androids, and the man who builds them. It reviews the progression of this new category in robotics, in Japan and to an extent around the world. This chapter also discusses what it takes to build an android, what happens to them after they are completed, as well as future plans.

There is a substantial volume of work regarding the intersection of androids and gender². This project focuses on the emergence of androids, the history, cultural environment and circumstances that provide insight into how they came to be. The concerns raised by our new found ability to create artificial life-like women is most certainly concerning and deserves ample attention and research. It is however beyond the scope of this particular project, and therefore will not be addressed further.

² A good example would be: Robertson, Jennifer. "Gendering Humanoid Robots: Robo-Sexism in Japan." *Body & Society* 16.2 (2010): 1-36.

Chapter 2- Technology, a Complex System

This chapter features a brief review of several topics that form the general theoretical framework of this project. The main discussion in this chapter will focus on how we perceive our relationship with the technology that surrounds us, the different ways to analyse this relationship, and the nuanced consequences of each of these analytical platforms. The first section is a wide angled review of a few prominent theories in the field of Science and Technology Studies (STS)³ and their conceptual evolutions. The relationship between society and technology, no matter which approach is used to analyse it, remains intertwined. The different approaches, however, lead to very different ways of thinking about technology and the world in which it exists. From this stems their importance. The second part of the chapter will focus more on how we feel about new and advanced technologies and their role in our life.

The techno-social narrative

“We shape our tools and thereafter they shape us.”

-John M. Culkin, 1967⁴

Technological Determinism

Technological determinism is an approach to analysing social change in a technocentric manner. Through this analytical lens technology is seen as the sole cause of social

³ Sometimes referred to as SST- Social Studies of Technology.

⁴ The quote is frequently attributed to Marshall McLuhan. It appeared in a 1967 article in the *Saturday Review* written by Culkin, discussing McLuhan. (Culkin 70)

change and as the ‘prime mover’ in history (Chandler 1995)⁵. The deterministic approach considers technology to be the root cause of fundamental changes in how human societies organize, and a major influence on our collective psychology, and on the way we look at the world (Chandler 1996). A very common example of this type of thinking comes from the early days of the personal computer revolution. There were common concerns that using computers for educational purposes will cause students to lose their mathematical skills (Bauchspies, Croissant and Restivo 80). The loss of skill was not attributed to behavioural changes due to shifting social norms concerning mathematical skills, but, according to the deterministic view, it will be the computer that causes it. On a grander scale, McLuhan suggests that “the goose quill put an end to talk. It abolished mystery; it gave architecture and towns; it brought roads and armies, bureaucracy. It was the basic metaphor with which the cycle of civilization began the step from the dark into the light of the mind. The hand that filled the parchment page built a city.” (McLuhan and Fiore 48).

Technological progress has been a profoundly influential force in shaping social structures since the dawn of humanity, and dates back to our first attempts at creating simple tools from stone. Anthropologist Robert Ardrey wrote: “when we took a stone and chipped it into a pattern that would suit our needs, then we created something that does not exist in nature. We were fashioning something to a design existing only in our minds. The story of man has several critical turning points, and this is one of them.” (Ardrey 137-8). The significance tools and technologies have in shaping the way we understand the world around us is evident when examining our most common method of classifying

⁵ Under Technology-led theories, second paragraph.

historical periods and civilizations- the Stone Age, the Iron Age, the Steam Age, the Computer Age (Wyatt 167), and more recently the Information Age.

The role of simple tools, and later very advanced technology at crucial milestones of human evolution is an overarching theme in the movie *2001: A Space Odyssey*. It is most notable in the film's progression from portraying an early ancestor of Homo Sapiens realizing how to make useful tools, and shortly thereafter realizing that they can be used as weapons, to perhaps the future product of humanity- a fully functioning Artificial Intelligence (AI) 'realizing' that it is not bound by the will of humans. Both Arthur C. Clarke⁶ and Stanley Kubrick read Ardrey's work while writing the screenplay for the movie, and his ideas about the evolutionary nature of the things we make are truly echoed in this film (Clarke 1972 12, 28).

The scholarship on technological determinism is vast, and expectedly nuanced. At its most extreme the argument often is that "new technologies transform society at every level, including institutions, social interaction and individuals. [...] 'Human factors' and social arrangements are seen as secondary." (Chandler 1995)⁷. No discussion about extreme ideas of the technologically deterministic variety can be complete, or perhaps even begin, without mentioning Jacques Ellul. Ellul argued that technology, and especially the process behind its development "elicits and conditions social, political, and economic change. It is the prime mover of all the rest, in spite of any appearance to the contrary and in spite of human pride, which pretends that man's philosophical theories are still determining influences" (Ellul 133). A well-known example for this type of deterministic thinking about the power of technology is Marshall McLuhan's argument

⁶ One of the world's most renowned Science Fiction writers

⁷ Under *Technology-Led Theories*, second paragraph.

that the invention of the printing press in the fifteenth century is responsible for creating individualism and nationalism (McLuhan 33). Printing, ‘a ditto device’ as McLuhan puts it, “created the public. Electric technology created the mass.” (McLuhan and Fiore 49-50, 68). And as Neil Postman would add, the printing press created childhood, as well (Postman 1994, xii).

Technological determinism views technology as an autonomous entity or force that is external to humans and society (Bauchspies, Croissant and Restivo 75). In other words, “Rather than as a product of society and an integral part of it, technology is presented as an independent, self-controlling, self-determining, self-generating, self-propelling, self-perpetuating and self-expanding force. It is seen as out of human control, changing under its own momentum and 'blindly' shaping society.” (Chandler 1995)⁸. Regarding technological development as an autonomous process leads to the conclusion that once started, this process cannot be stopped, and thus technological progress is inevitable. Hasan Özbekhan, an expert on social systems, once wrote that in a technology- dominated time, such as the one we live in, the concept of ‘can’ transforms in our perception into ‘ought’, at least where technology is concerned (Ozbekhan 87). On this ‘if a gun appears in the first act, it must be fired by the third act’⁹ approach, Chandler elaborates: “because a particular technology means that we can do something (it is technically possible) then this action either ought to (as a moral imperative), must (as an operational requirement) or inevitably will (in time) be taken.” (Chandler 1995)¹⁰.

⁸ Under *Technological Autonomy*, first paragraph.

⁹ A slight variation on the dramatic principle known as *Chekhov's gun*.

¹⁰ Under *Technological Imperative*, second paragraph.

Ellul further argued that technology” has become autonomous; it has fashioned an omnivorous world which obeys its own laws and which has renounced all tradition.” (Ellul 14). He continues, cementing his view that technology is an unstoppable force: “[it] tolerates no judgment from without and accepts no limitation.” (Ellul 134). This autonomous existence attributed to technology by the deterministic approach extends also to the process of creating new technologies. It assumes that new technologies are created by engineers who are following ‘internal technical logic’ only, and the social environment has no influence on the process (Wyatt 168). Approaching technological development as an autonomous process implies that technology is largely outside of human control, and so are all the unforeseen side effects that come with every new invention.

In his book *The Disappearance of Childhood* Neil Postman explores the influence technology has on our lives, and on the way we interpret the world. He argues that every machine represents an idea or a set of ideas, but they are not necessarily the same ideas that the inventor had when the machine was created. He calls the inventors ‘Frankensteins’, and defines ‘Frankenstein syndrome’ as:” One creates a machine for a particular and limited purpose. But once the machine is built, we discover- sometimes to our horror, usually to our discomfort, always to our surprise - that it has ideas of its own; that it is quite capable not only of changing our habits but [...] of changing our habits of mind.” (Postman 1994, 23).

Assuming that technology has ideas and a will of its own bestows an inanimate object with self-consciousness and thus anthropomorphises it. Modern technologies have reached a level of complexity and sophistication where most of the users know how to

use them and understand *what* it is they do, but they lack the knowledge to understand *how* they in fact do it. Or, as Arthur C. Clarke put it- “any sufficiently advanced technology is indistinguishable from magic.” (Clarke 1973 21). This lack of understanding of the interworking of intricate mechanisms is the root of technological anthropomorphism, and leads to technology appearing to have and follow its own ‘purpose’ while exceeding the limits of its technical function (Chandler 1995)¹¹. On this analysis, Chandler adds: “purposiveness arises in a device from the whole being greater than the sum of the parts which were humanly designed: unplanned, a ‘ghost in the machine’ emerges.” (Chandler 1995)¹². The ‘ghost in the machine’, a psychological side-effect of advanced machineries, has been eliciting suspicion towards technology for a very long time. It is only appropriate that these feelings of deep concern, and perhaps even fear, about technology becoming self-conscious are represented by Dr. Frankenstein’s creation¹³.

In a forward to Ellul’s *Technological Society* sociologist Robert K. Merton wrote: “Not understanding what the rule of technique is doing to him and to his world, modern man is bested by anxiety and a feeling of insecurity. He tries to adapt to changes he cannot comprehend.” (Ellul vii). Grim as the notion might appear, at least it is not part of an evil master-plan. According to Merton and Ellul “our technical civilization does not result from a Machiavellian scheme. It is a response to the ‘laws of development’ of technique.” (Ellul viii). A decade or so before Ellul was born, Emerson wrote: “Things are in the saddle, and ride mankind” (Emerson 103).

¹¹ Under *Technological Autonomy*, tenth paragraph.

¹² *Ibid.*

¹³ From Mary Shelly’s book *Frankenstein*, first published in 1818, and considered to be the first science fiction novel.

In *Does Technology Drive History?*¹⁴ historian of technology Merritt Roe Smith traces the ‘intellectual heritage’ of technological determinism to the 18th century leaders of the Enlightenment. That era saw technology evoke optimism about a better future and enthusiasm about its potential role as a great liberating force. It was then that the notion of technology being an integral part of society, and not just a tool it uses, began to formulate. When the industrial revolution began there was no turning back. Technology had cemented its place in the collective social consciousness as a powerful and influential force. Smith also notes that “deterministic thinking took root when people began to attribute agency to technology as a historical force.” (Smith 2).

During the 20th century, after being greeted as a liberator, and before becoming a source of great concern and fear, the theoretical framework that gave agency over social change to technology while taking it away from human society, became known as ‘technological determinism’. Not surprisingly, technological determinism was widely criticized over the years. Critics argued that technology does not design and create itself, and that “there is no abstract and logical scientific method apart from the actions of scientist and engineers.”, who, it should be mentioned, are parts of communities, and on a larger scale human society (Sismondo 10). Critics of deterministic thinking about technological development also argue that for the most part, technology is neutral, it is neither good nor bad in itself, and the consequences are determined by how we choose to use it (Chandler 1995)¹⁵.

As mentioned above, deterministic analysis of technology does not follow one set of rigid rules. The views of those who see deterministic elements in and around

¹⁴ Full title- “Does Technology Drive History? The Dilemma of Technological Determinism”.

¹⁵ Under *Technology as Neutral or Non Neutral*, first paragraph.

technological development create a deterministic spectrum of sorts, with varying degrees of agency awarded to both technology and society. This short review offers a general representation of the deterministic approach, and it is by no means a definitive characterization of the entire field of study. The enduring criticism of technological determinism, and its proponents' inclination to mainly focus on the social consequences of technology led to the development of a new approach to analyse the relationship between technology and society (Williams and Edge 868).

Social Construction of Technology

'Social construction' is a fundamentally different approach from determinism. It aims to demonstrate that technology is in fact a social creation, and not exclusively a product of its own internal technical logic (Williams and Edge 866). Social Construction of Technology, or SCOT, originated from the notions that both technology and science are social endeavours, and that "knowledge and artefacts are human products" (Sismondo 10). This approach became popular within the field of Science and Technology Studies (STS) in the late 1970's (Sismondo 51). The goal of the social studies of technology was to show that technology was socially shaped, from the design process to the way it is used (Wajcman 351). The fundamental assumption of SCOT is that science, knowledge and technology are social and cultural constructions (Bauchspies, Croissant and Restivo viii). This new approach strived to establish that technology does not develop in a vacuum, but is created within a specific social environment that informs its eventual characteristics. SCOT and other similar social approaches to the study of technology¹⁶

¹⁶ Social Shaping of Technology (SST), Actor Network Theory (ANT), Socio-Technical Interaction Networks (STIN). On STIN see (Meyer)

propose to completely rethink and reimagine the balance of power between technology and society.

SCOT is a method of explaining how in fact technology ‘arises’, how it is shaped by society, and why a particular technology ‘wins’ over other available alternatives (Winner 368). The process of designing a new technology is not straightforward, and can end with a number of very different outcomes, depending on the social circumstances in that time and place (Klein and Kleinman 29). A central aspect of the social approach to technological development is the existence of choices. Whether conscious or unconscious the design process is lined with ‘forking paths’ that requires choices to be made, and different choices naturally lead to different outcomes (Williams and Edge 866). These choices help explain why certain technologies are rejected, despite being technically sound. ‘Technical efficiency’ and the ‘best technology’ do not guarantee successful public acceptance (Wajcman 352). Wajcman maintains that “there is nothing inevitable about the ways technologies evolve. [...] different groups of people involved with a technology can have different understandings of that technology [...]. Thus users can radically alter the meanings and deployment of technologies.” (Wajcman 353).

A certain technology can be completely operational, widely accepted in one part of the world, and rejected in another due to cultural irrelevance. This point is aptly demonstrated by the rarity of organ transplantations in Japan. Although the Japanese medical system is very advanced and science based, this particular technology and methodology is largely not used. Social conventions about death in Japanese society generally do not differentiate between various stages of death, such as the death of the body and the death of the mind. Generally speaking, in Japan one can either be dead, or

not dead. Thus, removing organs from a not dead individual is understandably problematic (Bauchspies, Croissant and Restivo 81). In the West, where such social conventions regarding death are not common, organ transplants pose less of a spiritual issue. A notable expression, albeit for different reasons, would be some sects of ultra-orthodox Judaism. Members of these communities refuse to donate organs based on the belief that they will need them again when the messiah arrives and raises the dead.¹⁷

Social studies of technology coalesced around attempts to understand how and why technology is created. Various approaches to the study of technological development, whether historical, philosophical, or sociological “are committed to examining the historical and social contexts and contingencies of scientific knowledge and technology. In doing so they are explicitly rejecting a linear model of scientific and technical change and with it any hint of social, technical or scientific determinism, reductionism or autonomy.” (Cressman 3). Continuing within this tradition, a more inclusive and wide-scoped model for analysing technological innovation in a social context was proposed.

A significant step forward in our understanding of social relationship with technologies was taken when the enduring exclusion of non-human from the study of social interaction was challenged. The exclusion of nonhumans (animals, memories, objects, etc.) in the study of social interaction is usually based on a presumed lack of conscious thought or intention. This approach echoes anthropologist Rane Willerslev’s argument, which will be discussed in a later chapter, regarding personhood in the West

¹⁷ This notion is not supported by all the ultra-orthodox sects. It should also be noted that they have no problems receiving organs, when in need of a transplant.

being associated with humans only, while the definition of the animistic Yukaghirs in Siberia is much wider and more inclusive.

One of the key figures who ideologically restricted participation in social interaction was Weber: “Weber’s position specifically excludes animals, objects, and other nonhuman entities from engaging in social interaction. Interestingly, it excludes many humans as well: reactive humans; habituating humans; fatigued, sleeping, or comatose humans; and humans in the grips of euphoria.” (Cerulo 532). It was believed that intention is absolutely integral for one to be considered as a part of social interaction, which does not apply to animals, as they are seen as acting according to their ‘genetic programming’. Talking to your pet, for instance, would not be considered social interaction; it would be just like talking to your lamp. In the past 25 years these limits to social interaction were challenged, and new, more inclusive theories were developed as alternatives to previous ways of thinking about social interaction (Cerulo 532-3, 5).

Actor Network Theory

Redefining the social-

Rooted in French philosophy and semiotics, Actor Network Theory (ANT) was developed in the 1980’s by Michel Callon, Bruno Latour and John Law. It evolved from an existing tradition in the field of sociology of science to study the processes through which scientific facts are created (Miettinen 171). Cerulo describes ANT as “an ambitious model designed to account for the essence of societies.” (Cerulo 533). This echoes Latour, one of the architects of this theory, who said that it “aims at describing the very nature of societies.” (Latour 369). According to this approach, the modern world, with its complex social structures and institutions, can be described by networks of actors

who are humans and technological entities (Winner 366). Further, according to Latour “it is utterly impossible to understand what holds society together without reinjecting in its fabric the facts manufactured by natural and social sciences and the artefacts designed by engineers.” (Latour 370).

The basic model of ANT is created by actors, referred to as ‘actants’, which are independent entities, both human and nonhuman, who are able to affect change, or more generally make things happen, without any intention or conscious thought being needed on their part. The connections formed between these diverse actants results in an actor network. Simply put, ANT is a model for studying the connections between different types of actors within a network. These networks are forged by actants who can be groups, organizations, things, and even concepts (Cerulo 534), and their identity is defined through the various interactions they constantly have with other actants within the network (Cressman 3).

Cressman offers another way to look at the analysis model proposed by ANT as one that is “arguing that everything – people, organizations, technologies, nature, politics, social order(s) – are the result, or effect, of heterogeneous networks.” (Cressman 4). This underlines ANT’s most challenging concept- everything is ‘created’ by heterogeneous networks, and networks are created by everything.

Latour explains that the sometimes confusing concept of ‘network’ was chosen following its use by the philosopher Diderot, who used it “to describe matter and bodies in order to avoid the Cartesian divide between matter and spirit.” (Latour 370). Due to the ambiguity of its name¹⁸, actor networks are sometimes referred to as ‘heterogeneous

¹⁸ On misconceptions regarding ANT see: Latour, Bruno. "On actor-network theory: A few clarifications." *Soziale Welt* 47.4 (1996): 369-381.

networks’, ‘collectives of humans and nonhumans’, ‘hybrid collectives’, ‘actant-rhizome ontologies’ and ‘sociotechnical networks’ (Miettinen 173) (Cressman 2,4). This reflects ANT’s key feature: a lack of division between humans and nonhumans when examining societies, a principle that will become very relevant in future chapters.

Cerulo argues that today’s technology lead to “nonhuman objects becom[ing] an active part of social interaction as opposed to mere props used by humans to enhance or steer social interaction.” (Cerulo 539). Continuing this line of thought eventually leads to Latour’s point of view that considers the relationship between modern society and technology as being hybrid, as traditional distinctions and borders between object and subject are disappearing (Tully 445). Wajcman explores further the influences of ANT on the way we think:

since the widespread adoption of ‘actor-network theory’ (ANT), technology and society are no longer seen as separate spheres, influencing each other. Rather, the metaphor of a ‘heterogeneous network’ conveys the view that technology and society are mutually constitutive: both are made of the same stuff – networks linking human beings and non-human entities. The technological, instead of being a sphere separate from society, is part of what makes large-scale society possible. Their most controversial idea, that we cannot deny *a priori* that nonhuman actors or ‘actants’ can have agency, has helped us to understand the role of technology in producing social life. (Wajcman 354)

The development of ANT can be compared to the evolution of physical thinking. A modern era of conceptual thinking in physics was ushered in when physicists stopped trying to figure out ‘what acts upon what’, and began exploring the nature of interactions

between various bodies. This led to a new understanding of the natural world- and scientific advances that cemented our understanding about celestial mechanics, which changed the way we think about space and time.

ANT was a radical idea in its early days, and perhaps for some it still is. Its ability to reconceptualise the way we think about the mechanisms and building blocks of social structures has earned it a reputation of being “methodological provocations that constantly challenge traditional categories in social sciences” (Miettinen 171).

The concept of a network of semiotic actors offers an interesting way to look at the mechanism of change in societies. Nonhuman entities such as cellphones, robots, or even collective memories, for instance, can all make powerful connections within the network, and affect change. Latour’s comment that “ANT has some affinity with the order out of disorder or chaos philosophy” is particularly interesting. Chaos theory, widely known as the butterfly effect, describes how minor changes can result in very significant outcomes, in this case within a network. Although very hard to trace, minor decisions or moments of inspiration can produce unimaginable outcomes, as will be demonstrated in the next chapter.

This theory is applied in many fields of study, technology being the most relevant to this project. Looking at the world today it seems counterintuitive to think that technology is not a part of social interaction, and due to its lack of premeditated intention does not affect major social changes.

ANT offers an interesting way to think about the world. The boundaries between humans and technology are not as distinct as they once were- we ‘outsource’ many functions to technological devices and use them as extensions of ourselves. There is no

longer need to remember phone numbers, as we now rely on a cellphone to do that for us. The internet takes care of a lot of our communication needs and acts as an external information storage unit, eliminating our need to remember a wide range of things just by making them instantly available. It seems that especially today, any model of social interaction that excludes nonhumans cannot be very accurate.

ANT, by fully acknowledging the potential power of technology (in this case) to affect social and cultural change, creates a very interesting comprehensive model for analysing societies. Although ANT is not really a theory, as Latour points out multiple times, and does not have a defined set of tools to analyse societies, it does offer a very particular way of looking at a problem. A network that emerges from connections made by people, things, and ideas creates a powerful analytical model for science and technology studies, and many other disciplines¹⁹.

One of the best examples that clearly demonstrate how technology is socially shaped, on the most fundamental level, comes from Japan. The cultural perspectives regarding robots in Japan are very different than those in the West. Cultural, religious and historical factors shaped two very different approaches to robotics, leaving no doubt about influence of local notions and social aspects on developing new technologies. This is evident by the scale of the Japanese industry, the adoption rate of robotics in the country, as well as the particular types of robots being developed. The history of robotics, for the most part in Japan, as well as the social factors that shaped it, will be discussed in the next chapter.

¹⁹ Sociology, geography, management and organization studies, economics, anthropology and philosophy (Cressman 1)

The ghost in the machine

*“We must believe in free will—
we have no choice.”*

- Isaac Bashevis Singer.²⁰

Technology has become ubiquitous. It is both a theoretical abstract and a practical and mundane fact of daily life. Further, technology has become so integral that analysis of its role in society has become a central part of social theory (Wajcman 347). We have reached a point where many people, mainly in developed countries, experience a large part of their daily life through various technological means. The constant presence of technology in all aspects and during all hours of people’s daily routines has become increasingly prevalent. This has not gone unnoticed. For a while now, backlash against this trend has been gaining popularity. Public discussions are being had regarding the potential harm of social technologies, for example, to our human relationships, social skills, ability to deal with life’s challenges, and even our sleep patterns. A good example for calls to evaluate our current dependency on technology can be found in the writing and public speeches of MIT professor Sherry Turkle.

Claus Tully notes that young people, born in these technological times, usually do not associate risks with technological development. Rather, “Technologies are seen as an opportunity to conquer the world. They are equated with the future and with the power to create it.” (Tully 448). Optimistic views of technology seem to reflect relatively calm periods in human history, when large populations do not live under constant terror of a

²⁰ A frequently used phrase by Singer. One example is (Kanfer 1997).

newly developed lethal technology, or recovering during the aftermath of such a technology being used.

