

A Survey of Androids and Audiences: 285 BCE to the Present Day

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Abstract

This historical survey reviews incidences and popularity of mechanical humans from Ptolemaic Alexandria to the present day. These devices were of special interest in the Enlightenment as models of a Mechanistic self, as artistic and scientific spectacles, and as entertainment devices. Historical mass audiences may not have shared the negative associations held by audiences of today; however intense responses to android displays have been documented. The project finds that audience response is informed by a wide variety of factors that should be considered together when determining the depth of uncanniness present in a device. Therefore, the project explores issues related to the philosophical interpretation, imagery, and social contexts of android automata.

Keywords: automata; androids; eighteenth century; artificial life; popular culture; history

Dedication

*This project is dedicated to Daniel Dickson,
my heartbeat.*

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1. Introduction

While commuting to work, I saw a young man holding a tiny baby. I craned my neck to see her face but my efforts were thwarted by the careful bundling of the infant. Unable to see the face I felt a sinister twinge. The infant was sleeping peacefully, yet strangely the young man had no diaper bag, no stroller. He was woefully unprepared. Was the baby kidnapped? Was it unwell? Where was her mother? When we disembarked the train I heard the baby's hollow, inconsolable cries and turned once more. The young man lifted the infant, and I saw its unmoving face. The infant was an electronic doll.

It was a futuristic moment for me, though a commonplace one for secondary school students. We've come a long way from babysitting an egg for a week. Now the electronic baby tracks our nurturing, wakes us up with cries to be fed, changed and consoled. Indeed, each year, popular magazines suggest a robot revolution is upon us (for example, *The Economist*, June 2012, *National Geographic*, August 2011). Soon, they suggest, humanoid robots will be our servants, teachers and companions.

This paper is concerned with automated life in human form, but "robot" is too new – and inaccurate - a term to use. This distortion of the Slavic word *robotá* (forced labour) was coined to describe the man-made workers central to Czech playwright Karel Capek's 1921 play *R.U.R* (Horakova and Kelemen, 556). We shall see in this paper that actual mechanical people do the very opposite of industrial work: they play, they entertain, they teach. The words "android" or "gynoid" may be the best terms for such objects as they refer to a machine with male or female shape respectively. These machines are a subset of the more general term "automaton", coming from the Greek meaning "self-mover". At any given time in history, artificial life has taken both human and animal shapes. Although many of the humanoid automata described in this paper have female forms, I have chosen the more widely used "android" as a synonym for "humanoid automaton."

The history of android automata was once relegated to trivia and obscurity in favour of more obviously helpful technologies like pistons and water pumps. Android automata were easy to dismiss as trite amusements for wealthy classes, as toys, and as a misapplication of skills. For example, Professor of Greek History Peter Green writes off Greek automata as elaborate mechanical curiosities of “complete irrelevance” (1990, 478-9). Building an android can be an expensive endeavour that requires significant intellectual, financial and human resources disproportionate with the utility of the object. Renaissance and Enlightenment automata were maligned as useless inventions that only fanned the vanity of their makers, distracting audiences and inventors from reason-based inquiry (Marr, 162). By the Victorian age, automata were displayed primarily in circus and magic-show contexts to gullible and uneducated audiences. For example, Charles Babbage, inventor of the Difference Engine, revealed the frivolity of his audience by contrasting his engine of pure calculation against a charming mechanical dancer (Schaffer, 58). Automata have held a marginalized place in traditional histories as footnotes, trivia or examples of the decadence of a state.

In the twentieth century it was discovered that the control methods used for automata foreshadowed binary computer programming (see, for example, Schaffer). This essential link, combined with an ever-increasing sense that we are at the cusp of releasing mechanical helpmates to domestic households, made the study of android automata relevant to our present and resulted in a flurry of popular and academic publishing on android automata. Artificial life, historical androids, and the implications of new affective technologies have now attracted the interest of scholars from a range of disciplines. These include neuropsychology, music, cognitive sciences, history of technology, communications and engineering.