Optimistic views of technology were common from the days of ancient Greece to the middle ages (Chandler 1994)²¹. Another such period, according to Isaac Asimov²², lasted almost a century:

Between the year 1815, which saw the end of a series of general European wars, and 1914, which saw the beginning of another, there was a brief period in which humanity could afford the luxury of optimism concerning its relationship to the machine. The Industrial Revolution seemed suddenly to uplift human power and to bring on dreams of a technological Utopia on Earth in place of the mythic one in Heaven. The good of machines seemed to far outbalance the evil and the response of love far outbalance the response of fear.[...]Nevertheless, with World War I, disillusionment set in. Science and technology, which promised an Eden, turned out to be capable of delivering Hell as well. The beautiful airplane that fulfilled the age-old dream of flight could deliver bombs. The chemical techniques that produced anaesthetics, dyes, and medicines produced poison gas as well. (Asimov 1981 161-2)

Indeed, views of technology shifted after the war, “when the world had discovered the negative side of the assembly line” (Schodt 1988 29). Kara Reilly further expands:

The First World War was the bloodiest war up to that point in history. It was a war full of new technologies: tanks, grenades, mortar bombs, machine guns,

²¹ Under *The pendulum of hopes and fears*.

²² One of the greatest science fiction authors of all time. Wrote extensively both fiction and non-fiction about robots, and believed they will have a positive influence on humanity.

poison mustard gas, and zeppelins. Battle photographs captured the visceral images of the wounded and the dead, bringing them directly into people's homes via newspapers, also for the first time. Past wars had been visually recorded as paintings, drawing, woodcuts, etchings, or even daguerreotypes, none of which could capture the brutality of war with the same intensity as a photograph. All of these new technologies made people suddenly aware of the very real possibility of the destruction of the human race by its own machine-based creations. (Reilly 149)

Technological optimism of the recent past gave way to what Reilly calls 'anxious scepticism'. She notes that "This anxious scepticism was partially the result of machine warfare, but also of the sincere fear that human beings would become slaves to the machines they had created." (Reilly 149).

This fear is at the heart of what Asimov identified as the 'Frankenstein complex'. This complex refers to the wide spread fear generated notion that if created, a sentient humanoid machine will necessarily turn against its creators. Asimov writes:

What is the fear? The simplest and most obvious fear is that of possible harm that comes from machinery out of control. In fact, any technological advance, however fundamental, has this double aspect of good/harm and, in response, is viewed with a double aspect of love/fear. Fire warms you, gives you light, cooks your food, smelts your ore - and, out of control, burns and kills. Your knives and spears kill off your animal enemies and *your* human foes and, out of your control, are used by your foes to kill you. (Asimov 1981 156)

This fear, however, goes beyond this type of technological determinism, which posits that if your creation can harm you, it probably will. Deeper currents of human psychology are at play here, subconsciously signalling that nothing good can come out from creating machines in our own image. Elsewhere, Asimov suggests that “the creation of a robot, a pseudo human being, by a human inventor is [...] perceived as an imitation of the creation of humanity by God[...] In societies where God is accepted as the *sole* creator, as in the Judaeo-Christian west, any attempt to imitate him cannot help but be considered as blasphemous.” (Asimov 1984 4-5).

The story of Dr. Frankenstein and his creation is often used in discussions of potential harm that might come from an unrestrained pursuit of new technologies. Published in 1818, the tale of a scientist that created life by applying electrical current to a humanoid stitched together from dead body parts is widely considered to be the first science fiction book in history. The science fiction genre of literature emerged after the industrial revolution took place in early 19th century, in its place of origin- Great Britain (Asimov 1981 18-9). The full name of Mary Shelley’s masterpiece is appropriately *Frankenstein, or, the Modern Prometheus*, as the myth of the Greek titan Prometheus is echoed by Shelley’s Dr. Frankenstein and his fate.

Prometheus, as the myth goes, created humans from clay and gave them life. Dr. Frankenstein did the same, but with dead flesh instead of clay, and electricity instead of divine powers. Ultimately, both the titan and the scientist were punished for their perceived transgressions. The Frankenstein complex seems to describe pessimistic and perhaps technophobic interpretations of Shelly’s book. More than anything else, it now symbolises that through the generations, what became collectively known as ‘the moral

of the story' was a cautionary tale about the devastation that comes from uninhibited scientific exploration, and humans overstepping their bounds.

Deterministic thinking about technology ultimately always poses the question: can we create something that we will not be able to control? Asimov wrote:

From the start, then, the machine has faced mankind with a double aspect. As long as it is completely under human control, it is useful and good and makes a better life for people. However, it is the experience of mankind (and was already his experience in quite early times) that technology is a cumulative thing, that machines are invariably improved, and that the improvement is always in the direction of etherealization, always in the direction of less human control and more auto-control—and at an accelerating rate. As the human control decreases, the machine becomes frightening in exact proportion. (Asimov 1981 155)

Asimov tried to actively combat the Frankenstein complex since 1939 by portraying robots in his books and short stories as friends, servants and allies of humanity (Asimov 1981 162). Additionally, to neutralize fears about robots developing free will and a sense of purpose that might be in conflict with the interest of humanity, Asimov came up with his famous Three Laws of Robotics, in a story named *Runaround* originally published in 1942. The first law states that “a robot may not injure a human being, or, through inaction, allow a human being to come to harm.” The second law states that “a robot must obey the orders given it by human beings except where such orders would conflict with the First Law.” The third law states that “a robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.” (Asimov 1950 37).

These laws were meant to counter the Frankenstein complex by suggesting that the machines that we build will always be inherently under our control, even if they are autonomous for the most part. However, as Kaplan correctly points out, “with his laws, Asimov legitimized the Frankenstein syndrome yet further by viewing it as a fate that humans must try to avoid.” (Kaplan 11).

Fear and rejection of technology, particularly in western societies, is probably as old as technology itself. The Luddites, the Amish, ultra-orthodox Jews, among others, shun and reject many or all technologies. In all cases, technology is believed to threaten their way of life. It is feared because it is perceived as trying to force the modern world on their communities, against their will.

For a discussion of a certain technology to be substantive, it should be contextualized. Before analysing the origin and subsequent influence of a certain technology, it is important to ascertain what role technology has in and on society, and what, if any, its range of impact is. This project explores the circumstances that led, or allowed for, the creation of androids. As reviewed in this chapter, approaches to the study of technology changed over the years, and one might even say they evolved.

Deterministic thinking about technology, although no longer popular in academic circles, is here to stay. We fear what we cannot understand, and we fear what we cannot control. Social Construction offers a more organic analysis of how societies and behaviours are affected by new technology, but more importantly, how technology is created by, and reflects the society and culture of its origin. The Actor Network expands this idea of symbiosis even further. The most relevant part of the theory is that it ‘invites’ the nonhuman to participate in social interaction. As will be discussed in the final

chapter, androids are built to interact with humans on various levels. This type of interaction is different than one's interaction with a car, TV, or even a computer.

The non-discriminatory platform of ANT is a useful construct to keep in mind while attempting to analyse the emergence of a particular technology that seems to defy common sense, yet is completely historically predictable, all while being almost completely geographically bound to one country (for now, at least).

Chapter 3- Robotics: A Mechanical Dream

The previous chapter presented a theoretical framework of the deep connection between technology and society. This chapter will present a review of the field of robotics around the world, its roots in ancient times, the genesis of robotics in Japan, and the extent of the phenomenon today, while highlighting different approaches to the subject on both sides of the ocean. Charting the development of robotics in Japan, together with its impacts and social influences will be the foundation for exploring Japan's attitude toward advanced technology, and androids in particular.

The history of robotics is quite unusual. It began in myth and legend, progressed into fiction, and much later stepped into the real world. It is truly the history of imagination manifesting into reality. As such, this brief account of robotics throughout history will explore the early origins of today's modern machines.

From mythical origins to a fantastical reality

Life imitates art

The origin of the word 'robot' is from the old Czech word 'robota' (forced labour, serfdom). Its first public use was on January 25, 1921 in Prague, in a theater performance of the play *R.U.R-Rossum's Universal Robots* written by Karel Čapek. This now popular term was first suggested almost as an afterthought by Josef Čapek when his brother sought advice on how to call the artificial workers in a new play set in a dystopian future

he was about to write: “call them robots”, Josef answered, and we still do to this day. (Horakova 242-3, 246).

The play describes a disastrous outcome of industrial automation. Humans built machines to work on their behalf, but eventually the machines rebelled and eradicated all of humanity. According to Reilly, *RUR* is in fact the first literary occurrence of humanity being exterminated by its own technology (Reilly 149). The play is set sometime in the future,²³ and the plot revolves around the distant island where the R.U.R factory manufactures its robots. The story spans a decade, and chronicles the eventual destruction of the human race. A major factor in that final outcome is the demonstrated “dehumanisation of humankind (man becomes machine-like), and humanisation of artificial beings (through increasing machines human-like abilities), and [...] by situations of confusion caused [*sic*] by inability to distinguish between man and machine because of their similar behaviour” (Horakova and Kelemen 22). This happens due to certain robots having a more advanced brain that causes them to develop consciousness and emotions, and then revolt. Asimov notes that “It was the theme of *Frankenstein* expanded to a much larger scale” (Asimov and Frenkel 12).

Similar to Frankenstein’s creation, made from organic material, and unlike the more traditional idea of a metal robot that we know today, the robots in *RUR* were a metaphor for the state of humanity in the awakening age of machines. In the play, after the destruction of the human race, we learn that two of the robots are in love. *RUR* ends with the sole surviving human saying to them: “Go, Adam, go, Eve. The world is yours.” (Čapek 101).

²³The poster for the Prague production states that the year is 2000, but this fact is not mentioned in the play itself (Reilly 148)

RUR was a world-wide hit. It played 63 times in the theatre it premiered in, 184 times in New York and 126 times in London. It was translated into 30 languages, and performed on stages around the world (Reilly 150-1). The play was not without controversy, but it got positive reviews, as one critic wrote: “as a dream, an impossible fantasy [...] it makes an impression of reality which we may be able to see perhaps already tomorrow”²⁴ (Reilly 150). The play must have been deeply thought-provoking, as another critic, in London, was profoundly influenced. He described his thoughts upon leaving the theatre: “As one comes out, poor soulless Robots seem still to be crowding round – in the street, the tube lift, the straphung train. Curious effect! Can it be true?”²⁵ (Reilly 152).

In a New York production an epilogue was added to the play. It showed two robots, one male, one female, holding a baby in front of a postcard background of a sunrise over a small cottage. Reilly notes that the intent was to convey that the love between the two robots “somehow convinced Nature of their right to reproduce, transforming them from Robots into humans.” (Reilly 170).

It seems that the New York production attempted to soften the harsh conclusion of the play by suggesting that humanity will prevail. Nevertheless, the addition of the epilogue confused a few critics, and even inspired a minor investigation. One critic wrote to the theatre’s executive director asking for clarification on the origins of the epilogue, and other potential departures from the original, and according to Reilly he was lied to in response. He was assured that the epilogue appears in the original version, and that only minor cuts were made. It appears, however, that the epilogue was not penned by Čapek,

²⁴ Dramatist Jaroslav Hilbert writing about the Prague production. Quoted in (Reilly).

²⁵ A reviewer for the *Pall Mall Gazette*. No name given. Quoted in (Reilly).

and furthermore, the final monologue from the original version was cut entirely from the published translation (Reilly 171-2).

Further controversy surrounded the play when a British producer was asked to cut out all biblical references from the end of the play before getting permission to go ahead with the production. He was told that censorship-wise, the only problem was “the reading of the Bible passages on the last page of the play. That seems to me to go rather too far.”²⁶ (Reilly 173).

The concern about potential blasphemy probably arose from the possible suggestion that the person encouraging the robots at the end of the play to go forth and become the new Adam and Eve might through this act appear as if he has become God. To reassure all concerned that there was no measure of impiety, some praises were added to God and his creation, and that was enough for the producer to receive his green light. The controversy did not end there, and even George Bernard Shaw had an opinion on the matter²⁷. This too is a fascinating example of the problematic nature of any kind of creation ‘in our image’ within the context of western culture and Judaeo-Christian religion.

As in many other countries, the play became a hit in Japan as well. It was performed in Tokyo on July 1924 under the title *Artificial Human* (Jinzō Ningenshi) at the first theatre in Japan built to accommodate modern western drama, the Tsukiji Little Theatre. Unlike most western audiences, who usually found Čapek’s artificial people to be disturbing, in Japan it was met with fascination. One viewer’s impression was that “the author’s intent was to show people controlling the ultimate in science, yet not losing

²⁶ G.S. Street, a clerk at the Lord Chamberlain’s office. Quoted in (Reilly).

²⁷ For more see (Reilly) chapter 5

human love—that's where the future of humanity lies.”²⁸ (Hornyak 34). As for *RUR*'s blasphemous innuendoes debated in the West, the young man who was deeply inspired by the play and a few years later, in 1928, built the first Japanese robot, wrote regarding the play: “If one considers humans as the children of nature, artificial humans created by the hand of man are thus nature's grandchildren.”²⁹ (Hornyak 38). The difference in reactions between western audiences and ones in Japan demonstrate the notions discussed in the previous chapter about different societies having different reactions to the same technology, and very different ways of imagining what sort of future it might bring. As for Asimov, he really did not like it: “Čapek's play is, in my own opinion, a terribly bad one, but it is immortal for that one word.” (Asimov 1981 71).

The ancient world

The ancient ancestors of modern robots originated in antiquity. Ancient Greek texts documented construction of automata, Greek for ‘self-operating machines’, as early as the Hellenistic period. Prior to that, as is usually the case with such things, various automata appeared in myth and legend. Homer's *Iliad* has one of the earliest portrayals of a humanoid automaton. In the eighteenth book of the *Iliad*, Hephaestus, god of the forge, created golden women who could think, talk and perform various tasks: “there moved swiftly to support their lord handmaidens wrought of gold in the semblance of living maids. In them is understanding in their hearts, and in them speech and strength, and they know cunning handiwork by gift of the immortal gods. These busily moved to support

²⁸ Kihachi Kitamura, quoted in (Hornyak)

²⁹ Makoto Nishimuta, 1928. Quoted in (Hornyak).

their lord” (Homer 1925 319). Hephaestus also created Talos, a bronze statue, that became a sentry on the island of Crete (Nocks 5,6).

The term ‘automaton’ (‘automatically’, ‘automatic’) first appeared in the written version of the *Iliad* in the 8th century BCE (Vasileiadou, Kalligeropoulos and Karcanias 76). In the Fifth book Homer describes how Hera, Queen of Olympian gods, arrives at the gates of heaven on her chariot of fire, and before her “*self-bidden* groaned upon their hinges the gates of heaven” (Homer 1924 249; emphasis added). And according to an earlier translation: “the gates of heaven bellowed as they flew open *of their own accord*” (Homer 1898 85; emphasis added). Both are translations of the Greek αυτόματον, meaning automatically, by itself. Although lacking in mechanical details, Homer’s description of the gates indicates “a vague technical intention, an imaginary technical vision and paves the way for the later detailed descriptions of automatic machines that are ascribed to the great craftsman of Olympus, Hephaestus.” (Vasileiadou, Kalligeropoulos and Karcanias 77).

Although undoubtedly impressive, Homer’s imagined machines in the age before such a thing existed should perhaps be inspected from a different perspective. In her book *The Mechanical Hypothesis in Ancient Greek Natural Philosophy*, Sylvia Berryman suggests that all of Homer’s imagined inventions attributed to Hephaestus are in fact animated by his divine powers. She argues that “the act of animation is a distinct process [...] For a god to animate a statue by breathing on it is no technique of human craft. This story rather draws on the association of breath with life and on the view of the divine as life-giving.” (Berryman 26). Hephaestus’ creations are less mechanical miracles and more living beings created by divine methods. Looking at the *Iliad*’s golden maids and at

the *Odyssey*'s automatic ships that require no crew or captain, Berryman arrives at the conclusion that "These stories should not be read as evidence, then, that the creators of this early literature imagined the building of 'mechanical' automata. This is not only because there is positive evidence to suggest that divine animation is needed: it is *a priori* unreasonable to expect mechanical conceptions before the development of mechanics." (Berryman 27). Homer's original methodology for creating his imaginary devices, whether divine or mechanical, can be debated; what is certain, however, are the consequences. Homer's influence on humankind's collective imagination was integral to creations of later centuries that were surely made without any help from the residents of mount Olympus.

A manuscript named *Mechanica*³⁰, the earliest surviving work on mechanics is believed to have been written by Aristotle in the 4th century BCE³¹. It contains descriptions of many parts necessary for the construction of automatic machinery, among them pulleys, levers, wheels, forceps and gears. The manuscript remains an essential source for studying the mechanics of the ancient world (Berryman 55-8, 107-17, 46). The automata built in Aristotle's time were mainly used for entertainment purposes, and were commonly used on the theatre stages in Greece (Nocks 11-13).

The dream becomes reality

Automata, as Reilly notes, are hand-crafted, unique, and meant to entertain, while robots are an entirely different matter; they are a work force, mass produced on a grand

³⁰ Also referred to as 'Mechanics' and 'Mechanical Problems'

³¹ For more on the doubts surrounding the identity of the author of the manuscript, and the date of its creation see (Berryman), Chapters three and four

scale (Reilly 150). And the scale is only getting grander. The genesis of robotics as we know it today was in the 20th century. At first robots appeared only in science fiction literature, but by mid-century they transitioned into the real world. A chance meeting that took place in 1956 between George C. Devol, an inventor who held the patent for the first programmable industrial robot, and Joseph F. Engelberger³², an engineer intrigued by the possibilities of the patent, led to the foundation of a company named Unimation, which created Unimate, the world's first industrial robot (Schodt 1988 33-4).

The road toward building Unimate was convoluted, as was the task of describing what Unimate actually *was*. Frederik Schodt notes that Engelberger was a fan of Isaac Asimov, “the science fiction writer who rails against the robot’s ‘creaky gothic menace’ image.”, and so he was determined to call Unimate a robot from the very beginning (Schodt 1988 34-5). In a 1983 interview, Engelberger said: “Over and over, the advice was ‘don’t call it a robot. Call it a programmable manipulator. Call it a production terminal or a universal transfer device’. The word is *robot* and it *should* be *robot*. I was building a robot, damn it, and I wasn’t going to have any fun, in Asimov terms, unless it *was robot*. So I stuck to my guns.”³³ (Asimov and Frenkel 25).

Unimate’s debut was on a car assembly line in a General Motors plant in 1961, and the rest is the history of our times. Since Unimate’s debut robots have made their way to the depths of the ocean, into space, military uses, search and rescue, and various other fields. The objective of modern robotics is to imitate, and perhaps improve human capabilities, and perform tasks too dangerous for humans (Hockstein et al. 114).

³² Nicknamed ‘father of the industrial robot’ (Schodt 1988, 33)

³³ Quote by Joseph Engelberger, in (Asimov and Frenkel); from an interview on 12/06/1983.

Robotic traditions of the ancient world

‘Robot nation’ is a title Japan originally earned for being home for more than half of the industrial robots worldwide. The title remains relevant, but today it is usually used to reflect Japan’s technology- its consumption culture, especially the quick adjustment and the wide acceptance of robots, and other advanced technologies. A significant factor in the wide acceptance of robots in Japan stems from the age-long traditional craft of building wooden automata, *karakuri ningyō*. The word *karakuri* translates as a “mechanical devices to tease, trick, or take a person by surprise. It implies hidden magic, or an element of mystery”, and *Ningyō* means ‘shape’ and ‘person’, and can be translated as ‘puppet’ (Boyle).

The tradition originated much as in the West, with many clock makers in Japan becoming *karakuri* makers as well. *Karakuri* building was made possible with the arrival of clockwork parts from China in the 7th century CE (Schodt 1988 57-9). The philosophy behind the construction of *karakuri ningyō* is quite old, as the oldest creations coincide with the arrival of the clockwork mechanisms in the 7th century. It puts a great emphasis on obscuring the mechanism from sight, and thus creating the effect of an animated object (Boyle).

Karakuri ningyō are divided into three categories, among which are those that are used for theatrical performances (*butai karakuri*), those which are used for home entertainment (*zashiki karakuri*), and those positioned on small wooden floats, which reenact parts of the Japanese mythology during religious festivals (*dashi karakuri*) (Boyle). In 1662, a *karakuri* master named Takeda Ōmi, opened the first *karakuri* theatre in Osaka. The theater, Takeda-za, rapidly became an attraction in Osaka, and symbolized

the beginning of the golden era of *karakuri* theatre in Japan (Hornyak 19). From a 1750 account of one of the Takeda-za shows we are able to understand the level of spectacle that took place: “In between live acts, mechanical carp jumped out of the water; dolls shot darts from blow pipes at fans, simultaneously wrote characters holding one brush in the mouth and one in each hand, climbed ladders, and even urinated in stage.” (Schodt 1988 59). Takeda’s intricate creations utilized western clock-building technologies, which arrived in Japan in the mid-16th century along with the missionaries. Despite Japan’s isolation during the Edo period, those western technologies enabled the creation of the most famous *karakuri* model, the mechanical tea serving dolls, which are considered to be the first household robots (Boyle), and are often regarded as the first social machines (Hornyak 21-23).

The mechanical tea serving dolls became extremely popular in the home entertainment scene during the Edo period (1600-1868). They carried a cup of tea on a small tray to the guests, stopped in front of them at a predetermined distance, and waited for the cup to be picked up from the tray; they then stood by until an empty cup was placed back on the tray, then turned around, and went back to the host. Further, as Michael Ashkenazi notes, “Dolls are an important part of Japanese culture, because they replicate aspects of life [...] The tea-carrying doll – a *karakuri* – combines human with mechanical imagery [...] It was the ability of the mechanism to simulate the natural elegant presentation of tea that was significant.” (Ashkenazi 210).

In the 1960’s a professor³⁴ at Waseda University in Tokyo searched throughout Japan in an attempt to find an original surviving model of the tea serving doll. His quest

³⁴ Tatsukawa Shoji, professor of the History of Japanese Science.

was inspired by a 1796 *karakuri* manual called *Sketches of Automata*³⁵ (*karakurizui*)³⁶; he was unsuccessful. Later, in 1967, with assistance from six students, and two month of work, he finally succeeded in replicating the doll almost exactly to the specifications in the *karakurizui* manual. When it was finished, a newspaper ran an article about their project partially titled “successful recreation of a robot from the Edo period”³⁷, and TV coverage was not far behind (Schodt 1988 60-2). According to Schodt, the exceptional way in which this traditional craft was resurrected after being lost for nearly a century highlights a key difference between Japanese automata, and the ones created in the west (Schodt 1988 65).

The Toshiba Corporation started out as a small company founded by a known *karakuri* master³⁸ at the beginning of the Meiji period (1868). Many transformations later, today it is among the leading manufacturers of industrial robots (Schodt 1988 71-2). While *karakuri* are still being used today in religious festivals, and *karakuri*-building tournaments are held annually, the world of robotics did not stand still. In 1928 Makoto Nishimura built Gakutensoku (learn from nature), the first modern Japanese robot. Gakutensoku had a humanoid shape, and was essentially a *karakuri* of the 20th century. It was 2.3 meters high, could open and close its eyes, smile, move its upper body, and even draw *kanji*. While western automata of the time looked very machine-like, exposing the internal mechanisms, Gakutensoku was built to resemble a human, with all the

³⁵ This translation appears in (Schodt 1988, 60); other versions are: “Illustrated Miscellany of Automata” in (Nocks 36), “Illustrated Machinery” in (Hornyak 23), “An Illustrated Anthology” in Boyle, and “Illustrated Compendium of Clever Machines” according to the British Museum.

³⁶ Written by Hosokawa Hanzo Yorinao.

³⁷ Ran on May 17 1967 in the evening edition of *Nihon Keizai*. The full headline was “Successful Recreation of a Robot from the Edo Period- A Pure Japanese Doll That Moves.” (Schodt 1988, 62)

³⁸ Tanaka Hisashige; he founded ‘Tanaka Seizojo’- a company that built and repaired telegraph equipment (Schodt 1988, 71).

mechanical parts hidden from sight, as customary in the *karakuri* tradition (Hornyak 29-37). 1928 was the year of genesis for modern robotics in Japan. Gakutensoku influenced the literature and manga of the period, and the imaginary became more and more real as time passed.

The modern era

After Unimate, the first industrial robot, debuted in 1961, additional units were offered to manufacturers all over the United States, the vast majority of whom did not jump on the opportunity. In Japan, however, the reaction was quite different. In 1968 the Japanese company Kawasaki, in collaboration with the American Unimation, presented the first industrial robot to be built in Japan (Hornyak 80). Describing the differences in response to his creation between the U.S and Japan, Engelberger noted that “While we were agonizing in ‘66, the Japanese [...] were looking at what was happening and they came over, company after company” (Asimov and Frenkel 37). In 1967 Engelberger visited Japan, following an invitation by the government to give a lecture in Tokyo. Asimov describes how things unfolded:

When he arrived in Tokyo to lecture, his hosts were concerned that after his address the audience might not be inquisitive enough. So to be polite, they made up three or four questions before the audience arrived. Accustomed to speaking before eight or ten people in the States, Engelberger found himself in front of seven hundred engineers and executives. He began talking at 1:30 in the afternoon and was “dragged off the dais” at 6:30 at night.

(Asimov and Frenkel 37)

Schodt notes that the audience of seven hundred was not a group of “science fiction dreamers”, they were mostly executives and engineers, many of whom were ordered to attend by superiors. Engelberger commented that Japan, when presented with the idea of robotics “jumped right in, ran with it, and didn’t agonize over it either.”³⁹ (Schodt 1988 111). Today, a Unimate unit can be found in the industrial history wing of the Smithsonian Institution, an historical artefact that created robotics as we know it today (Nocks 67).

From 1978, and only a decade after the construction of its first robot, an average of ten thousand robotics systems were manufactured each year in Japan. At first mainly for the car industry, but later for every other industry they could be used in. The Japanese world of robotics marks 1980 as ‘year zero’ of the automation revolution in Japan, and it was then that Japan got the title ‘robot nation’ (Hornyak 80). During the 80’s, the Ministry of International Trade and Industry (MITI) began implementing policies regarding rebuilding and developing Japan as a technological nation. All necessary resources were allocated for research and development of advanced technologies needed for the creation of a modern and advanced information society (Schodt 1988 122-5).

The first of its kind

In 1973, five years after the first industrial robot was built in Japan, the robotics laboratories of Waseda University introduced Wabot-1, the first full-sized humanoid robot in the world⁴⁰ (Menzel and D’Aluisio 37). Wabot-1 was headless, had a metal frame that revealed computer components and various cables, had very basic vision capabilities,

³⁹ 1982 interview with Engelberger, quote in (Schodt 1988).

⁴⁰ Created by Ichiro Kato, Wabot-1’s name comes from an abbreviation of WAseda roBOT.

but nevertheless it could walk, move objects from place to place, and had the general mental capacities equivalent to those of an 18 months old child (Hornyak 75).

In 1984 Waseda University presented Wabot-2. This time the humanoid robot had a video camera for a head, and was equipped with limited artificial intelligence that mainly enabled it to read musical notes and play the organ (Hornyak 76). Another version of Wabot-2, a humanoid robot named Wasubot performed in 1985 *Bach's Air on a G String* accompanied by the NHK symphonic orchestra. The concert was held during the 1985 Japan Expo, and among the crowd of thousands who watched the performance was Emperor Akihito, crown prince at the time. Schodt further describes the significance of the moment that became a starting point to massive shift in Japanese robotics:

Wasubot was different. Wasubot was a humanoid, and when he played it was not a recording, but a provocative performance. Some listeners saw an enormously complex and expensive machine usurping a most emotive human activity, and felt a chill. Others saw a robot- a mechanical mirror of themselves- and heard music that moved them to tears. (Schodt 1988 13-4)

Schodt adds that Wasubot even got a personal visit from Emperor Hirohito, who was “enthralled” by the robot (Schodt 1988 13).

Wabot and Wasubot, but mainly the dream that led to their creation, have had a deep impact on Japanese robotics of the time. Schodt remarked that these first generation humanoids inspired researchers in Japan so much, that by 1988 there were humanoid robotics labs in over 20 universities all around the country (Schodt 1988 205). On a not-unrelated note, a year after the 85 Expo took place the Honda Corporation embarked on a long research project, which will culminate in the most advanced humanoid robot to date.

Part of the family

Various household robots are now extremely popular in Japan. For the time being the vast majority of them are used for recreational and entertainment purposes, but as they evolve, their roles in the household will change accordingly. Projections about the future of robotics in Japan estimated that by this year (2016) the household robots market, humanoid and others, should be larger than 18.5 million units in number⁴¹ (Robertson 2010, 61). The prevalence of different robots in the social sphere in Japan, compared to other developed nations, outlines certain social factors unique to Japan, which shaped the attitude and the approach toward advanced technologies, and robotics among them.

After transitioning from the literary world into reality, after the laboratories and factories, the next step was making robots a part of our daily life. Social robots differ from other categories of robots not only due to their function, but also due to the fact that they, by definition, are meant to take part in social interaction. Therefore, social robots are not ‘just’ robotic tools, rather, “they are personified, embodied, adaptive, and autonomous; and they can learn, communicate, use natural cues, respond to emotions in humans, self-organize, and pull on people in psychological rather than artifactual ways.” (Melson et al. 1649).

Sony’s Aibo was the first modern social robot, and the first autonomous robot to be mass-produced, beginning in 1999. Aibo is a robo-dog, that walks, talks, plays music, and expresses its feelings via LED display. Each Aibo develops its ‘personality’ according to its environment, and its natural behaviour leads many of the Aibo owners to

⁴¹ Current data unavailable.

treat their robo-dog as a regular pet, and like a member of their family (Hornyak 85). Soon after it debuted on the market, Aibo's initial run was sold out, at \$2500 apiece (Nocks xxix).

A study conducted among children between the ages of 7-15 concluded that most of the children interacted with Aibo as they would with a real dog. The researchers focused on four categories to conduct their study:

physical features (e.g. "Is AIBO [...] alive or not alive?"), *mental states* (e.g. "Can AIBO[...] feel happy?"), *sociality*, the state or quality of being social (e.g., "Can you be a friend to AIBO [...]?" "If you were sad, would you want to spend time with AIBO [...]?"), and *moral standing* (e.g., "Is it OK or not OK to hit AIBO [...]?" "If AIBO [...] is whimpering, is it OK or not OK to ignore AIBO [...]?") (Melson, et al. 1650).

They found that "the majority of children [...] affirmed that AIBO had mental states (56%), sociality (70%), and moral standing (76%). Moreover, a non-negligible number of children affirmed that AIBO had physical essences (22%)." (Melson, et al. 1651). As household robots such as Aibo become more technologically advanced and are better capable to simulate natural behaviour, there is little doubt that the results described above will become more prominent.

A productive member of society

Katō Ichirō , the creator of the first humanoid robots noted in the mid 80's that when humanoid robots will become more advanced, the first place he believes they will be utilized are the health and human service industries (Schodt 1988 204).

Unsurprisingly, he was not wrong. Japan's aging population, low birthrates, longevity, and lack of enthusiasm about the notion of foreign workers, all lead to the creation of a new category of household robots. The burden on the healthcare system is expected to rise in the upcoming years, and the predicted 20% population shrinkage by 2050 will create a severe shortage in working hands in Japan. With support and encouragement from the government, Japan is developing specialized caretaking robots for the elderly. There are already in existence a wheelchair and automatic-bathtub combinations, as well as a mechanical exoskeleton that assists people with weakened muscles to move (Hornyak 90-92).

Since in 2005, a robotic seal, Paro, has been sold in Japan⁴². It has been used for animal-assisted therapy for the elderly. Animal-assisted therapy is an established method for reducing stress and anxiety, but many institutions refrain from working with real animals due to hygiene considerations. In some of them Paro is used as a replacement for the real thing (Hornyak 90-2). In the decade since Paro's introduction numerous studies have been conducted in several countries to determine if it indeed has therapeutic properties. With the rising numbers of older populations in many countries, in recent years a sub category in social robotics was created: SARs (Socially Assistive Robots) that are designed to assist people with social interaction and other therapeutic functions.

A 2013 paper on Paro's effectiveness as a therapeutic tool concluded that "robots can successfully be included in therapeutic regimens for the elderly. Their effects can include positive health impacts, decreased stress and improved mood, decreased loneliness and better communication with others." (Sabanovic et al. 2). The team's

⁴² As well as in the U.S since 2009.

findings coincide with those of many previously conducted studies. They demonstrated that Paro has a positive effect on stress level and has increased social interaction among residents of care facilities⁴³, and their general engagement with their soundings (Sabanovic et al.).

Enter the mechanical human

In 1988 Schodt wrote that research and development of humanoid robots is extremely rare outside of Japan, and given the technology of the time building humanoids with expectations of them being even somewhat useful was largely considered to be “madness” (Schodt 1988 26).

Engelberger said once that “The minute you give robots sensory perception-vision, touch, voice communication, you’re going to get closer and closer to what Asimov was all about when he talked about robots” (Asimov and Frenkel 47). A major step in that direction was taken in November of 2000, when the results of the long research project Honda embarked on in 1986 were presented to the public. Asimo, the most advanced humanoid robot in the world looks like a vertically challenged astronaut; it walks quite naturally, avoids obstacles, and imitates human motion in a rather convincing manner. Asimo is serving as Honda’s unofficial ambassador, and was even awarded the honour of ringing the opening bell in the New York Stock Exchange in 2002⁴⁴ (Hornyak 103-5), and accompanying then Prime Minister Koizumi on a diplomatic visit to the Czech Republic (Krebs 64).

⁴³ This study focused on Paro’s benefit for elderly dementia patients in care facilities.

⁴⁴ Additional information about Asimo can be found on Honda’s website, at: www.asimo.honda.com

The achievement is beyond impressive. A glance over Asimo's history reveals how far technology has come during Honda's Humanoid project. For a long time Asimo, then named 'E' (and later 'P'⁴⁵), was a box of wires and chips on two legs. Each aspect of robotic bi-pedal motion had to be perfected, or invented, before development began on Asimo's ability to interact with his environment. The 2014 model can run, hop on one leg and communicate in sign language- both Japanese and English versions (Honda). 'Asimo' stands for Advanced Step in Innovative Mobility, and officially, Honda claims that the name is completely unrelated to Asimov⁴⁶.

After this brief review of milestones in the history of robotic, a question remains: what *is* a robot? In *Inside the Robot Kingdom* Schodt compiled some answers to this question given by leading roboticists. There are many different answers, but Engelberger's sums it up quite nicely: "I may not be able to define one, but I know one when I see one."⁴⁷ (Schodt 1988 43).

The valley of uncanny creatures

After mastering the basic functions expected from a humanoid robot, the next logical step in the mind of any science fiction fan would be, naturally, to make the humanoid actually look human: build an android. Most of the people who actually build robots for living, surprisingly, disagree. The reason for this shares its roots with negative reactions some people have toward puppets. Discussing people who hate puppets, Jane Marie Law writes that "the reason most commonly given is that puppets give people the

⁴⁵ Models *E* 1-6, and models *P* 1-3.

⁴⁶ Personally, I remain doubtful.

⁴⁷ Joseph Engelberger, father of the industrial robot, quoted in Schodt.

creeps. There is something unsettling about imagining that inanimate humanlike figures are actually human and then being brought back to the awareness these effigies are in fact nothing more than wood and paint.” (Law 22). Or, in this case, nothing more than metal, wires, and algorithms.

Android science is alive and well, perhaps unsurprisingly, in Japan. The current trends of this field of research, however, are conflicting with recommendations made by the robotics expert, Mori Masahiro. In an article from 1970, Mori presented a theory regarding people’s reactions toward nearly perfect artificial replicas of living beings. Mori’s theory describes an imaginary line that stretches between our emotional and psychological responses in reaction to an industrial robot, and those which arise in reaction to a living human being. The more something appears human, we find it more familiar, and feel considerably more comfortable around it. The upward trend continues until it reaches the point that is at the heart of Mori’s theory: ‘the uncanny valley’, the place on the imaginary line where we begin sensing discomfort and uneasiness. There, in the valley, Mori placed cadavers, zombies, and artificial arms that appear completely natural, but are cold and lifeless to the touch. On the ‘cliff’ before the valley, Mori placed humanoid robots, and consequently recommended creating robots that resemble the human form, but to make sure that their appearance is metallic and robotic, so they would not cross the border into the uncanny valley (Mori).

The artificial analog

‘Android’ is a term taken from the Greek word ‘androeides’- humanoid. Androids, robots with human exterior, appeared in literature decades before the coining

of the term ‘robot’ in 1921, and most of them still exist only in fiction. Japan is the center of android research and development. In 2005 Repliee, an android that looks like a newscaster from Japanese television was introduced to the world.⁴⁸ Repliee’s creator, Ishiguro Hiroshi, the leading name in android research, believes that as robots become better at imitating human appearance and behaviour, people will feel more at ease around them. Since the creation of Repliee he has created a few other androids, among them a tele-operated artificial version of himself (Hornyak 134-40).

Extensive research is carried out in Japan concerning methods of improving and naturalizing facial expressions of androids, humanizing their movements, expanding their vocabulary so they would be able to converse more naturally with people, and many other examples. The current trends in android science are focused on blurring the artificial characteristics of their appearance and behaviour. The leading assumption in the field is that as androids become better and better replicas of human beings, so will every small deviation that demonstrates their artificiality cause discomfort, and researchers are attempting to minimize those deviations as much as possible (Hornyak 141-2).

Employing robots in assignments that require them to communicate with the public (e.g. receptionist, information center, etc.) is possible only if people feel comfortable around the robot, and androids are therefore, the most natural candidates for this task. Thinking about these types of scenarios, Engelberger noted that “The more intimately our robots get involved in the world today, the more critical [Asimov’s] laws are⁴⁹” (Asimov and Frenkel 29).

⁴⁸ Repliee was created in the image of Ayako Fujii, NKH newscaster, and was showcased during the 2005 Aichi Expo

⁴⁹ Asimov’s laws of robotics, outlined in chapter two.

Robot Kingdom

A review of major milestones of Japanese robotics provides some necessary insight into the current scale, impact, and ambitions of Japan's robotics industry. Quite early in its development, Japanese robotics began leaning in a direction different from that of the West, becoming a fascinating case study for how socio-cultural considerations shape and guide technological development. The following discussion will focus on the relationship of Japanese society with robots and the socio-political circumstances that lead to Japan's extensive engagement with robotics.

Japan is a highly technologically advanced nation. Over half of the world's industrial robots are located in Japan, and the amount of Japan's household robots is practically incomparable to that of any other country. Japan is the most automated country in the world, a title it has held for the past three and a half decades, and there are always new and interesting plans for the future.

Government designed future

In her book *Innovation Ecosystems* Eunika Mercier-Laurent, while describing various factors in different countries' capacity for innovation, such as technical proficiency of the work force, amount of patents per capita, and government investment in research and development, notes that "According to the OECD⁵⁰, Japan is at the vanguard of the world scientific activity and is amongst the first countries of the OECD, in terms of intensity of public and private research." She contextualizes the OECD's data by citing Japan's 1980's emphasis on "high technology industries, which were based on

⁵⁰ Organisation for Economic Co-operation and Development

the miniaturization, the computerization, and the convergence of the various domains of communication, information and multimedia.” (Mercier-Laurent 6). The early emphasis on development of these aspects of the technology sector has proven to be effective, as all are used in the current robotics industry in Japan, among others.

In 2007 Prime Minister Abe Shinzō⁵¹ introduced a new initiative called ‘Innovation 25’, which offered guidelines for roboticizing Japan by 2025. According to Robertson, 26 billion dollars from Japan’s national budget were allocated to promoting Prime Minister Abe’s initiative, which intends to accelerate the development of robots with decision-making abilities (Robertson 2011 291). An account by a graduate student in one of Japan leading robotics research centres illustrates the government’s commitment to such projects. Describing a visit from a representative of the science and technology bureau, Eduardo Castello wrote:

During her presentation [...] she introduced the new plans of the Japanese government regarding the importance of robotics as one of the main engines of economic growth for Japan. During the lecture, she remarked (several times) how much money and time the Japanese government has invested in training and education of future researchers in this field. [...] she also explained [to] us the big challenges Japanese society is currently facing and how robotics engineering seems to provide an answer. (Castello)

‘Innovation 25’ was preceded by a few others. In 1998 Japan’s Ministry of Economy, Trade, and Industry (METI) invested 4 billion yen in a five year Humanoid Robotics Project. 12 corporations and 10 universities participated in the project, and were

⁵¹ This was during his previous tenure as Prime Minister of Japan.

tasked with developing “first-generation intelligent humanoid robots able to use hand tools and work in human environments, including hospitals, offices, and households.” (Robertson 2011 289). A similar objective is behind the 2003 proposal by a leading roboticist⁵² in Japan, who suggested investing ¥ 50 billion per year, for a 30 years period in ‘project Atom’, a project that would pursue the development of a humanoid robot with mental, motoric, and emotional capacities equivalent to those of a 5 years old child. (Schodt 2007 10)

Robots and religion

One of the elements that shaped its relationship with robots is Japan’s ancient religious traditions. Religion is a part of the cultural characteristics of society, and as such it influences the way we see the world, including our approach to technological development. Shinto and Buddhism hold important roles in the development of robotics in Japan. Shinto is an animistic religion at the base of which is the notion that *kami*⁵³ are everywhere, and in everything. They reside in trees, rivers, people, inspiration, and therefore also in robots (Robertson 2007 377). Shinto does not distinguish between natural and artificial, and according to these principles robots are regarded as parts of the natural world. From these ideas arises the widespread belief in Japan that technology in general, and robots in particular, are neutral, and the way they are used will be determined by the user’s intents, not their own mechanical logic. These ideas are closely tied to previously discussed notions such as ‘the ghost in the machine’, and the subsequent fear of technological autonomy, never taking root in Japan.

⁵² Kawato Mitsuo, head of the Computational Neuroscience Lab at the ATR Institute in Kyoto

⁵³ *Kami* is a Japanese term that describes god, spirit, consciousness, soul, etc.

In a 2012 study researchers seeking to isolate the factors that influence attitudes toward robots, especial in relation to the robot's exterior appearance, found that "individuals who profess Judeo-Christian religions like robots less than those of Eastern religions, which corroborate the idea that philosophical elements embedded in each culture-religion may hold an enduring influence on attitudes toward technology." (Halpern and Katz 140). The deeper meaning behind the described differences in reaction will be further discussed in the next chapter.

As for the people who build robots, not bound by the dynamics discussed in the previous chapter, as Shinto regards nature, gods, and humanity as equal, roboticists in Japan freely build humanoid robots (Geraci 229-30, 236). The clear contrast between approaches toward the subject is nicely illustrated by Honda's conduct as they were preparing to market humanoid robots to the West. The evident lack of enthusiasm on the part of most western companies' for building humanoid robots⁵⁴ made Honda officials quite concerned about the West's discomfort with humanoids. To address any potential issues regarding marketing, a company representative was sent to the Vatican in 1996 to consult them about Christianity's view on building humanoid robots (Geraci 239).

One of Japan's most famous roboticists, and the man behind the uncanny valley, Mori Masahiro, founded the Mukta Institute⁵⁵, a think tank that conducts robotics research based on Buddhist principles. The institute offers consultations to corporations on research and development of robots. Honda, among others, was on the client list. Most of the personnel of the institute belong to the Rinzai Zen sect of Buddhism, "which

⁵⁴ This is no longer accurate. Robots with general humanoid shape (head, 2 arms, 2 legs) have been built in several countries. Androids, however, are still mostly unique to Japan.

⁵⁵ Jizai Kennkyujo in Japanese

delights in shaking rigid human minds with riddles and paradoxes, thus allowing the truths to emerge.” (Schodt 1988 210). When the mind is properly shaken, they then, following Mori’s philosophy, think of new robots that embody Buddhist teachings.

Religion is a cultural aspect of society, even if it is not dominant in day-to-day life. Religious traditions shape values, and thus influence one’s worldview. Japan’s religious traditions do not differentiate between natural and artificial, and between animate and inanimate. This is illustrated by a ritual that was highly popular during the first days of automation in Japanese factories during the 1970’s and 1980’s: with the installation of each new robot a Shinto priest was summoned to perform consecration and naming rituals. These days this tradition is less popular, but today one can find a humanoid robot chanting Buddhist prayers on people’s behalf, in the central cemetery in Yokohama (Geraci 236-7).

During the Edo period automata participated in religious festivals by recreating the creation stories according to the Shinto tradition. The religious principles of the ancient traditions explain the lack of apprehension of the Japanese society from ‘the artificial man’. In Japan androids are not considered as unnatural, and so researchers are attempting to create artificial versions as close as possible to the human original.

Social dynamics

Japan’s vast and ongoing investment in advanced technologies, particularly in robotics, was made possible largely due to the employment structure. The ‘employment for life’ model that was widely used by the large corporations ensured that workers would not lose their jobs, even if those became obsolete due to the automation process, but

would instead be retrained and given a different assignment in the company (Sabanovic). The labour unions in Japan, as Schodt notes, were usually company-wide, and not trade specific, thus eliminating any conflict between robotization and trade unions that represent trades that have become obsolete (Schodt 1988 151). The government was able to increase the production volume and grow the economy through modernization and automation policies without having to worry about the social repercussions of mass layoffs and unemployment.

This was not the case in the U.S. Opposition to robots was common during the first days of automation, as workers feared for their jobs, and trade unions feared for their survival. One quite extreme demonstration of the uncertainty brought by automation happened in 1972 in a General Motors plant in Ohio. After the firing of 350 employees, a strike broke out, during which the cars built in the plant and the machines that built them were sabotaged (Schodt 1988 150). The introduction of industrial robots into Japan's plants and factories was not met by fears for the future of those who were to be replaced by a machine, and the negative associations that were very common in the West never took root in Japan.

The tyranny of numbers

Today, Japan's population is slightly over 127million people, 27% of whom are over the age of 65. Eight births against nine and a half deaths for every 1000 people create a negative population growth (-0.16%) (CIA 2015). According to estimates, in 2055 Japan's population will consist of only 90 million people, of whom 41% will then be over the age of 65 (Haub). The current trend, if allowed to continue, will cause in the

near future a severe insufficiency in the work force needed to fund the health-care services of the aging population, and to fuel Japan's economy.

One of the available solutions for a shortage in working hands is opening Japan's gates for migrant workers. During the 1980's the Japanese government encouraged the arrival of foreign workers who had Japanese ancestors (especially from Brazil and Chile), based on the assumption that their integration into the Japanese society would be more natural, as their ethnicity will eliminate any cultural friction with Japanese citizens. The government's predictions did not come true. The immigrants indeed looked Japanese, but were never truly accepted into Japanese society (Chapple).

According to estimates, if Japan chooses to compensate for the declining work force by encouraging immigration of foreign workers in a volume that will cover all the positions that need to be filled today, by 2055 30% of the Japanese population will be foreigners or their descendants. A survey conducted in Japan illustrates the problem with opening Japan to immigrant workers: when asked whether immigration should be a part of a government policy, only 17% gave a positive answer (Chapple).