Notwithstanding the recent interest in android history, this topic has been underrepresented in academic literature. There are several scholars whose research has made important contributions to the history of these remarkable devices. *Automata* by historian Alfred Chapuis and horologist Edmond Droz (1958) appears to be the seminal text, providing a common technical history for the study of automata. Silvio Bedini, Historian Emeritus of the Smithsonian Institution until 1987, referred to this book in his 1964 study “The Role of Automata in the History of Technology”. That same year, Derek de Solla Price, Historian of Science at Yale, also referenced Chapuis and Droz.

Since then, this history of automata appears as a reference for any discussion of mechanical life.

In the late 1990s, Cambridge professor of history and the philosophy of science Simon Schaffer made the links between automata, philosophical mechanism, and the history of computing that have been key references for scholars in the subsequent decades. Over the past 12 years, Stanford History associate professor, formerly of MIT, Jessica Riskin has published multiple articles on the history of artificial life and its relationship with eighteenth century philosophy. She is also editor of *Genesis Redux: Essays on the History and Philosophy of Artificial Life*, an interdisciplinary exploration of these matters. Associate Professor in history at the University of Missouri-St. Louis, Minsoo Kang's recent offering is a development of his 2004 PhD dissertation. His *Sublime Dreams of Living Machines: the Automaton in the European Imagination* (2011) is a study of historical androids and their evolving philosophical and literary associations. Both of these historians have been working in effectively uncharted territory, growing a field of inquiry in a topic that is 2000 years old, yet has lacked attention.

Shakespeare scholar Adam Max Cohen, of the University of Massachusetts at Dartmouth, found himself drawn to make connections between technology and art in the Bard's plays in the recent decade. Like Jessica Riskin, he found that mechanical representations interacted and sometimes equated with mechanical worldviews and correlated these to the daily experience of people. He perceived a seventeenth century saturated in new technologies, coming to terms with changes in timekeeping, navigation and scientific exploration. As Cohen found mechanism (both philosophical and physical) was ubiquitous in the seventeenth century, Elizabeth King's art and sculpture continues the discussion about the technological self. Her experience of, and research into, a sixteenth century mechanical monk, has been important to this paper, in no small part because she describes subjective spiritual and emotional resonances usually eschewed in academic writing. These resonances are part of the uncanny effect described in chapter 4.

Finally, Professor of Social Studies of Science and Technology at the Massachusetts Institute of Technology Sherry Turkle's contribution to the conversation about the impact of technology on human relationships should not be ignored. Since the

1980s, she has done important and groundbreaking analysis on interpersonal relationships mediated by - or experienced through - computer technology. In the past decade, she has turned her attention to relationships between humans and lifelike machines.

Generally speaking, historians have tended to equate mechanical representations with an increasing mechanisation of the self, society or the body. Just as Descartes and Hobbes found analogues for the body in clockwork, so historians have found automata to be analogues for mechanical philosophy. The lack of comfort with philosophical mechanism is transposed to the mechanical person. Explorations into the meaning of these machines have tended towards the cautionary, the dark, and the uncanny. Concerns about the future of both the soul and body of humanity reverberate in the texts. In works such as Minsoo Kang's *Sublime Dreams* and journalist Gaby Wood's popular *Living Dolls*, negative associations with these objects are highlighted in a sort of *Frankenstein*-inspired nightmare.

Yet to view fine artisanal mechanical depictions is a wondrous experience, a moment of revelling in the technological sublime. The objects are beautiful, their actions benign. Historical – and present – audiences appear to have delighted in them. Historical exhibitions were saturated with a wide variety of mechanical wonders. Some beautiful, some useful, others absurd, they were marketed as the product of human ingenuity. This is not to undermine the myriad concerns about connections between the technological pleasure, mechanistic worldviews, and machine humans. Rather, there is a disconnect between the exhibition context and design of automata and the dangerous philosophical intersections scholars have identified. This project undertook to explore automata as popular objects intended to entertain. Simply, this project wishes to consider that – despite today's discomfort with humanoid machines – building automata could not have been entirely dark and dangerous.