Jennifer Robertson argues that the Japanese government defines Japan's demographic problems (low birth rate, aging population) as biotechnological problems, and therefore the solutions they seek are biotechnological in nature, instead of social. The government's policy for dealing with these problems includes automation of every position that can undergo that process, and does not seriously consider the option of foreign workers. Robertson also claims that the Japanese people prefer humanoid robots to foreign workers as caretakers, and especially to Asian foreign workers, who might

bring up memories about Japan's behaviour in Asia half a century ago (Robertson 2007 371-2).

According to the Japanese government, the lack of human resources that is expected to hit Japan in the upcoming decades can be solved, at least partially, by increasing the use of robots. In 2007 the previously mentioned 'Innovation 25' initiative was introduced. The initiative's declared objective is to compensate for the low birthrate by robotizing Japan by the year 2025. Robot caretakers for children and for the elderly, robot housekeepers, teaching assistants in schools, robots that will eliminate more and more human jobs in the industrial field, and many other examples, are supposed to become an integral part of the shrinking Japanese society in the near future.

Between fiction and reality

The ancient *karakuri* tradition, mentioned above, became part of Japan's cultural background over hundreds of years. The traditional craft of building human looking automata that move on their own without a visible mechanism, set the stage for the robotics of the 21st century. Boyle notes that adopting western technologies and utilizing them in construction of *karakuri* during the Edo period symbolized the beginning of Japan's 'love affair' with robotics and technology (Boyle). The Dean of the Toyota National Technological College, Yoshikazu Suematsu, best summarized the great influence of the *karakuri* tradition on the development of robotics in Japan:

They shaped the way Japanese view robots. To put it simply, the difference between Mighty Atom and the Terminator shows the difference between how Japanese and Westerners view robots. Westerners tend to have this sense of

alarm or wariness. Japanese are unique in the world for their strong love and affinity for robots. (Hornyak 25)

The ‘Mighty Atom’ reference was not arbitrary. The animated character, known as Tetsuwan Atomu in Japanese and as Astro Boy in English (from here he on will be referred to as Atom), first appeared in 1951. The manga about Atom’s adventures, a robot built as a replacement for the scientist’s dead son, later only to be rejected by him, was published for 18 years, and in 1963 became Japan’s first anime series (Krebs). Part of Atom’s huge popularity in Japan was rooted in the character’s overwhelming humanity (Gilson). Atom’s positive image, and the fact that he was Japan’s first encounter with the notion of an autonomic humanoid robot, was a significant factor in the ‘Frankenstein syndrome’ not taking root in Japan. Or to put it more bluntly, as a Japanese journalist did: “Thanks to Astro Boy, Japan has become one of the most robot-friendly nations in the world, and Japanese workers raised few objections to the introduction of industrial robots into the workplace.”⁵⁶ (Krebs 65).

In Japan, manga and anime are much more popular than cartoons and comic books are in the West (Krebs). Generations of children in Japan grew up surrounded by robots with a positive image, first Atom, and many others after him, through manga, anime, and toys. Atom had a profound influence on the development of robotics in Japan, and on Japan becoming a robot-friendly nation. On top of the positive image humanoid robots have thanks to Atom, he also represented a vision of pacifism and technology combined for the making of a better future (Hornyak 45). And, as Kaplan notes “[Atom]

⁵⁶ Tachibana Takashi, quoted in Kerbs.

can be considered as the primary ancestor of most of the friendly artificial autonomous creatures, both imaginary and real, invented in Japan since then.” (Kaplan 2).

Over the years, Atom and robots in general became symbols of a wonderful future that science and technology could create for the benefit of humanity (Schodt 1988 76). Atom, as the name suggests, operates on nuclear power. It is not obvious when taking into account the fact that the character appeared only a few years after the nuclear catastrophe that ended the Second World War. Atom’s nuclear power was presented in a positive way, and thus softened to some extent its association with death and destruction. The fear of a potential association between Atom and nuclear energy lead to the anime series being televised in the United States under the name ‘Astro Boy’, removing all references to nuclear power (Kaplan 2).

Fukuda Toshio, a robotics professor from Nagoya University, claims that most Japanese people associate the word ‘robot’ with the image of Atom, and many of Japan’s roboticists state that Atom influenced their choice to work in the robotics field (Hornyak 54). Japan’s world of robotics consists of people who grew up with the image of the robotic good-hearted boy, and after obtaining the necessary skills, aspire to make the figment of The God of Manga’s imagination into reality. As one roboticist explained: “We are the Mighty Atom Generation, and we were brought up looking at Atom in comics and animation, so it just seemed like it would be a great deal of fun to create something that can walk.”⁵⁷ (Krebs 65). A good example for the influence the robotic boy has on Japan’s robotics experts is the above mentioned suggestion made by a group of scientists to commit to a long-term research project, to be named ‘Project Atom’.

⁵⁷ Katō Ryōza of Tōa University, quoted in (Krebs).

Chapter 4- Philosophical Adventures in the Natural World

“So, what's it like to live in the world we have lost, a mimetic world when things had spirit-copies, and nature could thus look back and speak to one through dreams and omens, nature not being something to be dominated but something yielded to or magically out-performed...?” (Taussig 100)

This chapter offers a review of philosophical, religious, and cultural influences that shape the ways technology is regarded. The first part of the chapter focuses on Japanese cultural heritage that differs from common western traditions. It discusses local Japanese religious philosophies, the concept of nature and the natural, as well as the treatment of ‘things’. These concepts are an important backdrop for reflecting on the topic of the following chapter, androids. The second part of the chapter reviews some real-world applications of some of the concepts featured in the first part.

The valley of human imagination

Mimesis

The concept of mimesis is an old one, and the quest for its original intention has inspired an overwhelming volume of scholarship. In his book *Mimesis* Matthew Potolsky notes that “Mimesis derives from the root *mimos*, a noun designating both a person who imitates [...] and a specific genre of performance based on the imitation of stereotypical

character traits.” (Potolsky 16). He translates it from Greek as ‘imitation’ (Potolsky 1). Throughout the centuries the meaning of this term changed, evolved, and expanded, but it appears that it always had a deeper meaning. According to Potolsky “even in its earliest uses, mimesis never simply meant imitation. From the very beginning it described many forms of similarity or equivalence, from visual resemblance to behavioural emulation and the metaphysical correspondence between real and ideal worlds.” (Potolsky 16).

First accounts suggest that mimesis was originally used to describe ritualistic practices of the Dionysian cult. Mimesis was then a term used for the songs, dance, and music performed by the cult’s priest. Władysław Tatarkiewicz notes that, as the term originally referred to dance and music, “Imitation did not signify reproducing external reality but expressing the inner one. It had no application then in visual arts.” (Tatarkiewicz 226). In the 5th century BCE mimesis came to refer to reproduction of the external world and mainly stood for imitation of nature in several different ways. As Tatarkiewicz explains: “For Democritus mimesis was an imitation *of the way nature functions*. He wrote that in art we imitate nature: in weaving we imitate the spider, in building the swallow, in singing the swan or nightingale.” (Tatarkiewicz 226).

Socrates, and later Plato and Aristotle interpreted mimesis as copying the appearance of things. It became the more popular interpretation, and mainly referred to works of art. As Plato’s views on the subject of mimesis evolved “his conception of art as imitating reality grew very extreme: he saw it as a passive and faithful act of copying the outer world.” (Tatarkiewicz 226). Plato was responsible for Mimesis becoming a common term in the public sphere, when in his treatise *Republic*, dated to 380 BCE, he “radically redefines art as essentially mimetic, as a representation of something else.”

(Potolsky 15). Eventually, Plato came to view the imitation of reality by artistic means very negatively: “Like an optical illusion, it introduces confusion into the soul, and undermines the powers of reason” (Potolsky 25).

Aristotle’s discussion of mimesis was very different. He viewed it as a natural part of any human, evidenced by the fact that children learn and develop by imitating those around them. Further, Aristotle thought that imitations themselves have value; imitation creates a fictional distance between the observer and the object of their observation, thus providing an opportunity to learn from the representation. Mimesis, according to Aristotle, facilitates rational thought in a way that might be emotionally difficult to accomplish when confronted with the original (Potolsky 37). Potolsky’s discussion regarding the fictional distance provided by the act of imitation was applied to theatrical performances; however, this particular aspect of mimesis is applicable elsewhere as well.

The theory of mimesis has had a profound influence on western thought regarding the relationship between art and nature. This historical influence, According to Potolsky, is not universal:

Many traditional cultures [...] do not make the sharp distinction between art and reality that Western theory has inherited from Plato. Art in these cultures is closely intertwined with ritual or with daily life, much as it seems to have been in archaic Greek culture before Plato’s intervention. Without the presumed difference of art from reality that underwrites Plato’s critique of mimesis, the idea of [...] reproducing life in a different medium, has little meaning. (Potolsky 94)

Here, discussing a theory mainly applied to artistic representations, Potolsky mirrors what we know to be true about cultural influences. Culture is the amalgamation of historical events, religion, philosophy and art, and even in the age of globalization it still has much influence on the way we see and analyse the world around us.

The multiple nuances of the philosophical aspects of mimesis are not of significant importance to this project. What is, however, is its very long history and influence on western thought. Potolsky's point about certain cultures, Japan being of particular interest here, having no strong deep-rooted historic a priori differentiation between the natural world and its artistic representation, provides a backdrop to the hypothesis of this project. As the focus of the next chapter is androids, machines in human image, the concept of mimesis serves an essential purpose. Androids, artificial simulacra of the human being, can be understood, in my opinion, as continuation of a long tradition of imitating nature.

Theories from the art world and literature are not usually applied to mechanics. However, since the external appearance of an android has no technological function, the aspiration for human likeness can be interpreted as art. As mentioned above, Aristotle's point about the potential benefits of creating a fictional distance reflects much of the reasoning behind the creation of robotic copies of humans. Its relevancy is rooted in the possibility to understand the human being on a basic and profound level, in a way that is perhaps impossible when studying the original, as understandable apprehensions might obscure the field of vision. Applying scientific scrutiny to abstract notions regarding what makes us human is quite impractical. By building a perfect human analog, however, we might be able to tell what it is that separates us, or perhaps find that there is nothing at all.

Animism

No one translation, and no one interpretation, is sufficient to encompass [mimesis'] complexity and the tradition of commentary it has inspired. Nor can any one translation account for the range of attitudes mimesis evokes. Mimesis is always double, at once good and bad, natural and unnatural, necessary and dispensable. It is the sincerest form of flattery as well as the trade of pirates and plagiarists, the signal behaviour of great artists as well as apes, parrots and children. (Potolsky 1-2)

The concept of mimesis has been used to study representation in a wide variety of disciplines⁵⁸, anthropology being of particular interest here. A fascinating study conducted among a group of hunters in Siberia, the Yukaghirs, demonstrates how essential mimesis is for fully understanding certain, mostly non-western, ways of interacting with the world. In his book *Soul Hunters: Hunting, Animism, and Personhood among the Siberian Yukaghirs* anthropologist Rane Willerslev examines the daily practices of indigenous Siberian hunters who hold animistic spiritual beliefs. Based on his encounters with the Yukaghirs' hunting methods, Willerslev suggests that in their 'animated world' (Willerslev 1) mimesis is far from being an abstract concept.

In his introduction of the concept of mimesis, and the particular aspects he intends to apply in this discussion of animism, Willerslev references Walter Benjamin's interpretation of the concept. He argues that "mimesis [is] not a theory but a "faculty," which, like the body, is an inherent part of the human condition" (Willerslev 9). Or, in the

⁵⁸ Psychology, anthropology, educational theory, feminism, post-colonial studies, political theory, neo-Darwinian biological speculation, and literary and artistic theory (Potolsky 2).

words of anthropologist Michael Taussig, the mimetic faculty is “the nature that culture uses to create second nature, the faculty to copy, imitate, make models, explore difference, yield into and become Other” (Taussig xiii). Reflecting on Taussig’s concept of ‘second nature’, Willerslev suggests that it “is nature that is reflexively aware of itself as standing somewhat *apart from* nature [...] Second nature reflects upon itself in activity, and it is through its mimetic encounter with other things and bodies that it acquires its self-awareness of standing apart from them.” (Willerslev 26).

Willerslev argues that in the case of the Yukaghirs animism is not an abstract philosophy, but more of a daily practice of mimesis. Animism, from the Latin *animus* (spirit, soul), was first applied to anthropological enquiry in the 19th century by Edward Burnett Tylor, who “used it to analyze how primordial people attributed “life” or “soul” or “spirit” to all things, living and nonliving.” (Wallace 5). Tylor thought of animism as the early stage of later religions, and generally described “animism as a system of spirit beliefs, of nature inhabited by a myriad of beings in which the boundaries between the spiritual and the material are effectively dissolved” (Clammer 85).

In *Animism: The Seed of Religion*, published in 1905, Edward Clodd, as did Tylor, argues that monotheism has its roots in animistic beliefs. In a discussion on how these beliefs originated, he offers a thought process that might have taken place a very long time ago: “reasoning in the first place from what he knows of himself, remembers that as, for example, in dreams, his own spirit moves with complete activity even when his body lies motionless, so there is no reason to doubt that the spirit within the motionless rock has the power of activity also.” (Clodd 43).

Willerslev argues that mimesis is an integral part of the animistic culture in question, and the act of mimicking the natural world is at the center of their animistic perception of personhood and fluid identities (Willerslev 9). This argument is aptly demonstrated by the author's account of a typical hunting scenario among the Yukaghirs:

A female elk appeared from among the willow bushes with her offspring.

At first the animals stood still, the mother lifting and lowering her huge head in bewilderment, unable to solve the puzzle in front of her. But as [...] [the hunter] moved closer, she was captured by his mimetic performance, suspended her disbelief, and started walking straight toward him with the calf trotting behind her. Later he explained the incident: "I saw two persons dancing toward me. The mother was a beautiful young woman and while singing, she said: 'Honoured friend. Come and I'll take you by the arm and lead you to our home.'"

(Willerslev 1)

The bewilderment on the elk's part was an intentional outcome, inspired by the Yukaghirs' hunting methods, an important aspect of which is to look the part. "The elk-hide coat worn with its hair outward, the headgear with its characteristic protruding ears, and the skis covered with an elk's smooth leg skins, so as to sound like the animal when moving in snow, made him an elk" (Willerslev 1). Willerslev provides a 'behind the scene' explanation for this scenario: "By means of mimicry, the Yukaghir hunter assumes the viewpoint, senses, and sensibilities of his prey while still remaining aware of himself as a human hunter [...] he [...] retains a personhood of his own and is capable of individual agency and intention." (Willerslev 26). Or, in other words: "he was not an elk, and yet he was also not *not* an elk." (Willerslev 1).

The way the Yukaghir hunter sees the world is echoed in Clammer's more general discussion about the nature of animistic thought. He writes:

animism, embodying as it does an experiential, active, and everyday relationship to creatures and things in nature, does not diminish 'religion' to its point of ('primitive') origin, but to the contrary expands it by including nature, dissolving the boundary between the animate and inanimate, spiritualizing the mundane, and locating the core of religion in praxis rather than belief and in social-experiential forms rather than in theology. (Clammer 87)

The concept of personhood, Willerslev suggests, is at the heart of western preconceptions that make it difficult to fully understand animistic cultures. Western cultures, he claims, attribute personhood only to people, while animals are seen as living solely by following their survival instincts. Higher brain functions such as morality, language, intentionality and reasoning are reserved for humans alone (Willerslev 2). His argument about personhood in the West being associated with humans only, echoes very closely the previously discussed exclusion of nonhumans from the study of social interaction until fairly recently. Furthermore, mirroring Weber's criteria for participation in social interaction, most western definitions of personhood require intention and conscious thought.

The Yukaghirs perceive the concept of personhood in a completely different way. Their animistic view of the world suggests that human is only one shape a person can take: "They can also appear in the shape of rivers, trees, souls, and spirits, but above all it is mammals that Yukaghirs see as "other-than-human persons"⁵⁹" (Willerslev 2). Or, in

⁵⁹ 'Other-than-human persons' is a term coined by Alfred Irving Hallowell in 1960

the words of a Yukaghir hunter: “animals, trees, and rivers are “people like us” [...] because they move, grow, and breathe” (Willerslev 73).

An interesting discussion on the cultural variations of personhood is offered by Graham Harvey in his book *Animism: Respecting the Living World*. ‘Person’, in many parts of the world, is not as narrowly defined as it is in the West, and awareness of this basic difference can help appreciate the world view of cultures that “envision nonhuman nature as “ensouled” or “inspirited” with living, sacred power.” (Wallace 5). On such cultural variations of defining personhood, Harvey notes:

In the philosophical language of many religious cultures ‘person’ is applicable not only to humans but to various significant other-than-human beings (e.g. deities and angels). Animists recognise a much wider range of persons. There is nothing in these discourses that should be understood as implying (let alone asserting) that humans are the primary exemplars of personhood [...] ‘other-than-human person’ [...] arises from animist engagement with a world that is full of persons, only some of them are human; (Harvey xvii-xviii)

Harvey offers a clear definition of the animistic take on personhood. His approach to the subject proves useful for establishing how different cultures see the world truly uniquely. He argues that animism challenges European notions of personhood, particularly due to the fact that according to the animistic perspective “To be a person does not require human likeness, but rather humans are like other persons. Person is the wider category, beneath which there may be listed sub-groups such as ‘human persons’, ‘rock persons’, ‘bear persons’ and others. “ (Harvey 18).

As for the Yukaghirs' perspective, Willerslev explains that according to their beliefs humans and animals can move between their respective identities, assuming the shape and perspective of whichever suits them best at the moment. This ability to move between identities is in fact an essential part of being a person in the Yukaghirs' animistic culture (Willerslev 2,6). This particular lack of fixed identities might suggest that the Yukaghirs have an even wider definition of personhood than that proposed by Harvey. However, Willerslev clarifies that their animistic beliefs do not mean that personhood can be attributed to everything, and at all times. In fact, "The personhood of animals and things is [...] something that emerges in particular contexts of close practical involvement, such as during hunting. Outside these particular contexts, Yukaghirs do not necessarily see things as persons any more than we do" (Willerslev 8).

One of the better known forms of animism still widely practiced today is native to Japan. There, it informs many aspects of life, from identity to ecology, and suggests that within the industrialised modern world there are "alternative modes of social analysis, starting from different premises about what is significant and leading to different conclusions about the actual dynamics of social organization." (Clammer 84). One of these key 'different premises' can be generally attributed to the notion that "Japanese culture has an alternative vision on categories of 'aliveness'; such an attitude is generally ascribed to Shinto tradition, an animistic religion in which deities are frequently associated with animals or things which serve as incarnations or messengers of spirits." (Ghedini and Bergamasco 734).

Shinto

And how real are the dwellers in the invisible world to the Japanese is seen in the attitude of the soldiers in the recent war with Russia (1905) towards their fallen comrades, who [...] are thought to be leading their ethereal life in the same world in much the same state as that to which they had been accustomed while on earth. (Clodd 95).

Edward Clodd wrote this at the beginning of the 20th century, and it is at least since then that ‘animism’ has been a popular subject for discussion in Japan, making it the only country, and certainly the only industrial country, where the term animism ever was, and still is widely used (Clammer 96). In Japanese discourse, as Clammer notes, animism is often used “as a way of explaining the distinctiveness of the national culture and as a vehicle for constructing a model of Japanese society”, as well as to “express and encapsulate a complex of questions relating to identity, society-nature relationships, and images of the self” (Clammer 83).

Most of the discourse about animism refers to Shinto, the ‘way of the gods’, “a complex and specific form of animism” (Clammer 84). Clammer believes that among all major world religions Shinto stands as the one least understood (Clammer 88). For this, there are many reasons, among them the countless interpretations and vast scholarship dealing with its multiple nuances. To accommodate the scale of this project only a few relevant elements of Shinto will be discussed.

Shinto is a complex idea, difficult to define even if only due to the weight of its long history that can be traced at least as far back as to the *Nihon Shoki*, completed in 720

CE (Inoue et al. 1). Writing about Japan's wild nature, Aya Hayashi shares her view of Shinto:

Shinto is the Japanese traditional religion based on an ancient Japanese philosophy that is an animistic ethnic belief with influences from Buddhism and Confucianism. The main doctrine of Shinto is the worship of nature and the ancestors. In this philosophy, the Gods, called Kami, live everywhere, especially in pristine nature [...] This pantheistic belief has developed from the basic Japanese way of thinking rather than from a religious doctrine. (Hayashi 35)

Clammer, approaching the topic from more of a system-analysis perspective while discussing the historical and political implications of attempts made to define Shinto, writes:

'Shinto' in its most general meaning refers to a complex of beliefs and, more importantly, practices encapsulating an understanding of human-cosmos relationships. Historically, it has never been a single thing, but rather a loosely connected set of localized behaviours, Japanese in its specific configurations, but with many parallels to nature –based religions elsewhere (Clammer 88)

One of the challenges of discussing Shinto in the context of religion as understood in the West comes from Shinto being regarded as a 'religion' only after the Meiji revolution in 1868. Earlier in its history there were no attempts made, nor was there any reason to define what exactly Shinto is and what it stands for. It was simply regarded as "an expression of human-nature relationships in the context of an animistic universe." (Clammer 89).

It worth noting that in the face of the very visible influence of Shinto on almost all aspects of life in Japan, less than 4% of Japanese people define themselves as followers of a religion called Shinto (Teeuwen and Breen x). This seeming inconsistency is one of many nuances that contribute to the complexity of defining Shinto. Being an organic part of life in Japan throughout centuries without a centralized overarching institution steering and regulating the practice, Shinto became so ingrained in the practices of daily life in Japan that for most it does not feel like a religion at all.

According to Clammer, there were originally no shrines affiliated with Shinto, that particular aspect of religious expression was added later on (Clammer 93). Today there are over 100,000 Shinto shrines throughout Japan, some are large and famous, others small and private (Teeuwen and Breen ix). Shinto shrines remain very popular in modern-day Japan among most of the population, mainly on special occasions. A significant majority (70% of Japanese people) visit shrines during New Year (*hatsumōde*), while more than half do so to celebrate the birth of a baby. Regarding matters of a more material nature, a third of Japanese invite a priest to perform ritual purification for a new car or building plot, and a quarter of the population prays in shrines for success in exams. Those who do not pray in shrines for any occasion are a minority of only 16% (Teeuwen and Breen ix-x)⁶⁰.

Notwithstanding, as noted by Clammer, many of the rituals do not require a formal holy site, and in certain cases even particular parts of nature, such as mountains, can become holy site on their own (Clammer 94). In fact, “Religious sites need not be shrines at all, but are today often rocks or, in particular, trees, marked by a straw belt

⁶⁰ According to 1997 survey conducted by the Shrine Association, in (Teeuwen and Breen ix-x).

(*shimenawa*) tied around them to mark them as *kami* or as the residences of *kami*.”
(Clammer 94).