1.1. Research Project Foundation

European technological history has included mechanical life as a manifestation – or personification– of each major technological development. Historical androids are

perplexing because they are aesthetically beautiful mechanical objects that appear to have no use. The historical android is more similar to cultural products such as paintings or sculptures than to astrolabes and clocks, but has not been studied in this manner. Like other arts or media, the subject matter being communicated may be exciting, profound, or unsettling. In addition, androids are produced within a social, economic, and technological context. In this research project I wanted to explore historical androids as cultural products in time, produced as communicative devices designed to achieve certain goals. I hoped to uncover what these goals were and what has contributed to the popularity of automata.

In my research I was surprised that many of the sources focus only on the technological development of androids and clockwork automata, without describing the social factors leading to their creation and exhibition. Monumental clocks such as the Strassbourg Clock or the Tower of the Winds in Athens have been understood as statements by ruling classes about our role in the cosmos (for example, by de Solla Price), but say little about whether the intended audiences interpreted these objects as such. When I wanted to know more about human replicas, I also found the histories of technology inadequate for explaining the aesthetic language being applied.

The aesthetic combination of subject matter, depiction, and materials has been under-explored in the scholarly literature in favour of a focus on technological novelty. However, this combination is consistent with other types of media. If early films are moving-pictures, historic androids are moving-statues, a sort of proto-animation in the way early motion pictures simply depicted things-in-motion, and early sound recording represented human speech. This approach takes historical and present-day androids as artistic and communicative objects, like films, intended to signify a variety of meanings within an economic and philosophical context. From this perspective, the design of automata becomes crucial to both the message being communicated and their appeal to audiences.

The disparate literature that surrounds android studies presents particular challenges to scholars seeking an integrative approach to interpreting audience engagement with these machines. Specialized disciplines treat androids as specialized machines with single purposes: as models for scientific or philosophical inquiry, as

propaganda for elite purposes, as eerie titillation for a mass audience, or as developmental steps towards the information age. The android is too often pulled out of its contemporary context as a commodity produced for audience enjoyment. This paper attempts to re-establish these devices as media and entertainment products that participate in a multi-layered dialogue about humanity, technology, and society.

1.2. Structure of the Paper

Chapter 2 acquaints the reader with historical androids, their creators and their audiences, in preparation for the discussions in further chapters. I divided this chapter into three sections based on the primary technology in place rather than on traditional historical periods. The actual mechanisms used to motivate automata did not undergo significant change in concert with changes of historical period such as “medieval” or “enlightenment”. The first section is devoted to hydraulic and pneumatic automata primarily from Alexandria, Egypt, constructed from 200 BCE through the eighteenth century. The longest section of the chapter explores clockwork automata from the late medieval period to the nineteenth century, found in Turkey, Europe and Japan. This section describes late medieval automata and well-known eighteenth century androids by Jacques Vaucanson, Pierre and Henri Jaquet-Droz, and Pierre Kintzing. The final section describes some animatronic modern androids created in the past half-century, which are outfitted with visual and tactile sensors as well as artificial intelligence and most closely approximate a human replica.

As objects, historical androids are delightful, and this aspect is key to interpreting them as cultural products. Chapter 3 explores whether wonder and aesthetic design may explain interest in automata across the centuries as the spectatorial culture in Europe transformed. Aesthetic design and the subject matter depicted by androids are analyzed with consideration of audience response.

Androids entertain their audiences, but they also inspire philosophical inquiry and unease in their audiences. These three essential responses are themes that are present, in varying degrees, in all scholarly work reviewed for this project. These themes are distinct but not mutually exclusive. Androids appear capable of producing all three

responses in the audience. Chapter 4 considers the uses of automata as metaphor and model in philosophical dialogue. However, although the philosophical and theological issues are important, they may not contribute to the gut reaction experienced by modern audiences to lifelike automata.

Chapter 5 explores nineteenth and twentieth century repulsion to artificial life and androids in particular, drawing from psychology, art history and robotics. Verisimilitude's interplay with the 'uncanny valley' hypothesis is described in this chapter, and I propose a pair of alternate perspectives regarding the uncanny response. Firstly, that the intensity of response to these objects is essential to their ongoing attraction for audiences, and secondly that the aesthetic of the uncanny may be alleviated when the 'abnormal' is rendered 'ordinary'.