An integral and philosophically inseparable part of Shinto, *kami* is a multilayered concept that proves very resistant to precise and enumerated definition. Nevertheless, in the (translated) words of an 18th century Shinto philosopher Norinaga Motoori:

The term *Kami* is applied in the first place to the various deities of Heaven and Earth who are mentioned in the ancient records as well as to their spirits... which reside in the shrines where they are worshiped. Moreover, not only human being, but birds, beasts, plants and trees, seas and mountains, and all other things whatsoever which deserve to be dreaded and revered for the extraordinary and preeminent powers which they possess, are called *Kami*... Then there have been numerous examples of divine human beings both in ancient and modern times, who[...] are treated as gods[...] Amongst the *Kami* who are not human beings, I need hardly mention Thunder [in Japanese *Naru Kami* or the Sounding God]... There are many cases of seas and mountains being called *Kami*. It is not their spirits which are meant. The word was applied directly to the seas or mountains themselves as being very awful things.⁶¹ (Aston 1921 6-7)

The concept of *kami* is a central part of Shinto. People, their ancestors, animals, gods, trees, thunder, rice, stones, mountains and waterfalls are all entities “appearing as a unified and dynamic field of existence”, and can all be *kami* (Jensen and Blok 97). It is also important to note that none of the *kami* is supreme (Clammer 91). In other words, “Shinto posits a radical ‘personalization’ of the universe, with both human and non-

⁶¹ Written in the second half of the 18th century by Norinaga Motoori (1730-1801), quoted in (Aston).

human worlds consisting in a plethora of ‘spirit beings’ known as kami, the boundaries between which are vague and interchangeable.” (Jensen and Blok 97). In fact, the barrier separating deities and human beings is so vague, that extraordinary humans are frequently worshipped as ‘living kami’ (*ikigami*) (Inoue et al. 7).

Shinto plays a major part in understanding the Japanese socio-cultural landscape, especially when examined against the backdrop of western thought. Clammer notes that “a major difference between Shinto and most other major systems of belief is that the boundaries between the human, the natural, and the divine are extremely permeable.” (Clammer 91). Further, “Shinto forms an indigenous knowledge system, alive and well in contemporary Japan in the shape of everything from life-cycle rituals and religious festivals (*matsuri*) to aesthetic renditions of nature, indigenous people’s struggle for land rights, scientific discourses and intellectual work related to (contested) Japanese worldviews.” (Jensen and Blok 97).

Ultimately, Shinto traditions organically form a bypass of the strong nature–culture dualism prevalent in western thought, and allow for human/non-human continuities and boundary-crossings (Jensen and Blok 104). This notion is a critical part of this project. The absence from the collective cultural consciousness of rigid dualistic views of nature and culture, human and nonhuman, real and artificial, creates a foundation for the exploration of extreme technological paradigms within Japan’s socio-cultural landscape. Finally, as Clammer notes, Shinto “creates a world view in which humans are a product of nature and nature is in a sense a product of humans” (Clammer 102).

Nature

Anesaki Masaharu wrote that “Both Buddhism and Shintoism teach that the things of nature are not essentially unlike mankind, and that they are endowed with spirits similar to those of men.” (Anesaki 10). This approach is at the heart of a widely accepted Japanese esthetical philosophy concerning the natural world. Matsuhara Iwao, for instance, wrote:

The Japanese treat nature as respectfully as they treat their fellow men, and are moved by the beauty of nature just as they are moved by the beautiful deeds of men. The intimate relationship with nature may be accounted for by the fact that nature in this island country is so gentle and beautiful.⁶² (Asquith and Kalland 5)

Pamela Asquith, while analysing the Japanese ‘love of nature’ notes that in Japan “Nature and the spiritual world are inseparable.” (Asquith and Kalland 2). Aesthetic appreciation of nature is synergetically bound to the religious, creating a very personal relationship between nature, kami, and people that formed the core of the ancient religious ethos in Japan. This bond is established in the Shinto tradition by kami being everywhere and everything, and supported by Japanese mythology that describes kami as the ancestors of natural phenomena, thus making nature itself divine (Asquith and Kalland 2).

Hayashi further notes that “The Japanese were awed by nature, saw divinities in natural beings, and believed that nature would retaliate if it were not treated with respect. This belief and attitude still exists today within the spiritual structure and religions of the Japanese people.” (Hayashi 35). Indeed, Japanese spirituality is heavily affected by the

⁶² Written by Matsuhara Iwao. Quoted in (Asquith and Kalland 5)

religious overtones associated with nature. As mountains, wind and mist became deified, the distinction between animate and inanimate, between people and all the rest became very hard to define (Asquith and Kalland 3).

Clammer, discussing the integral part nature has in shaping the collective identity, notes that “For the Japanese nature is indeed part of social self-image; there is no gap between humans and the rest of creation, and when society, especially urban society, creates one, the recovery of humanness requires a return to nature” (Clammer 105). Further, Clammer argues that unlike classical western sociological theories about our relationship with the natural world, nature is a key part of the constitution of Japanese society (Clammer 83). The significance and larger implications of this assertion deepen when taking into account that before the late 19th century there was no word in the Japanese language corresponding to the western understanding of ‘nature’⁶³. Hayashi explains that “The reason the Japanese did not have the concept of nature as a separate term is that nature and people’s lives were unified. Nature had existed as itself and did not include any concept that implied the opposite meaning of artificiality.” (Hayashi 34).

The unified existence of humanity and nature in Japan is further illustrated by the absences of the ‘sublime’ from the natural world. Anesaki wrote that “awe and sublimity are almost unknown in Japanese painting and poetry, but beauty and grace and gentleness are visible in every work of art.” (Anesaki 10). Saito offers an interesting narrative to understand the “conspicuous absence of the sublime in the Japanese appreciation of

⁶³ For discussion on the history and the politics behind the concept of ‘nature’ in Japanese see-

- Thomas, Julia Adeney. Reconfiguring Modernity: Concepts of Nature in Japanese Political Ideology. Berkeley: University of California Press, 2001.
- Tellenbach, Hubertus and Bin Kimura. "The Japanese Concept of "Nature"." Nature in Asian Traditions of Thought: Essays in Environmental Philosophy. Ed. J. Baird Callicott and Roger T. Ames. Albany: State University of New York Press, 1989. 153-162.

nature” (Saito 241). She explores both the roles of Japan’s tame landscape as well as the identification with nature in the lack of appreciation for the sublime. Regarding the influence of a particularly convenient natural environment on socio-cultural views of nature, Nakamura Hajime wrote that:

This sentiment for nature, which contributed to the sympathetic heart of the Japanese people and their love of order in communal life, may be due partly to the influence of the land and climate and to early attainment of a settled agricultural civilization. Everywhere in Japan there are passable mountain ranges, rich in streams and lakes; the land was favourable to settled abodes and the development of communal life. The mild climate, the variety of scenery, the rich flora and sea-products and the remarkable absence of beasts of prey—these combined contributed greatly to the development of a peace-loving and docile disposition and to an ability to establish order and attain solidarity. (Nakamura 12) ⁶⁴

Hayashi elaborates on Nakamura’s argument; she notes that close to 70% of Japan is covered by forests, mountains, and fields. This type of tame environment according to Hayashi, makes it easier to ‘unify’ with nature, than perhaps in a desert, where unity with the environment might be dangerous⁶⁵, and suggests that different environments lead to different relationships with nature (Hayashi 35). Further, she notes that “For ancient Japanese people, in this environment, nature was a mysterious and powerful place, and people developed effective methods for living in harmony with it. People realized that

⁶⁴ The general description of Japanese people as ‘peace-loving’ and ‘docile’ perhaps is not accurate throughout Japan’s history.

⁶⁵ It is worth mentioning that the desert is not universally considered to be dangerous. The Bedouins, for example, a very large group of desert nomads, live all across the deserts of the Middle East and northern Africa.

everything is ephemeral in the circulation of life, and they aimed for unification with all animate beings.” (Hayashi 35).

Saito argues, however, that the tame and beautiful Japanese landscape and mild climate do not fully account for the absence of sublime notions from Japanese appreciation of nature, as Japan has its share of “fierce and awful aspects of nature such as annual autumn typhoons, earthquakes and rough seas” (Saito 141). Indeed, the other side of Saito’s proposed narrative regarding the absence of the sublime from Japanese concepts of nature is that “the Japanese appreciate nature primarily for its identity with man.” (Saito 242). She argues that the Japanese identification with nature traditionally includes emotionally based identification, as well as “identification based upon the transience of both man and nature.” (Saito 242). The emotional identification with nature is highlighted by a very long tradition in Japanese literature of expressing emotions with terminology borrowed from nature. Saito illustrates this literary tradition by quoting the opening paragraph from a poetry anthology from 905 CE:

Japanese poetry has the hearts of men for its seeds, which grow into numerous leaves of words. People, as they experience various events in life, speak out their hearts *in terms* of what they see and hear. On hearing a warbler chirp in plum blossoms or a kajika frog sing on the water, what living thing is not moved to sing out a poem?⁶⁶ (Saito 243)

The notion of nature as a mirror reflecting emotions is not uniquely Japanese, though it is an integral part of the aesthetic appreciation of nature in Japan (Saito 245).

⁶⁶ Written by Ki no Tsurayuki in the preface to *Kokinshū*, anthology of poetry, compiled in 905 CE. Quoted in (Saito 243).

Along those lines, expanding her narrative on emotional identification with nature, Saito argues:

Whether the emotive identification between man and nature is rendered primarily as a result of man's intuitive grasp of the essence of a natural object or as a result of the imposition of feeling onto the outward reality, this appreciation of nature for being emotionally charged constitutes an important aspect of the Japanese aesthetic appreciation of nature: the appreciation of nature for its expressive quality. (Saito 244)

The second traditional aspect of identifying with nature in Japan comes from the transitory nature of *nature*. According to Saito, things and phenomena that do not last for long have an inherent aesthetic appeal, hence, from a psychological prospective we appreciate things more once we know that they will never be the same (Saito 245-6). In other words, “If flowers are in full bloom all the time and if we exist forever, we won't be moved by this encounter. Flowers exhibit their glow of life by falling to the ground.”⁶⁷ (Saito 246). As Saito points out, “It is not yet clear whether transitoriness itself directly contributes to the aesthetic quality of the object, but it is aesthetically relevant in the sense that it predisposes the viewer to attend very carefully to the object and fully savour whatever the object has to offer at the moment.” (Saito 246).

Such sentiments are exemplified particularly well in Japan by the blossom of the cherry tree. With the season comes also extensive media coverage that includes forecasts of the progression of the blossom from southern Japan to the north, as well as blossom-viewing motivated internal tourism. Discussing the significance of the cherry blossom,

⁶⁷ Higashiyama Kaii, contemporary Japanese painter, quoted in (Saito 246)

Saito notes that “Cherry blossoms are more effective than other flowers for symbolizing transience because they look most fragile and delicate, they stay in full bloom for only a short period of time, and they drift down slowly petal by petal, giving an impression that they regret falling.” (Saito 247).

Through her exploration of the identification with nature in Japan, based in part on its ever-changing characteristics, Saito presents her main argument: as the transient nature of everything, most importantly life, is at the heart of humanity’s suffering. “Grief experienced at the transience of human life is transformed to aesthetic pathos when it is compared to the transience of nature (Saito 247-8). The transience of nature as a parallel to the transience of human life has been widely used in Japanese literature for centuries. This common coupling, according to Saito, “stems from the conviction that nature and man are essentially the same, rooted in the same principle of existence.” (Saito 248).

Ultimately, Saito suggests that along with the effects of being surrounded by tame landscape, the Japanese appreciation of nature is mainly rooted in co-identity: “By identifying human life with nature, the Japanese find a way to justify the transience of life. That is, since everything is in constant flux there is no escaping change and this recognition leads to resignation and finally to an acceptance of the sorrow of human existence (Saito 248). The strong identification with nature and its transient properties is representative of the very vague boundaries that exist between people and nature:

the perception of nature and life as one and the same, and the ascription of unhappiness and misfortune to the transiency and evanescence of nature and things impermanent.[...]Unhappiness in life is expressed through the guise of

nature; because of the evanescence of nature, man realizes that it is senseless to grieve and should become reconciled to fate.⁶⁸ (Saito 249)

Or, in other words- “Nature is alive and always changing. At the same time, we ourselves, watching nature change, are also changing day by day. Both nature and ourselves are rooted in the same fated, ever-changing cycle of birth, growth, decline and death.”⁶⁹ (Saito 248).

According to Hayashi, the Japanese language, not having a word parallel in meaning to the western concept of ‘nature’ until quite recently, often raises the necessity to discuss comparisons with western views of nature to reveal Japanese views (Hayashi 34). Kaplan, for instance, suggests looking at the differences between Japanese and western fountains as a case study that illustrates the differences between Japanese and western views about the natural world; western fountains throw water upward, forcefully, against its natural flow pattern, demonstrating superiority over nature. Small Japanese cascades, in contrast, attempt to mimic as accurately as possible the natural flow of water. Copying a natural element, and reconstructing it artificially, with a hidden mechanism, is considered to be a tribute to nature (Kaplan 5). Kaplan’s example and the notions behind it mirror Ashkenazi’s analysis of ‘natural’ versus ‘artificial’ in Japan. Ashkenazi writes:

‘Natural’ seems to imply, conceptually, something different in Japan than in the West. It is the cunningly disguised artifice that counts, not nature wild and woolly, red in tooth and claw. The natural which is significant culturally is an artificial construct which conveys the *flavour* of nature, its essence, rather than its presence. (Ashkenazi 216)

⁶⁸ Originally by psychologist Hiroshi Minami, quoted in (Saito 249)

⁶⁹ Higashiyama Kaiti, contemporary Japanese painter, quoted in (Saito 248)

Hayashi further notes that views of nature usually fall within one of two categories: humans as part of nature, as in the Japanese case, or humans as separate from nature, as in the western case (Hayashi 34). Illustrating how different natural environments inevitably lead to different views and different cultural perspectives concerning nature, she writes:

The Western view of nature, which reflected the Judeo-Christian tradition, was born in the desert areas of the Middle East. Due to the severe climate, the people who lived there looked at nature as harsh and separated nature from humans in order to survive. In this environment, the people carefully observed the rules of nature, and that is said to have been the start of natural science. They began to control the natural environment using new scientific knowledge that they had gained through their observation of the natural environment. They used the raw materials available for development. This raw material was supposedly given by God with the stipulation that people would have dominion over their environment and should modify it to their needs. (Hayashi 34-5)

Furthermore, Saito notes that unlike Japanese traditional appreciation of nature, the traditional western view does not omit the notion of the sublime. She proposes to look at Kant's theory of aesthetics concerning the sublime. Kant posits that appreciation of the sublime is rooted in the fundamental contrast between people and nature, because both the inability of people to comprehend nature in its full magnitude and have full dominion over it, as well as people's ultimate superiority over nature (Saito 242).

During the seventh century in Japan farming was a declining occupation among many aristocrats who chose to reside in urban areas; this move away from vast open

landscapes brought with it a renewed appreciation for nature “as a part of their culture, education, and intellectual entertainment.” (Oyadomari 24). The limited space in urban environments encouraged a trend among aristocrats of bringing nature into their homes, instead of seeking it outdoors (*Ibid.*).

According to Saito, not much has changed in this regard since those early days. She notes that in Japan people still “attempt to bring nature into the proximity of their daily lives[...] they construct gardens even in confined spaces, or reduce nature into miniaturized presentations by[...] cultivating a dwarfed pine tree (*bonsai*) or creating a miniature landscape on a tray (*bonkei*).” (Saito 239). Ashkenazi notes that these art forms are shaped by “cultural rules [...] define the appropriate way to represent natural forms by artificial manipulation of natural material.[...]In those cases, the artist is intent on expressing something that ‘should be’ in nature, but often is not.” (Ashkenazi 216; clarification added).

According to Nakamura, Japanese culture has a tendency to cherish miniature forms of nature. He notes that “The Japanese garden typically exemplifies the Japanese interest in expressing natural scenery on a miniature scale.” (Nakamura 13). This sentiment is further embodied by the previously discussed art form *karakuri*, Japanese automata, and in particular, the tea serving doll: a low-tech, miniaturised replica of a human being, created to perfectly and elegantly carry out its task. As Ashkenazi notes, the tea dolls are yet another attempt by Japanese artists to refine nature (Ashkenazi 210). Regarding the evolution of miniaturised nature in Japan, Oyadomari further notes that “these developments arose from the same idea—an attempt to bring nature into living

space by reducing it artificially.” (Oyadomari 24). Indeed, “artificiality is licit” in a culture dominated by Shinto traditions (Kaplan 5).

The ‘Japanese love of nature’ has been widely discussed in scholarship, and as all topics that are of interest to a large group of people, attitudes vary greatly here as well. Questioning the fundamental premise, Pamela Asquith notes that “Taking poems, paintings, sculptures, gardens and other artefacts as proof of this alleged love and harmony, scholars and others have been preoccupied with trying to explain *why* the Japanese love nature rather than with testing the validity of this widely held notion as such.” (Asquith and Kalland 4). She also questions “to what extent can monks and *haiku* poets be taken to represent *Japanese* sentiments and attitudes?” (Asquith and Kalland 5).

These questions are raised by many who find an essential contrast between the almost axiomatic notion of the ‘Japanese love of nature’, and reality. According to Asquith this reality includes over-exploitation of natural resources, and mass-scale pollution of land, water and air (Asquith and Kalland 5-6). Many have noted “the Japanese appreciation of nature is directed exclusively towards those objects and phenomena which are small, charming and tame.” (Saito 240). This, perhaps, is a possible attempt to reconcile Asquith’s contrast.

Kaplan offers another resolution. Discussing the seemingly inherent contradiction between excitement about cherry blossoms and whale hunting, he notes that “these paradoxes are only apparent. To protect nature efficiently, one must see it as something separated, something that falls under human responsibility. A clear idea of the frontier between the natural and the artificial is necessary. Japanese people seem to have trouble with this Western view.” (Kaplan 7).

In Japan, it seems, there is no unequivocal distinction between ‘natural’ and ‘artificial’. Among many other things, this might shed some light on how tools become ‘sacred’.

Sacred tools

When the New Year approached, every peasant would offer rice cakes to his washed and purified tools as an expression of thanks for working with him throughout the year and as a way of personifying and anthropomorphizing them. Praying for the restoration of the tool’s magical powers once a year was a way of resurrecting its former existence solely as a religious tool in the sacred world.⁷⁰ (Schodt 1988 199)

Schodt notes that most Japanese peasants in earlier times felt that they could enhance their productivity by paying more attention to their tools, appreciating their inherent magical properties, and sanctifying them (Schodt 1988 199). He further notes that “The act of making things has always had a religious undertone in Japan”, offering a potential explanation for the special treatment robots appear to get (Schodt 1988 199). He elaborates by quoting Yoshida Mitsukuni, who wrote that “when form and function were created through human labour [...] labour was a truly sacred act, and was determined by the degree to which man could understand and accommodate nature.”⁷¹

This philosophy is subsequently demonstrated by rituals concerning puppets that were no longer used. Jane Marie Law writes that “Until the late nineteenth century, they

⁷⁰ Yoshida, Mitsukuni. *Kikai: mono to ningen nobunkashi* [Machines: A Cultural History of Man and Things]. Vol.13. Tokyo: Hosei Daigaku Shuppankyoku, 1974. Pages 196, 199, 209. Quoted in (Schodt 1988); original not available in English.

⁷¹ *Ibid.*

[puppets] could not simply be thrown away or recycled [...] they were buried and a *kuyō* service was performed for them.” (Law 201). A general understanding of the *kuyō* ritual deepens further the sense of respect traditionally accorded to puppets in Japan. Law explains:

Kuyō [...] refers to a ritual practice that is at once a worship service, a formal apology and an expression of gratitude, an appeasement rite, and a funeral. Often recipients of the rites are inanimate objects such as needles, calligraphy brushes, household cleaning instruments, and even underwear. A *kuyō* is conducted when these objects are brought to a temple or shrine; the people who brought them make a series of invocations and statements of apology or gratitude; the objects are then ritually disposed of in a way that concretizes the feelings of the people who used them. (Law 201-2)

Ghedini and Bergamasco see this practice as an indicative of puppets being perceived as living entities within the cultural framework of the time (Ghedini and Bergamasco 734). Further, according to Law:

Broken puppets routinely had *kuyō* rites performed for them, and after the rite was concluded, they were buried in a cemetery [...] The practice of burying these images carved “in the shape of the human” [a literal translation of *ningyo*] suggests an awareness that while matter and spirit may appear to be separate orders, once spirit has encountered a material form, the latter cannot return to mere matter but becomes matter set apart. A dilapidated puppet - a head, arms, perhaps a costume, rattles, flutes and masks - will never again be merely the sum

of its parts. Today, they are put in museums or glass cases, a practice that worries many older puppeteers. (Law 202)

Ghedini and Bergamasco elaborate further on how ambiguous boundaries relate to our relationship towards certain objects:

Specifically, robots, puppets, and “things” crossing category boundaries, question what we perceive as “life”. They suggest that there is no such a thing as a discrete gap in our perception between animate creatures and inanimate objects, rather a continuous category. Moreover, in their paradoxical status of quasi-living entities, they are agents of cognitive dissonance, addressing the ambiguities of our perceptions and confronting us with stimuli that we “know” are deceptive or fictional, but accept as “true” or “real”, operating a “suspension of disbelief”. (Ghedini and Bergamasco 736)

Through the Looking-Glass

The first section of this chapter reviewed a number of rather abstract concepts that jointly form a philosophical foundation for the creation of androids in Japan. As the previous section was purely theoretical, the following (short) section is dedicated to connecting the previously discussed high concepts to the daily reality of robotics.

Techno-animism

‘Robot-kingdom’, ‘robot-nation’, ‘robotopia’, and the simpler ‘robot friendly’ are closer to being accurate descriptions rather than just silly hyperbole when it comes to Japan’s relationship with robots. A convergence of social, historical, political, and

cultural circumstances created a rather unique climate for development of advanced robotic technologies. One way to conceptualise this particular climate is through the lens of what Anne Allison terms ‘techno-animism’. According to her, “This intermixture of the old (spirituality) with the new (digital/virtual media) in Japan exemplifies [...] techno-animism: animating contemporary technology and commodities with spirits” (Allison 21).

Technological practices infused with overtones of animism, or ‘techno-animism’, exemplifies how in Japan “The aesthetic or technological manipulation of nature has a spiritual dimension; intervention by human hands can be seen to enable the ideal or potential of life to be more fully realized.” (Allison 21). Further, discussing the overlapping domains of technology and religion in Japan, Jensen and Blok note that “practices of techno-science do not appear radically separated from spiritually informed ideas of worldly cohabitation [...] Instances of Japanese techno-animism, in short, seem to run contrary to espoused western-modernist notions, according to which science is very specifically demarcated from religious practices.” (Jensen and Blok 86-7).

Another distinction from common western notions that contributes to Japan’s robot-friendly atmosphere, as partially discussed above, has to do with the idea that

The Shinto animistic attitude increases the scope of what can be perceived to be “alive”, and blurs the distinction among human, animal and machines: this implies that Japanese society generally has a more positive attitude towards robots - while western culture is preoccupied with robots harming humans and rebelling, Japanese robots are generally keen to help and protect humanity. (Ghedini and Bergamasco 734)

Japan's designation as uniquely robot-friendly makes sense only if it truly differs from most other nations in that regard. Another factor in establishing this point of difference is, say Ghedini and Bergamasco, that "while the Japanese concepts of distinction [between] animal/man/machine is not crucial, Westerners continuously define themselves in comparison and in contrast with the machine and the animal." (Ghedini and Bergamasco 734).

Kaplan also sees technology as central to how Westerners view themselves, and argues that it is so easily accepted in Japan in part because Japanese people do not find technology to be an important and central part of their daily lives. They do not view it as a major issue in their society, and so they have a much easier time handling new technological developments (Kaplan 2). Without any major philosophical dichotomies and religious ambiguities about attempting to build a human 2.0, robotics seems to be just another example of advanced technology penetrating the public space in Japan. With all the social, cultural, and moral inhibitions out of the way, Kaplan believes that Japan's cultural history encourages the artificial reproduction of nature (Kaplan 2). As human being are largely considered to be part of nature, the notion of artificial reproduction of nature serves as a foundation for understanding androids.

Biomimetics

*"Who has not been used to this world from early childhood would go mad over it. The miracle of a simple tree would destroy him."*⁷²

Nature excels at finding elegant solutions to an infinite spectrum of complex problems. It might take thousands or millions of years, but the evolutionary process

⁷² Quote by Christian Morgenstern, quoted in (Gleich, Pade and Petschow 12)

usually produces designs that are nothing short of inspirational. Indeed, the founding principle of Biomimetics is an attempt to utilize natural designs, the subsequent products of millennia of rigorous research and development. Put simply, biomimetics is “learning from nature to improve technology” (Gleich, Pade and Petschow 17).

‘Biomimetics’ is derived from *bios*, life, and *mimesis*, to imitate. Preceded by the term ‘bionics’ for a decade, ‘biomimetics’ was coined in 1969 and came to represent a new scientific field concerned with “the study and imitation of nature’s methods, designs, and processes.” (Bar-Cohen 2006 2). Biomimetics incorporates such disciplines as biomechanics and biomaterials and computer modeling, and its mission is “abstracting principles from nature and offering *biological inspiration* to engineers.” (Meijer, Bar-Cohen and Full 26). In other words, biomimetics develops technologies by turning to “nature’s patent bureau” (Gleich, Pade and Petschow 10).

Yoseph Bar-Cohen⁷³ sees the natural world as an endless source of inspiration for development of advanced technologies ranging from machines to innovative cutting-edge materials (Breazeal and Bar-Cohen 5). Reverse-engineering natural systems is not an easy task. Complex aspects of natural creation cannot be simply copied, they have to be painstakingly identified, isolated, and translated into the limited scope of human made technological abilities. As nature is not well-known for record keeping, deciphering the interworking of biological systems in the pursuit after the desired attribute or characteristic proves to be a constant challenge (Breazeal and Bar-Cohen 10).

A very worth-while challenge, though. The natural world has a profound influence on human imagination, while inherently confining its scope. Our biologically-

⁷³ Bar-Cohen literally ‘wrote the book’ on Biomimetics, as well as many others.

inspired way of thinking is nicely illustrated by the terminology we assign to human-built things. Just a few examples from the world of computers and software are widely used terms such as ‘virus’ and ‘infection’ to represent the more complex notion of an execution of a malicious source code. We use ‘brain’ to represent the central computing system, and “the use of the terms *intelligent* or *smart* suggests the emulation of biological capabilities with a certain degree of feedback and decision making.” (Bar-Cohen 2006 4-5). Fundamentally, to our very core, we think and analyze the world biomimetically. To borrow from Ursula Le Guin’s book that seems to be completely unconcerned with the subject matter of biomimetics- *on a world where no living thing is winged, how would it ever occur to a sane man that he could fly?*⁷⁴ (Le Guin 260).

When people (of this world) finally realized that human flight was indeed possible, it already had a very long history in fantasy and myth. During the bygone days of myth and legend, before recognizing that if humans were ever to fly it would be in a contraption that will carry them through the air rather than on their own accord, the flying creatures of human imagination came with wings. Not surprisingly, rather bird-like wings. Angels, for instance are usually imagined as winged beings. So are many goddesses and gods from folklore and mythologies of many different cultures. Referencing the winged Egyptian god Khensu, Bar-Cohen proposes that the existence of this creature and others like him illustrate the age-old human fantasy of being able to fly (Bar-Cohen 2006 5). Since our idea of flight is most likely inspired by birds, it is not surprising that when Daedalus sought to build a device that would accommodate human flight, the final product was a set of wings, covered with feathers.

⁷⁴ From Chapter 18 of Ursula K. Le Guin’s 1969 book *The left hand of darkness*. This does not appear as one sentence in the book; the words and meaning are Le Guin’s, the editing mine.

When time came to find the best approach to moving people via air from place to place, Daedalus' idea of crafting wings and flapping them was quickly abandoned. Early endeavours did indeed try to mimic the wing motions of birds and bats, but it appears that this particular flight mechanism does not successfully translate to a metal tube that weighs a few hundred tons. Mimicking the flapping flight mechanism may have failed, but we did learn a few things. The small vertical 'fins' on modern aircraft wings that influence airflow were developed based on observations of birds of prey⁷⁵. The birds have 'fingers' on their wingtips that extend and flex while it hovers and glides (Allen 10). And now, so do our aircrafts.

Flapping flight was not completely abandoned, though. Insect sized surveillance drones are one of the most interesting examples of modern day biomimetic research aimed at creating tiny autonomous flying devices. Dragonflies, for instance, are a good model for researchers to study and improve the mechanism of hovering, flying backwards, and manoeuvring in tight places (Allen 11). The first micro-aviation vehicle (MAV) that could hover in place was built in the University of Toronto 15 years ago. It was 30 cm high, weighed 435 grams, and had "the double-hummingbird X-wing model" (Hanson 186).

A lot of progress has been made since then. Flies became a favourite model for scientists perusing various MAVs, particularly due to their well-studied and relatively simple flight mechanism based on 'only' two wings (Ma et al. 603). The main reason engineers turned to nature to seek ideas on this particular issue is the difficulty to adapt drone technology for use in crowded urban areas. Unlike most unmanned flying vehicles,

⁷⁵ Not the Klingon warship.

flying animals adapted remarkably well to the relatively new urbanised environments (Lentink 1). On a smaller scale, Ma notes that “using flapping wings and tiny nervous systems, flying insects are able to perform sophisticated aerodynamic feats such as deftly avoiding a striking hand or landing on flowers buffeted by wind.” (Ma et al. 603). Echoing the general consensus in the field, Lentik suggests that “remarkable utility could be achieved by figuring out which principles enable animals to outperform our drones.” (Lentink 1).

Another reason engineers turn to nature is the problem of scaling. When trying to construct an insect-sized flying robot, conventional flight mechanisms, such as propulsion systems, for example, are not a viable option. Downscaling systems that work well on drones and aircrafts to insect size creates inefficiencies, and is impractical in general (Ma et al. 603). Considering that insects constantly (and successfully) disregard all the impracticalities of an insect-sized flight mechanism, it is not surprising that scientists are intrigued.

Flies might represent the ‘gold standard’ for high performance insect flight (Lentink 2), but the insect world has more to offer, such as the Japanese flying robotic butterfly (Fujikawa et al.). Concurrently with the above mentioned considerations, Fujikawa suggests that “flapping mechanism of small flying insects is particularly useful for manoeuvring through narrow spaces, such as gaps between debris.” (Fujikawa et al. 252). In the field of robotic flying insects, the robotic butterfly immediately stands out. Not only does it fly like a butterfly, but it looks like one⁷⁶. Since this project is concerned more with *human*-like robots from Japan compared with those from elsewhere, rather

⁷⁶ Image on page 255 in (Fujikawa, Shindo and Kikuchi)

than with comparing Japanese and non-Japanese *insect*-like robots, no conclusive argument can be made. However, it is worth mentioning, even if anecdotally, that the design of the Japanese flying robo-insect is different from designs that originated in other parts of the world⁷⁷. Its elegant design hides almost completely the flight mechanism in a manner reminiscent of *karakuri* design. This approach to robotic design might be considered as yet another example of mimicking and replicating nature in Japan, as discussed earlier in this chapter. It also takes Biomimetics to the next level.

Biomimetics, in its essence, has probably been around since we first started making tools. Three thousand years ago people in China attempted to create artificial silk (Vincent et al. 471). Artificial silk was successfully produced only recently, in historical terms, but they had a very good reason to try, as to this day (or up to the very recent past) the quality of natural fibre far surpasses human-made fibre. In fact, silk produced by spiders is much tougher than Kevlar⁷⁸ and stronger than steel (Bar-Cohen 2006 5,21,367).

An Israeli researcher believes that fish have the right idea about body armour. Inspired by the flexibility of hard armour defending soft tissue he designed a material architecture that combines a hard scale-like cover with a soft matrix underneath. This fish-based architecture was tested, and demonstrated that “penetration resistance can be amplified by a factor of 40, while flexibility decreases in less than 5 times.” (Rudykh et al. 2547). This research has the potential, in the not-too-distant future, to render the body-armour dilemma obsolete- strength and protection vs. one’s ability to carry the extra weight and be able to move. Unless, of course, someone figures out how to mimic the

⁷⁷ The observation is based on my review of many sources regarding flying robotic insects; only a few are mentioned and cited. This by no means represents an in-depth exploration of the field, and all conclusions drawn are purely anecdotal.

⁷⁸ Kevlar is widely used to create bullet-proof vests.

amazing ability of the sea cucumber to remain soft and flexible in ‘relaxed mode’, and to induce a chemical reaction that forms a rigid shield when in ‘defensive mode’ (Yen 42-3).

In the 1950’s a hooked seed that landed on someone’s coat served as an inspiration for Velcro (Vincent et al. 472). Today, studying the echolocation mechanism bats use to navigate inspired things like the Robo-cane, a potential alternative to the ‘white stick’ used by visually impaired people. It analyses the echo signals it detects, and notifies the user via a tactile feedback system (Allen 10). Our understanding of the world around us and our technological abilities are progressing faster than ever before. We now have the tools and know-how to do things we only dreamed about. Considering how far modern biomimetics has come- what’s next?

Perhaps we go back to the beginning. Bar-Cohen suggests that

Humans have always endeavoured to mimic and adapt human appearance, capabilities, and intelligence in both art and technology. The field of biomimetics is the latest expression of this, and the desire to engineer machines that display the appearance and behaviour of biological humans, and that can perform various functions as efficiently as humans can, represents one of its biggest challenges.“ (Bar-Cohen 2010 46).

Here, from his modern day perspective, Bar-Cohen echoes the long history of creating artefacts in our own image. There is a chronological continuum between the ancient clockwork automata and modern humanoid robots, as was discussed at length in previous chapters. This continuum, stretching from our fantastical past to our science-fictional

future represents, more than anything else, the ubiquitous and inescapable human curiosity about what makes us human. It began with automata:

It constitutes simultaneously a poetical and a technological invention. It is poetical because in ancient Greek poetry the concept of 'anthropomorphism', i.e. of ascribing human attributes to nature, its phenomena, and even to the human technological achievements, was dominant. The construction of automotive machines that looked like live beings, that were equipped with 'soul – ψυχή', strength and human abilities, was at the beginning no more than a mythical poetical invention, which however expressed a technical vision and an aspiration. (Vasileiadou et al. 76)

The next step, as suggested by Bar-Cohen is androids, the topic of the following chapter.

Chapter 5- Humanity: The Next Generation

“Isn’t it possible I may be so cleverly artificial that in every respect, from largest to smallest, I am indistinguishable from the natural. If I were, how could you tell the difference between me and a true human being?”

“It seems to me then, that a robot that can in no way be distinguished from a human being is a human being.”

(Asimov 1986 49-50)

Androids are humanoid robots whose external appearance mimics that of humans to the best of the technological abilities available to their creator. Our technology is already advanced enough to mislead people and make them think they are in the presence of another person, not a robot, albeit just for a few seconds. Inescapably, this is where things get complicated. At this stage of technological advancement, and with AI capabilities getting better by the day, we cannot disregard some of the currently theoretical scenarios about the not-so-distant-future.

This project cannot accommodate a serious discussion about the vast scope of posthumanism and all it entails, with the exception of one small observation. It is worth mentioning that if examining the spectrum of scientific work and research on robotics, from industrial robots to androids, interestingly, as one gets closer to the android terminus, notions and ideas about evolution and next stages of human existence become quite frequent. The stepping stone toward most of these techno-futuristic theories is the human-machine hybrid, the cyborg.

Cyborgs

“We discovered that the dawn of our postbiological future may arrive sooner than we imagined” wrote Peter Menzel in the introduction to his book *Robo Sapiens: Evolution of a New Species*, mainly, because we are already “part way there” (Menzel and D’Aluisio 17). Androids with artificial intelligence that enables autonomous decision-making are still mostly spoken of using the future tense. Cyborgs, however, are all around us, have been for years, and there is even a popular notion that in these technological times, we are all cyborgs (Haraway). Technology today is an integral part of life. It substitutes some of the functions of our memory, acts as a conduit for a great amount of our inter-personal communication, and shapes the way we conduct ourselves in our daily lives.

For some, technology is also an integral part of their bodies. Prosthetic limbs for amputees have been around for thousands of years (Vanderwerker 15), but a new generation of prosthetics developed in recent years challenges notions that cyborgs are creatures of the imagination. ‘Cyborg’ stands for ‘cybernetic organism’, and essentially describes the merging of organic tissue with mechanical devices. In 2005 a man who lost both arms was fitted with advanced robotic prosthetics, or ‘bionic arms’, as the organisation behind the technology prefers to call them. The innovation is not in the arm itself, but in the way it works- a link was established between the robotic arm and the nervous system and to a healthy muscle, thus allowing “the user to move his or her prosthetic arm as if it were a real limb – by simply thinking about what they want the arm to do” (RIC). When a body part moves obeying a thought command, and that body part happens to not be organic... it becomes hard to deny that we might be in cyborg territory.

There are also tiny chips implanted in people's brains that allow them to move external robotic arms just by thinking about it (Abbott). In the field of motion assistance, exoskeletons are now becoming a viable option. An Israeli company developed ReWalk a powered "wearable robotic exoskeleton" that allows people who cannot walk, to walk (ReWalk). Meanwhile in Japan, HAL⁷⁹ (Hybrid Assistive Limb) is an exoskeleton created by a company appropriately named Cyberdyne, and it is "the world's first cyborg-type robot, by which a wearer's bodily functions can be improved, supported and enhanced. Wearing of HAL leads to a *fusion* of "man", "machine" and "information"." (Cyberdyne ;Italics added). In his 2004 paper *Who Is Afraid of the Humanoid?* Kaplan wrote that in Japan "Convergence between technology and biology seems to always be considered in negative terms." (Kaplan 3). This might no longer be accurate.

The cyborg would most likely be found in the deepest abyss of Mori's uncanny valley, but according to Jennifer Robertson, in Japan, the notion of combining man and machine to create a new species is perceived quite positively (Robertson 2007 380).

Androids, so far

One reason androids make a particularly interesting research subject is that given today's globalized nature of technology, androids remain rather geographically bound. As most new technological advancements constantly become less restricted by national borders, the case of Japanese androids keeps getting more intriguing. There are, however,

⁷⁹ It is interesting to note, if only anecdotally, that Japanese companies unintentionally manage to come up with names for their product that appear to have strong connections to Science Fiction. The name 'HAL' evokes HAL 9000 from the movie *2001: A Space Odyssey*, while the company's name *Cyberdyne* is only a slightly more obscure reference- it is the name of company that creates Skynet in the movie *Terminator*. Both HAL 9000 and Skynet turn out to be very violent AI's. If nothing else, this is an interesting coincidence.

some efforts to build androids outside of Japan, mainly in the U.S and Korea. Korean and Chinese android research seems to be going in the general direction of the research done in Japan, while the U.S ‘android field’ follows a much different direction.

When discussing U.S ‘android industry’ it should be pointed out that it mostly consists of android *heads*. One such example is Bina-48, an android head designed to resemble the real life Bina Aspen, released in 2010 (Hanson Robotics). Bina-48 is the physical manifestation of an artificial intelligence (AI) that connects to the internet, and has three functions- a ‘chat-bot’ designed for small talk, an encyclopaedic function that can provide various types of information, and a personal side that occasionally repeats personal details from Bina Aspen’s life, collected during long interviews (Kavner 5). Bina-48 reportedly gets better with time, but conversations with her are “far from a consistently fluid experience” (Kavner 3,6).

Bina-48 was designed and built by Hanson Robotics, a company based in the U.S, headed by CEO David Hanson. The company’s mission statement is:

to bring-to-market the most compelling and engaging humanlike robots with greater-than-human wisdom, that are capable of developing a deep, trusted relationship with people. Our mission is to create a better future for humanity by infusing artificial intelligence with kindness and compassion, achieved through millions of dialogs between our robots and the people whose lives they touch.

(Hanson Robotics II)

Another such attempt is the ‘Albert Hubo’ robo-android, created by Hanson Robotics in cooperation with KAIST (Korea Advanced Institute of Science and Technology). Albert Hubo is 137 centimetres tall, weighs 57 kilograms, has the body of a ‘regular’ bi-pedal

humanoid robot topped with the slightly oversized head of Albert Einstein (Oh et al. 1428). Albert Hubo's locomotion is untethered and completely battery powered (Hanson Robotics III). The body was built by KAIST and the head by Hanson Robotics to celebrate the 100th anniversary of Einstein's theory of relativity. According to the designers, the body's astronaut-esque appearance was intentional: "The design concept of Albert HUBO was "Return of Einstein." This concept contained the resurrection of Einstein's and his comeback from the outer space." (Oh et al. 1428).

Yet another example of the U.S android arena is the quite realistic looking head of science fiction writer Philip K. Dick. According to the designers, "The robot portrayed Dick in both form and intellect through an artificial intelligence-driven personality." (Hanson Robotics IV). Unfortunately, in 2005 the head was lost during a flight somewhere between Dallas and Las Vegas, never to be seen again (Dufty). When asked about his customer base, David Hanson, the man who made, and then lost Philip K. Dick's (android) head said the market mostly consists of AI researchers (Robberson).

In China, attempts to create a realistic full body android are ongoing. One example is the android Rong Cheng, created by the Institute of Automation of the Chinese Academy of Science in Beijing. Rong Cheng can dance, bow, and speak some Chinese; all useful skills, as the android is a tour guide and a receptionist at the Sichuan Science Museum in Chengdu, where it is on permanent exhibit (Bar-Cohen and Hanson 37). The better known (at least to English speakers) is the Chinese 'android clone' of roboticist Zou Renti. Besides looking great in pictures with his creator, this android can blink and move its head (Bar-Cohen and Hanson 37-8).

Korea is perhaps the closest to Japan with regard to the nature of its android research. The EveR androids, four generations so far, get their name from a combination of the biblical 'Eve' and 'Robot' (Lee et al. 4336). EveR-2 has silicone based life-like skin and an expressive face on a 161 centimetres tall body that weighs 60 kilograms (Bar-Cohen and Hanson 35-6). EveR-3 was created for stage performance, and is the first of the EveR series to be mobile. Mobility was the reason a female form was chosen, as the locomotion system of EveR-3 is a two-wheeled wirelessly controlled lower body platform that can be easily disguised with skirts (Choi et al. 83). In 2010 EveR-3 was the lead actress in the play *Robot Princess and the Seven Dwarfs* that was performed to sold-out audiences (BWW News Desk).

Android anatomy

One of reasons androids are not more ubiquitous among robotics researchers around the world is that they are notoriously complicated. Creating a life-like android involves collaboration between an almost endless list of field of knowledge and expertise, and research across disciplines and faculties. It is truly a trans-disciplinary endeavour, and a very expensive one.

To mimic human movement and locomotion knowledge about human biology and anatomy is required. Attempting to adapt this knowledge and translate it into mechanical forms is the domain of a very diverse group of engineering expertise- from mechanical and bio-chemical to software and algorithms. The humanoid frame requires lightweight and highly efficient actuators, various sensors to determine the relative position in a space and to generate feedback from the immediate environment, and a power source that is

lightweight yet has a reasonable charge capacity. A simulation, as close as possible, of movements and function of human arms and legs in androids and other humanoid robots is usually achieved by using ‘artificial muscles’⁸⁰ (Bar-Cohen 2013 58-9).

In the relatively short history of modern robotics, stable bi-pedal locomotion has been notoriously challenging. As discussed in previous chapters, this goal was rather successfully achieved, as evident by the wide range of bi-pedal humanoid robots that we see today. Achieving the same goal with the constraints of human looking legs and ‘natural’ looking movement is not easily done. This might be the main reason why the most advanced bi-pedal androids usually sit, and advanced mobile androids do so by other means, not bi-pedal locomotion. The mobile, yet not bi-pedal, above mentioned android EveR-3 serves as a good example.

Humans perceive the world surrounding them through their senses. For robotic systems to have instantaneous access to even a part of the data humans simply sense requires a substantive array of sensors. Sensors are necessary to determine position, orientation, speed of movement of body and joints. Gyrometers, accelerometers, force sensors, tilt sensors, and others, provide the system with information about its own condition. Proximity sensors provide the system with data about the surrounding world (Bar-Cohen and Hanson 67).

‘Computer vision’ allows robotic system to ‘see’. Cameras capture the surrounding environment, but the true challenge is to enable the robotic system to ‘understand’ what it is in fact ‘seeing’. For computers, identifying and recognizing shapes within images is harder than it might seem. A basic task was discerning borders of

⁸⁰ actuators, using electro-active polymers

individual parts of an image; in a picture of a ball lying on the floor in front of a wall, identifying that the ball is a separate shape from its surroundings is no easy task for a computer. Adding another layer of complexity into the mix is perspective; a cube might look like a cube from certain angles, but tilted it might look like trapezoid from the front. Additional challenges are presented by the depth of the field of vision. This simple concept is responsible for our understanding that a large object in the background and a closer small object might both look the same size from a certain perspective, while we know that a car in the distance and an apple we hold in our hand are in fact quite different in size. Teaching a computer to correctly interpret our three dimensional world is indeed complicated. Great progress has been made and is being made all time, but the underlying task is monumental.

Before noticing the naturally fluid movements of an android and its impeccable object and speech recognition abilities we see its exterior, and mainly, we look at its skin. Artificial human looking skin is integral for androids if they are to live up to their definition of being human-looking robots. One version was developed in Japan through collaboration between Keio University and Kao Corporation- a cosmetics manufacturer. The material was described by 10 out of 12 people as having the feeling of normal human skin, and its textural similarity was further confirmed by test machines. Like human skin, this material consists of an inner elastic silicone 'dermis' layer 1 cm thick, and a 0.2 cm 'epidermis' made of firm urethane with tiny hexagonal indentation throughout, to simulate the look and feel of human skin (Bar-Cohen and Hanson 59). The appearance of an android is what makes it an android and separates it from other types of humanoid robots. This distinction makes the artificial skin a critical part of any android, and so, in

the words of one of the creators of EveR-3, requires both technology and art (Choi et al. 86).

The anatomy of androids is not straightforward. Although constantly evolving, the challenges remain numerous and constant. All aspects of the anatomy can be improved to become better, faster, more efficient, and a closer facsimile of the organic model. On top of the regular challenges of humanoid robotics, android developers have the added challenges of natural movement, appearance and behaviour. These demands take the android project out of the engineering department, into a much larger world of collaboration across disciplines.

In his own image

The most advanced androids still come from Japan, mainly from the laboratory of Ishiguro Hiroshi. As the main difference between robots and androids is appearance, Ishiguro sought to create “a copy of an existing person” (Ishiguro 2)⁸¹. Professor Ishiguro is a renowned and very prolific scientist. He also belongs to a small group of scientists who have attained somewhat of a celebrity status among the general public. He has been a part or an objective of many documentaries, has given several Ted Talks around the world in both English and Japanese and the number of interviews conducted with him in both print and video is not easy to keep up with. In addition to his very frequent media presence he is also the director of the Hiroshi Ishiguro Laboratories in the Advanced Telecommunications Research Institute (ATR), as well as a director of the Intelligent

⁸¹ An almost identical paper by the author appeared two years later: Ishiguro, Hiroshi . "Android Science- Toward a New Cross-Interdisciplinary Framework." Robotics Research- Results of the 12th International Symposium ISRR. Ed. Sebastian Thrun, Rodney Brooks and Hugh Durrant-Whyte. Vol. STAR 28. Berlin: Springer, 2007. 118-128.

Robotics Laboratory (Ishiguro Lab) in the Graduate School of Engineering Science of Osaka University.

The first version of an android Ishiguro built was designed to look like his young daughter. Repliee R1 is the size of a regular 5 years old Japanese girl, has a limited range of movement and very few facial expressions (Minato et al. 429). The name Repliee was taken from the French word *repliquer*, to replicate, and in the context of androids it is hard to avoid referencing the androids known as ‘replicants’ from Ridley Scott’s 1982 movie *Blade Runner*⁸² (Hornyak 140)⁸³.

Repliee R1 is known informally around the lab as Lisa (Macdorman and Ishiguro 2004 74). The artificial silicone skin was created using a mould (Minato et al. 429-30). Lying on a table without the internal mechanism of the android, the skin-suit looks a bit eerie, like a deflated human child. The jerky unnatural movements and facial expressions of the completed android scared the real child so much that she refused to return to her father’s lab (Hornyak 144). In an interview Ishiguro refers to Repliee R1/Lisa as “my daughter’s copy”, and explains that his first android had unnatural looking eyelids and facial expressions that culminated in mouth movements. Another detail that probably scared his daughter is that when her lookalike’s neck turned the whole body of the android would shake (Guizzo).

Although Ishiguro states that a photo of the Lisa android is indistinguishable from a photo of the real child (Ishiguro 2), a close up look at a video of the android’s face

⁸² Based very loosely on Phillip K. Dick’s 1968 book *Do Androids Dream of Electric Sheep?*

⁸³ It might also be yet another example of Japanese robotics projects coincidentally having names that are extremely popular in western science fiction. Ripley, although spelled differently, is one of the most recognisable names in science fiction, and in further coincidence, Ripley is a woman. The gender of the character is worth mentioning only because out of all the instantly recognizable names in science fiction, very few belong to women. This naming coincidence joins others, discussed in a footnote above, such as Asimo, HAL, and Cyberdyne.

demonstrates how truly new this whole scientific pursuit used to be not very long ago. Up close, the silicone skin around the eyes, particularly the eyelids looks quite unnatural due to small silicone lumps and imperfections that look like substantial scars. Ishiguro noted that it is difficult to accurately recreate the outer corners of the eyes with silicone, and there is still much work to be done. Another eye related issue affecting his first android is “details of the wetness of the eyes” that are very hard to recreate, and he concludes that “although the android has a mechanism for blinking and the eyeballs are perfect copies, we are aware of the differences from a real human.” (Ishiguro 2).

Acknowledging that movement plays an integral role in building androids, Ishiguro sought to develop “an adult android because the child android is too small” (Ishiguro 2). Focusing on movement, 3D motion trackers were used to analyse human movement and decide how to position the actuators in the android’s frame (Ishiguro 2). This was the Repliee Q1 model, referred to as Andosan (Macdorman and Ishiguro 2004 74). Andosan is a ‘woman android’ with significantly more degrees of freedom in her movement than the child android. She can simply ‘idle’ by slightly shifting her posture, blinking, and looking around (Macdorman and Ishiguro 2004 69). Andosan cannot walk, but appears to be breathing, and has the ability to generate many diverse facial expressions carried out by an array of actuators placed in the head (Ishiguro 2). Tactile sensors under her silicone skin enable her to sense when touched, and further input comes from floor sensors positioned near the android, as well as microphone and camera arrays. Feedback from these sensors to the android’s AI system allows for natural real-time interactions with Andosan (Nishio, Ishiguro and Hagita 345-6).

A problem arises, however, if one wants the interaction to involve a real prolonged conversation. Artificial Intelligence has come a very long way in the past few decades, and new developments are happening all the time at an accelerating pace. At this moment in time, however, the currently available AI technology does not allow for a natural real-time interaction with androids, and this has created a bottleneck in the development of realistic androids (Nishio, Ishiguro and Hagita 346). The most fundamental question regarding AI is how exactly we define *intelligence*, an important step if we wish to recreate it, artificially. Focusing too narrowly on this particular question, however, can have unintended consequences, and in doing so “there is danger of deep philosophical regress with no recovery.” (Brooks 1991a 569).

As Ishiguro notes, previous approaches to AI research, particularly concerning implementation in robotic systems, focused mostly on memory functions. Later, focus shifted to behaviour-based systems, and emphasis was given to a system’s ability to interact with the environment (Ishiguro 1). The predominant avenue of AI research today, machine learning, can be seen as a practical implementation of the behaviour-based systems approach. In a very general sense, machine learning can be defined as a “field of study that gives computers the ability to learn without being explicitly programmed.” (Simon 89).

Consequently, the paradigm behind behaviour-based systems is to create a system that can successfully operate in “an environment that has not been specially structured or engineered for it.” (Brooks 1991c 1227). With respect to robotic systems, this means that “there is a much stronger feeling that the robots must find everything out about their particular world by themselves.” (Brooks 1991c 1232). The ‘intelligence’ in behavioural

systems is not created by a pre-programmed set of sophisticated algorithms, but rather emerges, more ‘organically’, from interactions with its environment. Nature is generally considered to be a good model for successful R&D, and a gradual build up in intelligent capabilities through interaction with the environment is a proven model. In other words, “From an evolutionary stance, human level intelligence did not suddenly leap onto the scene.” (Brooks 1991a 569). Not surprisingly, much like Ishiguro’s own endeavour, the behaviour-based approach “draws its inspirations from neurobiology, ethology, psychophysics, and sociology.” (Brooks 1991c 1227). The shift in focus also meant that increased importance was given to embodiment of AI systems, so robots became a useful research tool (Ishiguro 1).

To appreciate how far we have come in respect to AI, and how fast the progress has become, all we need to do is look to our smartphones. Apple’s Siri and Microsoft’s Cortana are voice controlled virtual assistants that demonstrate the latest advancements in voice recognition, and more crucially, natural language comprehension. Natural interaction with an AI, embodied in an android or otherwise, requires it to be able to process authentic human speech patterns, and both Siri and Cortana are already pretty good at understanding what we want. Answering questions is a different matter. For an AI to reach a point where conversations are possible it not only has to be able to understand what we want, but to also be able to produce *new* knowledge from existing knowledge.

IBM’s Watson comes pretty close. The most advanced AI to date, in 2011 Watson won the game show ‘Jeopardy’ by defeating former (human) champions. Understanding questions and correctly answering them is a very promising step towards a true AI.

According to two small humanoid robots appearing in an IBM promotional video, Watson has been studying Japanese with some assistance from Softbank Robotics, the creators of Pepper, “the world's first personal robot that reads emotions”. So far 7000 units were sold in Japan (SoftBank Robotics). At the beginning of 2016 a further cooperation between the U.S AI and the sold out Japanese humanoid robot was announced. The vision for this new collaboration is “to enable Watson-powered Pepper to make sense of the hidden meaning in data that traditional computers cannot comprehend” (IBM).

Maybe the bottleneck will soon be resolved, but we are not there yet. A decade ago when a real solution was even further away Ishiguro found a way to avoid the AI bottleneck problem altogether while work continued on perfecting all aspects of human likeness in androids. His ‘temporary’ solution was to once again bring to life⁸⁴ a completely new category of robots- the Geminoids. “We coined “geminoid” from the Latin “geminus,” meaning “twin” or “double,” and added “oides,” which indicates “similarity” or being a twin. As the name suggests, a geminoid is a robot that will work as a duplicate of an existing person. It appears and behaves as a person and is connected to the person by a computer network.” (Nishio, Ishiguro and Hagita 346).

Indeed, the geminoids are tele-operated androids that allow a person to remotely control their physical avatar in real time over great distances. As the authors note, “since geminoids are equipped with teleoperation functionality, they are not only driven by an autonomous program. By introducing manual control, the limitations in current AI technologies can be avoided, enabling long-term, intelligent conversational human-robot

⁸⁴ Metaphorically speaking (worth clarifying in this context).

interaction” (Nishio, Ishiguro and Hagita 347). And so, the original geminoid model, first of his name, was a twin of Hiroshi Ishiguro, the HI-1.

Completed in July of 2006 (Nishio, Ishiguro and Hagita 349), the HI-1 looked remarkably like his namesake. They wore the same glasses, similar clothes and hairstyle, and pictures of both together could be seen in practically every news outlet. The HI-1’s robotic elements are very close to those of the android Andosan, so largely “efforts concentrated on making a robot that appears—not just to resemble a living person—to be a copy of the original person.” (Nishio, Ishiguro and Hagita 347).

The teleoperation interface has monitors showing the geminoid and its surroundings, a headset to transmit the voice of the operator into the geminoid, and a graphic interface for controlling movements such as nodding the head and looking at a certain direction (Nishio, Ishiguro and Hagita 348). Not all movement is manually controlled:

To increase the robot’s naturalness, the geminoid server emulates the human autonomous system and automatically generates these micro-movements, depending on the state of interaction each time. When the robot is “speaking,” it shows different micro-movements than when “listening” to others. Such automatic robot motions, generated without operator’s explicit orders, are merged and adjusted with *conscious* operation commands from the teleoperation interface. (Nishio, Ishiguro and Hagita 349)

Another layer of nuance is added to the realistic appearance of the geminoid by its ability to recreate the operator’s mouth movement in real time. The positions of the operator’s lip corners are measured, in real time by an infra-red motion capture system and

constantly transmitted to the geminoid, enabling a better synchronisation of speech with lip movements (Nishio, Ishiguro and Hagita 348).

Geminoid HI-2 came about because the prototype system was too big and heavy and became practically immobile. HI-2 was created with travel in mind, and it does so quite a bit. Another reason for a new model was that the geminoid and its creator no longer looked like twins: “I have undergone cosmetic surgery and I am looking much younger than the Geminoid HI-1. We needed a younger Geminoid too.” (Paré 132). The HI-4, so far the latest HI model, continues to fly around the world to attend conferences where he gives pre-programmed talks followed by a Q&A session teleoperated by Ishiguro from Japan (Lederman).

The travel arrangements do not seem to fit such a famous robot. Instead of traveling first class the body goes into the cargo hold in two suitcases and the head is carried by a human chaperone as hand luggage (Parry). This arrangement seems to work for Ishiguro: “I don’t need to go to foreign countries anymore”, he noted in reference to HI-4’s travels (Lederman). The latest model is the first that can stand, giving it a larger range of movement than its predecessors (Paré 132). HI-4 also has new glasses that match the ones Ishiguro now wears, but there are more reasons to believe that the man and his mechanical avatar will keep looking like twins in the future:

When I made my copy I was 41 years old. Later on, of course, I’m getting old and androids never get old,” says Ishiguro, now 51. “So I needed to do something so we can be identical. Of course, the one approach is to make the new android with my old face. But I don’t like to get old and actually [...] the cosmetic plastic surgery is much cheaper. (Lederman)

There is also the Geminoid F, the first ‘female’ member of the Geminoid family. Like the HI models F was also modeled after a real person, and just as with the HI models, pictures of the human original with the android version are very impressive. F’s proportions, facial features and hair were carefully modeled to exactly resemble those of the original, and in fact “at first sight and from a distance it is difficult to tell them apart.” The focus here was enabling the F to make sophisticated and nuanced facial expressions through multi directional movement of eyebrows, eyelids and eyeballs. F can also move her lips and mouth, simulate breathing, and tilt her head (Becker-Asano and Ishiguro 217).

Like the HIs, the F is a world traveler as well (Parry). She is also a veteran theatre actress, and has made her debut on the big screen. Part of Ishiguro’s multidisciplinary approach to robotics includes theatre and comes to life through the ‘Robot Actors Project’ by way of collaboration with famous Japanese playwright Hirata Oriza (Paré 129). *Sayonara* is a play written by Hirata and performed by a small cast that includes one actress and one android. In the play Geminoid F plays a caregiver to a dying woman, and according to some “you honestly can’t tell that it’s a robot.” (Lederman). Bryerly Long, the human actress in the play said that according to Hirata "There's no difference between working with robots and people" (Miller). The Ishiguro-Hirata partnership was well thought out. According to Hirata, “My actors were shocked to learn this, but what makes it so congenial to work with Ishiguro is that in fact I used precisely the same vocabulary with Ishiguro’s robots as I do to direct my actors.” (Poulton 283). Paul Miller, who watched the play in New York and later spoke with Long, notes that “much of her direction amounted to down-to-the-second placement of her lines, along with work to

subdue her own emotionality, so to leave the role of emotional resonance with the audience.” He later concludes: “For me, the effect was odd. It was as if human and humanoid were trying to out-artificial each other. I was surprised, however, to hear that many members of the audience were actually unaware that either actor was a robot, so it seems Oriza fulfilled his goal.” (Miller).

“Theatre is also the android science for me” Ishiguro said when asked about his interest in the theatrical (Asaro and Sabanovic)⁸⁵. Indeed, his interest in stage performances by his androids has a wider scope than a simple proof of concept, demonstrating that his artificial people can be accepted as actors on a theatre stage. The goal behind the effort is to study human behaviour in the most detailed and nuanced way possible and thus to improve their ability to recreate this behaviour in androids. He notes that:

The theatre is very important for the development of the human-like robot because nobody knows what kind of behaviour is natural as humans in a daily situation [...] At the same time, we can provide new tools to the theatre directors. The android will be a very good actor or actress in some sense. And of course it depends on the scenario, but somehow the android can relay the humanity very [well]. (Lederman)

A broad discussion of the convergence of theatre and robots is beyond the scope of this project, but it should be noted that, particularly in Japan, it is not a fringe occurrence or an avant-garde event for a specialized audience. This notion is perhaps best demonstrated by the fact that Hirata Oriza, the theatrical half of the Ishiguro-Hirata ‘Robot Actors

⁸⁵ Subsection 4.10 of the interview, titled *Robots and Theater*.

Project', was also a special advisor on cultural and international affairs to the cabinet of Japan's Prime Minister (Poulton 281).

Recently Geminoid F got another title: the first android to star in a film⁸⁶. The film is called *Sayonara*, an adaptation of Hirata's play, translated to the big screen and directed by Kōji Fukada. The film opened in the 2015 Tokyo film festival and features F in the role of Leona, an android companion to a woman dying from radiation poisoning. In the movie Leona is wheelchair bound due to a malfunctioning knee joint, and in reality F appeared at the movie premier in a wheelchair because she cannot walk. *Sayonara* is a science fiction drama set in the aftermath of a nuclear disaster, and as one reviewer put it "the film is very good, but by no means a laugh riot." (Collin).

Geminoid DK came about in 2011 as a result of cooperation with Dr. Henrik Schärfe, and looks remarkably like him. The DK has textured artificial skin complete with facial wrinkles designed to resemble Schärfe's own. The same attention to details was given to DK's hair color and style, facial bone structure, as well as facial hair. As with previous geminoid models, the DK automatically simulates the human autonomous nervous system by appearing to breath and blink. This constant effort to perfect the geminoids' 'natural behaviour' is supplemented by the DK's motion capture system that monitors the operator's head movements and facial expressions, and recreates them using the geminoid's head and face (Vlachos and Schärfe).

The past few years have seen considerable technological progress on the artificial intelligence front. This fact is probably not entirely unrelated to Ishiguro's research turning again toward autonomous androids, after spending quite a few years focusing on

⁸⁶ F is also the first android to have a personal IMDB page: <http://www.imdb.com/name/nm7651980/>

teleoperated geminoids. Erica was created in 2015 by Ishiguro under the umbrella of ERATO (Exploratory Research for Advanced Technology) research funding program that distributes government funds to various research projects (ERATO). Erica (ERato Intelligent Conversational Android), as the name suggests, was developed as part of an ongoing process to improve conversational skills in artificial intelligence based systems. The approach taken by Ishiguro's team is interesting, and perhaps telling of the role they envision androids will eventually have in society. "The idea is for ERICA to remember conversations it's had with a human it interacts with and pick up from where they left off the next time they converse. It will [...] be in possession of a "memory" of sorts." (Jozuka). Most interactional AI's have some sort of a database allowing them to answer questions, as well as a range of pre-programmed responses to 'small-talk' question. Erica's 'memory' takes a more personalized approach, enabling an early version of a continuous relationship with individuals based on familiarity. In trying to perfect conversational skills, to simulate human conversation as much as possible, it is not surprising the Erica's 'memory' mirrors the function of human memory.

Although she cannot walk, Erica's movements, facial expressions and 'behavior' are a testament to how fast technology has progressed in the last decade.

According to one reporter:

Coming face to face with Erica can be disconcerting. Her ability to express a range of emotions via dozens of pneumatic actuators embedded beneath her silicone skin – left this human momentarily lost for words when invited by Ishiguro to strike up a conversation in her native Japanese. For the time being, a flawless chat with Erica must revolve around a certain number of subjects, yet

experts believe that free-flowing verbal exchanges could be only a few years away. (McCurry)

Finally, there are Otonaroid and Kodomoroid, (adult-droid and child-droid, respectively). As their not too imaginative names suggest, they are mirror images of their human originals, an adult woman and a young girl. Both ‘work’ at the Miraikan, the National Museum of Emerging Science and Innovation located in Tokyo. Otonaroid was “hired” as a science communicator, and Kodomoroid is a multilingual news announcer for the museum (Miraikan). Otonaroid is a hybrid of Ishiguro’s two approaches toward creating artificial humans- androids and geminoids. She can be teleoperated like previous geminoids and speak with the voice of the operator, or she can be autonomous and speak using her own synthesized voice (Hiroshi Ishiguro Laboratories).

Ishiguro Hiroshi is at the vanguard of android robotics. He is the most famous and constant proponent of this field of research, and the most prolific creator of androids. At this point in time he is still a member of a very small group of scientists who take part in android research, and as such much of their work takes place in uncharted territories, both from the perspective of the technological aspects of the work, as well as the social ones. The best way, Ishiguro believes, for a comprehensive approach to this relatively new research area would be to establish a new field of research, dedicated exclusively to androids.

A field of androids

To create androids that fulfill their original mission statement, and to study the social aspects of this particular technology, the tools and methods used to study robotics

are not enough. Slightly over a decade ago, Dr. Ishiguro began advocating a new multi-disciplinary approach to study androids, a new field of research called ‘android science’. One of the problems he wishes to address is the process of evaluation. For non-android robots evaluation criteria are fairly straightforward, and mainly based on speed and precision. With androids, some of the evaluating criteria are based on the android’s appearance and behaviour, factors that only became relevant in robotics research with the introduction of androids (Ishiguro 1,5).

The evaluation of an android’s appearance and behaviour is mostly based on subjective impressions of a human subject while interacting with the android, as well as on their subconscious physical reactions during these interactions (Ishiguro 1).

Developing benchmarks to empirically evaluate androids appears to require expertise and knowledge that is out of the purview of most engineers. Android Science is Ishiguro’s proposal for a trans-disciplinary approach to this very particular field of research. What he proposed then, and has been implementing since, is integrating into his work “insights from cognitive and brain science, the social and behavioural sciences, robotics, sensor information processing, material science, mechanical and control engineering, and artificial intelligence.” (Macdorman and Ishiguro 2004 74).

Appearance and behaviour are integral aspects of android research, and cannot be handled separately (Ishiguro 2). On this foundation he believes that “the development of androids is beyond the scope of mere engineering: To make the android humanlike, we must investigate human activity, and to evaluate theories of human activity accurately, we need to implement them in an android.” (Macdorman and Ishiguro 2004 71-2). Essentially, Ishiguro believes that the only way to develop an effective methodology to

evaluate androids is to rely on interaction analysis based on cognitive science research, and android science creates the cross-disciplinary space to do just that.

Ishiguro's writings about android science as a new research methodology are often accompanied by a small diagram that offers a visual characterisation of his ideas. The diagram is titled "The framework of android science" and it includes two rectangles; one has *Neuroscience, Cognitive science* and *Psychology* written inside, titled 'Analysis of human', the other features *Mechanical engineering, Robotics, and A.I.*, under the title "Development of mechanical humans'. The two rectangles are connected by a two-way arrow symbolising "hypothesis and verification" (Ishiguro 1).

Humans 2.0

The fundamental question at the heart of this project considers the motives and justification for building androids. A good approach to gain insight on the matter is to examine what the people who build androids say about their work and vision. The particular way Ishiguro defines androids is rather telling, and suggestive of his views regarding future technologies. "We define an android to be an artificial system that has humanlike behaviour and appearance and is capable of sustaining natural relationships with people." (Macdorman and Ishiguro 2004 69). The memory function of the Otonaroid, as discussed above, was designed to enable personalized and more 'natural' interactions with people, and clearly reflects Ishiguro's vision, as evident from his definition of an android of a decade prior.

Ishiguro's reference to androids as 'mechanical humans' in his blueprint for androids science is very much in line with how he thinks about people, and about our

interaction with advanced technology. In a paper titled “The Study of Interaction through the Development of Androids” Ishiguro argues that “human beings, having evolved in a social context, often treat computers, robots, and other media as if they were people.” (Macdorman and Ishiguro 2004 69). This type of interaction with technology has a potential of being further amplified when the technology in question is an android. The human brain includes a specialised area dedicated to recognising human faces (MacDorman and Ishiguro 2006 318-9). As androids get more ‘natural’ looking, considering that we have been assigning personal agendas and free will to our technology for a very long time, the case being made for the study of human-android interaction gets more interesting.

Ishiguro’s theory of the case for Android Science is that behavioural science is a critical aspect of making androids more ‘human’, and in return, androids can be used to conduct new types of cognitive and behavioural research. In other words, “the development of androids is key to exploring human activity because only very human-like machines can elicit natural responses in people. Conversely, insights drawn from detailed investigations of human activity are needed to build androids with humanlike behaviour.” (Macdorman and Ishiguro 2004 69). The way people respond to and interact with androids can provide insight into human reaction on both the conscious and the subconscious levels to something that looks human, but clearly is not. At the same time, the very same interaction can be used to evaluate the human-likeness of the android.

Ishiguro made an interesting observation regarding human reaction toward androids slightly over a decade ago. Describing his observations of people around Andosan, he notes that:

Since she has been programmed to respond to touch sensors located on her head, shoulders, and arms, if we, for example, gently tap her shoulder, she will turn and ask “What is it?” in Japanese. However, if we slap her or hit her face, she winces, pulls back, and lifts her forearm to protect herself. Guests typically cannot help but feel sympathy for Andosan in these moments, nor can they be enticed to treat her so rudely. [...]Those of us who are developing Andosan are more willing to treat her as a mechanism just as surgeons can treat a person as a body. But people from outside our project are inclined to treat her as if she were a person, although they must surely know that she is not. (Macdorman and Ishiguro 2004 69)

It is not difficult to understand the guests’ response, as even reading the above description can make one feel a certain level of uneasiness. The knowledge that the above paragraph describes a lab experiment on what is essentially a machine, does very little to combat the fact that it just *feels* wrong. *We know* that this is not an infuriatingly casual description of a violent assault on an innocent victim, but our evolutionary programming tells us otherwise. This logical loophole is exactly what Ishiguro is counting on to facilitate ‘natural’ social interactions with androids.

On a lighter note, Ishiguro describes another interaction in his lab, only this time no androids were hurt in the process: “it is normal to ask a robot’s caretakers for permission to touch it, but a visitor to the lab instead asked his wife, “May I touch her? “ because he was concerned how his wife would feel about it.” (MacDorman and Ishiguro 2006 317).

An account by a reporter who visited Ishiguro’s lab paints a similar picture:

If my experience is anything to go by, when you meet an android you should prepare for reactions outside your control.[...] she makes eye contact with me and I unconsciously drop my eyes, move to a more correct social distance, and blurt out an instinctive "excuse me" for staring at her. And while the incongruity of apologising to a brainless android is flashing through my mind, I also notice that I've begun mirroring her body posture. My reaction draws a laugh from Ishiguro. "From our experiments we've found something quite surprising," he says. "If a human subconsciously recognises an android as a human, he or she will treat it as a social partner even while consciously recognising it as a robot." (Anderson 47)

The imitation game

Treating an android as if it were human speaks to our brain's tendency to, not surprisingly, associate human likeness with humans. It does not, however, provide much information on how human-like, both in appearance and in behaviour, the android actually is. To put it in other words: can it pass for a human? The same question was asked, hypothetically at the time, about artificial intelligence. Alan Turing opened his now famous 1950 paper "Computing machinery and intelligence" with the words: "I propose to consider the question, "Can machines think?"" (Turing 433). Turing proposed a method to determine if a machine can 'think' by testing its ability to successfully imitate a person in a conversation with an actual person. This was all highly theoretical in 1950, but as the Turing Test became more relevant in past decades, we usually think of

its implementation as an AI trying to imitate human language and behaviour over an online chat with an unsuspecting participant.

While Ishiguro has obvious interests in the development of AI, he is much more focused on being able to create a convincing mechanical simulacrum of a human by the time artificial intelligence reaches the level needed to enable an android to be autonomous. To evaluate his progress, Ishiguro proposes the Total Turing Test. In this modified version, to successfully 'pass' the test a participant would have to find an android's appearance and behaviour to be indistinguishable from those of a real person (MacDorman and Ishiguro 2006 319-20). Success on the Total Turing test does not mean that an android can be mistaken for a human being indefinitely, following Turing's original time limited test for AI.

One of the first experiment Ishiguro preformed was designed to test how many people recognise that the android in front of them is android, not a human being, after an initial two seconds of exposure. The android was positioned behind a curtain and a large piece of fabric was hung behind the android. "A task is given to the subject to find the colors of the cloth. The screen between the android and the subject opens for two seconds. The subject then identifies the color. At the same time, the subject is asked whether he/she became aware the other is an android." (Ishiguro 3-4). Two separate experiments were performed within this setting; one with a static android, and another with an android exhibiting unconscious movements, like blinking and breathing. The results are not surprising⁸⁷: "70% of the subjects did not become aware they were dealing with an android when the android had micro movements, but 70% became aware with the

⁸⁷ This was a small scale experiment- 20 participants.

static android. This result shows the importance of the micro movements for the appearance of humanlike reality.” (Ishiguro 4).

As Ishiguro readily admits, the results of the test do not mean that the moving android passed its Total Turing Test, but rather demonstrates the potential of a cross-disciplinary (engineering and cognitive science) methodology, such as android science (Ishiguro 4). Many other experiments conducted using his androids and geminoids explore human-android interaction in less restricted settings than those offered by the Total Turing test⁸⁸. In one instance Ishiguro found that many participants averted their gaze from the android’s face when asked to lie to the android. He notes that “Obviously the subjects consciously recognized the other as an android. However they unconsciously recognized it as a human and dealt with it as a social partner.” (Ishiguro 5).

These types of reactions towards machines seem newly noteworthy, largely due to the fact that the machines in question look like humans, when clearly they are not. Yet, none of this is new. It is the same way people have always reacted to machines, especially advanced ones. In more empirical terms, studies have shown that “people have an innate tendency to interact with a computer using the same social behaviours and rules they display with other human beings [...] people use what they know about human behaviour to predict and explain the behaviour of systems that have neither human form nor behaviour.” (Blumberg 48). This tendency represents the ‘ghost in the machine’ aspect of our interaction with technology. When said ghost appears to be in a human looking machine, things get more complicated.

⁸⁸ For more, see (Straub, Nishio and Ishiguro), (Abildgaard and Scharfe), (Dougherty and Scharfe), among others.

The problem in a nutshell is the expectation gap. When a computer is not working properly, all it means is that a technical issue has arisen and needs to be fixed, something we completely expect to happen from time to time⁸⁹. We do not have evolutionally cultivated expectations regarding the functions or malfunctions of rectangles. We do, however, have very particular expectations regarding the behaviour of human-like entities, mainly because these entities happen to be almost exclusively human beings. So, given our behavioural expectations of organic human-looking creatures, when a non-organic one seems to not be working properly or just moving strangely it creates a certain cognitive dissonance in the observer. Things do not much improve if the very human looking android stays completely still and forgoes all the cognitive dissonance inducing movements. As Ishiguro noted “When I saw the static android, I thought this is strange. This is kind of a dead person. We should make it move.” (Asaro and Sabanovic)⁹⁰.

This expectation gap, famously referred to as “the uncanny valley”, has never been more relevant. In an interview, Dr. Ayse Saygin, a cognitive neuroscientist, explores this predicament:

She attached people to an MRI machine, and tested their brain activity when exposed to video of a regular human, [and] an android replica of that human...What she discovered was that the test subjects’ brains “lit up” when exposed to the human-looking androids because they were working “extra hard” to make sense of what they were seeing. “What we found was that if you’re going to get so close to what the brain considers a person, you better get it right,” Saygin says. “Because the brain is not very tolerant of deviations from

⁸⁹ Or it might be personal. No way to know.

⁹⁰ Subsection 4.6 of the interview, titled *The Android Project*.

that. We're not evolved to see something that looks human that isn't human." Saygin pointed to human beings who've had too much plastic surgery. We notice that there's something not right with the way their faces move. If humanoid robots are ever to become commonplace in our society, she suggested, the designers are going to have to work that much harder than if they just let these robots look like robots. (Kavner 13-4)

Ishiguro shares Dr. Saygin's philosophy. He believes the uncanny valley is more of a bridgeable gap rather than an infinite abyss. David Hanson agrees: "I have found in experiments, people become used to the robots [...] The less startling they become, the more commonplace they get. If these robots do become commonplace then that uncanny effect will go away." (Kavner 12).

One aspect of the uncanny valley in relation to androids suggests that there might be a way out after all, as it appears that the valley might be age-based. One year olds seem to be intrigued by androids, and are not bothered by jerky movements, while three to five year olds appear to be scared. This, Ishiguro explains, has everything to do with our expectations: "If the baby's model of others is not so well-developed, the android may be able to pass itself off as human. Adults know the android is not human, so they do not expect it to fit closely a human model. However young children seem to be in the middle ground of applying a human model to the android, but finding it mismatches." (Ishiguro 4). Exposure to androids might be the key to overcome the uncanny valley. Young children already seem to be perfectly fine in the presence of androids, so it stands to reason that if they continue being exposed to androids, they would simply be used to them when they get older.

Does Ishiguro Dream of Electric Sheep?

Ishiguro's own daughter, around five years of age at the time, needed some time to get used to her mechanical copy, Repliee R1/Lisa (Guizzo). Her father, interestingly, had a very different reaction. While openly admitting that "My daughter's copy was in the bottom of uncanny valley", he points to an interesting phenomenon that might be indicative of how the human brain reacts to human likeness. Ishiguro attempted to explain the uncanniness of the whole situation:

So, suppose this is my daughter's copy. I try to give a hug, right? And then, I get close to my face to the android face. At that moment, I got a smell of my daughter. It's a virtual thing [...] The human-like appearance, they give us some memories about the smell, just giving a hug, or just closely watching the face of the daughter's android, I could remember the smell of my daughter. But it was not remembering. It was quite realistic the feeling. (Asaro and Sabanovic)⁹¹

The boundaries between Ishiguro and his androids are dissolving. While he knows better than almost anyone else in the world that his creations are not 'real', he accepts that the human brain interprets them as more than mere 'things'.

An interviewer once suggested to Ishiguro that accepting androids as social actors and interacting with them according to established social conventions might be difficult as we realise they are not flesh and blood, as we see what is under their skin. To this, Ishiguro replied: "Normally we do not get under the skin of other people. Have you ever looked under my skin? Who am I today? I don't know what you're made of, you don't know what I'm made of. We both seem to be humans." (Paré 134). If you are capable of social interaction, Ishiguro really does not care what you are made of. In his words, "If

⁹¹ Subsection 4.6 of the interview, titled *The Android Project*.

something appears to have a soul, it has one.” (Parry 17). This perspective is integral to understanding how exactly Ishiguro views and thinks about the world and the new technological reality he helped create. He would probably agree with the words of Asimov from the top of the chapter: “It seems to me then, that a robot that can in no way be distinguished from a human being is a human being.” (Asimov 1986 50).

The boundaries between Ishiguro and the HI geminoids are even harder to ascertain. Talking about the experience of operating one of his twin geminoid he notes that “When I am tele-operating, it is very interesting what happens. The true situation is that I am controlling a robot, but I feel something. It's as though I am there. If I look at the robot's body from this viewpoint, I feel as if the robot's body is my body. If someone walks up and touches the robot face, I feel something.” He was then asked if it is a strange feeling, “It is natural. The question is very philosophical: I think this is my body, but my brain is here - a kind of mind-body separation. Physically, my mind and body can be in different places. Is that possible? Until we built this android we had no way to do this, or to investigate the mind-body issue experimentally.” (Anderson 47).

By now this ‘phantom poke’ is a well-documented phenomenon around Ishiguro. In one instance, while being interviewed in his lab he was tele-operating his mechanical twin, who happened to be in a café in Austria. During the session a boy touched the geminoid’s face. Erico Guizzo, the reporter observing Ishiguro back in his Osaka lab noted that- “But what just happened was quite profound. Ishiguro says that when the kid poked the robot’s face, he felt a tingle on his cheek—even though nothing was attached to his face. For an instant, Ishiguro’s brain mistook his body for another—in Austria.” Guizzo suggests that “[Ishiguro] feels as though the touch were real. He believes the

phenomenon stems in part from observing the synchronization of the android's head and lips with his own [...] Because he is watching the robot's lips move as he speaks and seeing its head move when he turns his own neck, Ishiguro's brain starts to treat the robot as an extension of his own body." (Guizzo).

It is important for Ishiguro that he and his 'tween', the mechanical extension of his body, look as indistinguishable as possible. Maintaining this effect means that sometimes the appearance of the HI has to be adjusted to resemble Ishiguro's, other times, it's the other way around. When Ishiguro got new glasses, so did the HI. No detail is too small- from clothing to accessories, it all matters to him (Paré 131-2). Ishiguro underwent cosmetic surgery for this very reason, because it was more cost effective than updating the Geminoid's face. Asked once why he always dresses in black, Ishiguro replied that one's name, face and clothes are part of who you are, your identity. Since you do not change the first two, why would you change the latter? (Guizzo). For Ishiguro, appearance is vital. If you appear to have a soul, you have one. If you appear to be human, he will accept as such. The boundaries between 'natural' and 'artificial' appear to be wholly irrelevant in Ishiguro's case.

For Ishiguro, people are organic systems, biological machines. His main interest in androids lies with their ability to facilitate an exploration of certain aspects of humanity, in a way previously unavailable. From the very beginning, Ishiguro has always believed that "We can never deeply understand human beings without building androids, and we cannot build androids without deepening our understanding of what it means to be human." (Macdorman and Ishiguro 2004 74). The notion of deepening our understanding of humanity through the study of androids comes from Ishiguro's view

that “Robots and androids [...] are mirrors reflecting what it is to be human.” (Poulton 283). Consequently, Ishiguro sees androids as the ultimate research apparatus, as “Only humanlike appearance and behaviour can elicit fully humanlike communication, which is why androids will be one of the most useful platforms for investigating human behaviour.” (MacDorman and Ishiguro 2006 321). It should be noted that Ishiguro is not alone in recognising the potentially important role androids can have in our ongoing study of ‘humanology’. As Bar-Cohen puts it- “By developing robots that appear and function similar to humans we understand ourselves better and we make robots that we can better relate to, as though we were relating to fellow humans.” (Bar-Cohen and Hanson 57).

Acting as a research platform is not the eventual role Ishiguro envisions for his androids. In accordance with long standing plans by the Japanese government regarding robotics, as well as the daily reality in Japan, Ishiguro fully expects his androids to become part of society, in the not too distant future. For Ishiguro, “The most important aspect of an interactive robot is its role as a social partner for a human. A human can project many things onto a robot, so essentially studying a social relationship between a human and a robot will allow us to comment on general human society.” (Grogan). When asked about the prospects of androids truly becoming social partners, he answered:

Yes, that is my goal: for a human to become believably affectionate towards a robot social partner. Belief is the single most important aspect of a human being. You believe that I am a human, right? The human brain is just guessing, perceiving and believing. Everything is just a kind of illusion, or a trick, because the human brain cannot process everything. Everything is subjective. (Grogan)

This answer underlines Ishiguro fundamental view of the world, and the somewhat unusual origins of his interest in robotics.

Ishiguro planned on becoming a professional oil painter, but decided that he was not talented enough to truly stand out and make a career as a painter. He then turned his interest toward the next best thing: computer science and artificial intelligence. “I tried to be an oil painter. Oil painter world closely related to the computer graphics and computer visions. I was interested in how the human recognize the visions.” (Asaro and Sabanovic)⁹². To him, there is not much difference in the essence of his dream profession and his current one: “I'm not interested in robotics in itself - I could give it up at any time [...] My concern is not how to develop a robot, but what makes a human. An artist tries to represent himself on canvas, to find a better understanding of humanity. I am doing the same thing with a robot. The robot is a canvas for me.” (Parry 16).

This perhaps makes Ishiguro the poster-child for Kaplan's view of Japanese roboticists and the larger motivation behind building androids. “The artist-engineer shows his art by transferring the elements that really count from the natural cascade to an artificial one. In this respect, to be able to copy means to understand and to pay homage to nature.” (Kaplan 5). Kaplan's notions are tailor-made for Ishiguro. These days the part of nature he is trying to copy and understand is the human being: “As an oil painter, I was thinking what is human, how we can represent ourselves on the canvas. So, I believe I am doing the same things.” (Asaro and Sabanovic)⁹³.

For Ishiguro, androids are a logical evolutionary step that comes after humanoid robots. It is a natural progression that unfolds at the rate of new relevant technologies

⁹² Subsection 4.1 of the interview, titled *Early Life and Education*.

⁹³ Subsection 4.2 of the interview, titled *Early Robotics Projects*.

becoming available. From his point of view, humanity has been doing the same thing for a very long time; it is just that now he has better tools. “Humankind is always trying to replace human abilities with machines. That’s our history [...] I’m doing the same thing. Nothing special.” (Guizzo). History seems to be on his side. Previous chapters explored the human fascination with creating simulacra in our own image, from the automata of ancient Greece, to Japanese *Karakuri*. Ishiguro seems to position himself as a modern iteration of the age old quest.

His research interest, however, appears to be driven by more than just building androids solely because technology allows it and history dictates it. Many years ago as an artist, and today as an engineer, he seems to be fascinated with the meaning of being human more than anything. What *exactly* it is that makes us human. It appears that his life’s work and philosophical research methodology is to build an artificial human being, perfect it to the best of his abilities, and then see what is missing, if anything at all.

Ishiguro suspects that when you eliminate all other possibilities, what remains as the one difference between human and machine is noise. “The fundamental difference between a machine and a human being, [Ishiguro] suggests, is the presence in the human of “noise” (yuragi), the term used in electronics to contrast with “signal” – that is, order. Perhaps the element of chaos – what cannot be predicted or programmed – is what makes us human after all.” (Poulton 287). It is interesting to note that fundamentally, Ishiguro believes that if anything, what separates humans from robots is our *ghost in the machine*.

Chapter 6- Conclusion

At this point in time, in 2016, androids are not in a position to have an imminent impact on our life. The technology, advanced as it is, is not 'there' yet. Therefore, if we look at androids as an independent phenomenon, separated from all historical and cultural contexts, the whole endeavour might seem strange. Perhaps even silly. Why would anyone, individual or government, spend so much time and money creating a robot that appears human?

It is well established that the humanoid form is the most efficient design configuration for service robots, as humanoid robots are naturally more compatible with human-created environments. Stairs, for instance, are best navigated bipedally, and things that humans use are easiest to handle with hands and fingers. Honda's Asimo is a great example of the type of service or household robot that could become commonplace in the not too distant future.

If efficiency is key, androids become even more perplexing. The outer layer of their humanoid shape, the android's external human-like appearance has no function. And yet, considerable efforts are being invested perfecting our un-organic counterparts. As mentioned in the introduction, androids cannot be analysed solely through the lens of gradual technological progress in the field of robotics. From the narrow perspective of robotics and engineering, androids are not simply the next 'evolutionary' step after humanoids. They offer no functional improvements.

A much wider perspective is needed.

Androids: a self-fulfilling prophecy?

Historically speaking, androids make perfect sense. Thousands of years ago human imagination conceived of machines in the image of humans. Greek myth gave us Hephaestus's golden women and a bronze sentry. Later, as tools and skill developed, automata in human likenesses, small and full size, became popular. Centuries later, when modern technology was taking its first steps, we began telling stories about the future, a time when machines in our image, androids, would be commonplace. Many of these books and stories depicting robots and androids were written when radio transmission technology was still very much a novelty. Human imagination was never limited to what we knew for certain to be possible.

For well over a century now we have been reading books about how in the future we will go to space and explore the cosmos, have talking computers, virtual reality, and androids. Therefore, it is interesting to note that in reality, we seem to be doing things, from a technological development standpoint, pretty much by the books. We have been to the Moon. We have a space station orbiting our earth, and research is currently ongoing in preparation for a human mission to Mars. We also have computers that answer our questions, and virtual reality has been around for long enough to be having a 'comeback' lately, after being largely ignored for a decade.

Androids are perhaps less avant-garde and radical than they seem at first. If we look at androids as the last addition to a very long line of artificial humans, whether it is in myth, fiction, or reality, it all becomes less dramatic than it seemed to be at first. So if we look at the long arc of the history of such things, we can objectively say that humanity was heading in that direction all along, as evidenced by books and myths and automata. It

appears as if we were collectively, in a way, always assuming that this day would come, and now we have Ishiguro and his androids.

A deterministic universe?

Was this inevitable? Were we always fated to fulfill the android prophecy, handed down to us through the generations from as early as ancient Greece? And if so, why would it happen in Japan? Androids point to certain weaknesses in deterministic thought and analysis. Firstly, androids are in no way, shape, or form the result of a technological imperative, of technology moulding itself and following its own internal technological logic. This is mainly because this endeavour does nothing to further robotic technologies. The focus of android science is appearance and behaviour.

Secondly, the weakness of the deterministic proposition is further demonstrated by just how fundamental human contribution is in this case. Androids are the product of human imagination developed over millennia. When the necessary technology became available, androids emerged from fiction into reality. The human factor is completely integral. Human imagination and curiosity created and shaped our mechanical analogs.

Androids emerged from a vast network of influences and interactions. Culture, religion, tradition, socio-economics, among others, played a role in the creation of androids. The seed, however, was planted long ago.

You can't spell 'artificial' without 'art'...

Mimesis too, is an old idea. Imitation and replication of various aspect of the natural world is as old as human civilization. As technology became available, this idea

expanded from art to science. Biomimetics is the modern attempt to understand and replicate natural phenomena using modern technology. Androids are the latest and greatest attempt so far to replicate a natural phenomenon.

Pamela Asquith points out that “the nature cherished by most Japanese is not nature in its original state but in its idealized state.” (Asquith and Kalland 16). Perfecting and improving nature in Japan is a tradition, and an art form. As humans are notoriously imperfect, and taking into account Dr. Ishiguro’s artistic sensibilities, his work might be in line with simply trying to create a better human being. He often says that making androids and being an oil painter are the same to him, just different paths to try and understand what it means to be ‘human’.

To be, or not to be, an android.

For an engineer, Ishiguro seems to be quite preoccupied with philosophical questions. As with most natural science disciplines, when you go far enough in theoretical research fields, your scientific inquiries eventually end up veering into philosophical discussions, the meaning of all things, or a debate over the reality of 'existence'. This is an established (and somewhat frowned upon) fact in mathematics and physics, among others. It is, however, noteworthy that Ishiguro managed to import the questions that ultimately arise if you spend your time on advanced topics of purely theoretical scientific disciplines, to the very nuts and bolts field of engineering.

Ishiguro says that his research question is “to know what is a human” (Guizzo). Creating a fully autonomous android can offer insight into the definition of ‘human’. Does the label apply only to entities made of flesh and blood, even if inorganic entities

exist that look and behave just like the organic ones? In other words, “It seems to me then, that a robot that can in no way be distinguished from a human being is a human being.” (Asimov 1986 50). Or is it?

Is this the end?

Concerns regarding androids and other social technologies are common. The past decade has seen an increase in the amount of time people spend with computers and on the internet, especially since mobile devices such as tablet computers and smartphones have become increasingly popular and affordable. There are growing concerns for the potential loss of social skills, and of the potentially negative effect of decreased in-person social interaction. When it comes to androids, the questions regarding social change becomes more complicated. For now it is still hypothetical, but if Ishiguro indeed succeeds in creating his envisioned social companions, basic structures of social interaction, already somewhat in flux, might become unrecognizable.

It is interesting to note, that with all the critique of our dependence on technology for social contact, there is no evidence of its declining use. More likely, it is only increasing. Asimov offers some historic context:

Fear of machinery for the discomfort and occasional harm it brings has (at least until very recently) not moved humanity to more than that occasional sigh. The love of the uses of machinery has always far overbalanced such fears, as we might judge if we consider that at no time in the history of mankind has any culture *voluntarily* given up significant technological advance because of the inconvenience or harm of its side effects. [...] Mankind has always chosen to

counter the evil of technology, not by abandonment of technology, but by additional technology. (Asimov 1981 156)

Artificial social companions might have an objectively negative influence on society.

There is also the possibility that many, who now find themselves isolated, might no longer be so lonely. We already know that Paro, the robotic baby seal, has a very positive effect on seniors, especially in care facilities. The eventual outcome might be good, bad, or both. We might even get to find out at some point in the future.

From fiction to science.

Androids, as a technological innovation, emerged from a complexly interconnected network of influences. Androids first only existed in human imagination, appearing first in the mythology of ancient Greece, and much later in European literature. Actual androids, however, emerged in Japan. From a purely technological point of view, humanoid robots were previously developed in Japan, so this type of project becomes vastly more practical. In previous decades Japan has already proven to be very ‘robot friendly’, so university facilities and government funding have been made available. The aging population in Japan and the very low birthrate encourage innovative ideas for the future of the country.

Ishiguro’s androids emerged in Japan out of a perfect storm of local culture and tradition, social and technological circumstances, and an engineer who is an artist at heart. As to the future of this endeavour, it is best summed up with the words of a theoretical physicist, Asher Peres, who said: “unperformed experiments have no results” (Peres 745).

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