In the conclusion of this project, I describe some of the new roles proposed for androids by roboticists in the past 20 years. Unlike the androids of the past, which operated as communications tools that depicted vignettes of daily life, the androids of the present are intended to be partners to human beings. There are many opportunities for further study in a humanities-based approach to robot sciences.

2. Historical Review / Background to Paper

To understand these objects as cultural products, we have to understand when, where, and for what uses they have been produced. Artificial humans have been and continue to be built and used in specialized circles such as medicine, magic, courtly life, leisure entertainment, art and scientific expositions. Machines whose motion comes from within are documented from around 300 BCE, by Hellenistic mechanics Philon of Byzantium, Ktesibios of Alexandria, and Hero of Alexandria. The experimental machines described in these texts were copied from library to library, and, one expects, attempted. No extant machines have been discovered. First translated into Arabic, then Latin, these inventions were improved on in medieval Turkey and Persia, developed further in Burgundy and Switzerland, until what had become a tradition of entertainment automata reached a zenith in France and England during the eighteenth and nineteenth centuries.

Europe and North Africa were the primary locus for android development until the twentieth century. The countries east of Iran, such as India, Tibet, China, Korea and Japan, all had developed or obtained hydraulic and pneumatic technologies in the pre-medieval period. For example, clepsydra of varying complexity were used for timekeeping across India and Asia from the first century CE. Automated entertainment devices may have been built but they have not been of sufficient note to be described in accessible scholarly work. Therefore, I have concluded that there may not have been significant analogous development in these regions. Similarly non-Mediterranean Africa and the Americas are devoid of examples of entertainment automata in general or androids in specific.

It is clear that having access to technology is only one aspect of android construction. Because designing and building a mechanical human model is an expensive endeavour, social factors also must be in place to support this type of invention. Automata builders required access to resources such as financial sponsorship. As skilled mechanics, they would also have balanced the anticipated

positive return on the investment of time and money in the form of improved reputation, exhibition fees, or future employment. Therefore in this chapter, we find that those societies that supported automata were also ones that had developed spectator and patronage opportunities, and that valued displays of technology or mechanical skill.

2.1. Hydraulic Automata

Androids' first appearances to culture has been in myth and legend, and their first uses were likely in festivals (Herodotus, Book 2). Ancient androids were powered by water and air – hydraulic and pneumatic power – and used pulleys and levers to control movement. Rotating cams and gears enabled the programming of simple action sequences. These androids were built from wood, metal, and leather and embellished with gold, precious stones, and fabrics.

2.1.1. Automata from Alexandria and Rome

Early automata are depicted in texts by Philon (sometimes spelled Philo) of Byzantium (third century BCE), Ktesibios of Alexandria (third century BCE), and Hero of Alexandria (first century CE). These individuals were all based in the Greco-Egyptian city of Alexandria, which employed an aggressive information-collection regime on incoming ships with a policy of confiscation and copying of all texts brought into the city. The Library of Alexandria contained the original texts and the scholarly discussions thereof. Alexandria also maintained a reputation for technological achievements (Coleman, 57). Auxiliary to the library, the Museum of Alexandria supported research and technical experimentation (White). While Ktesibios was the first Director of the Museum, Hero was likely also affiliated with the Museum (Papadopoulos, 3).

These three inventors made important advances in technology: the chain drive, water mill, pneumatics, and wind wheel, among others. Yet all three also designed a number of water clocks, organs, and amusing automata. The designs depicted scenes familiar to their viewers: vignettes drawn from everyday life, nature, religion, and myth. For example, in *Pneumatica*, Philon invents a wine-pouring servant. This life-size android's action was triggered upon the placement of a cup in its hand. Controlled by

internal mechanisms, the android portions wine and water until the cup is removed from her hand. Such a servant is not necessary in a society that keeps slaves, but would likely have been fascinating to behold.

The *Statue of Nysa* was constructed by Ktesibios, the first director of the Museum of Alexandria. Displayed in 285 BCE, the humanoid automaton was a cam-operated female figure used in the “famous Grand Procession [of Ptolemy II Philadelphus], where it carried out a continuous performance, entertaining the festival crowd by standing up and sitting down” (White, 217). *Nysa* was an imposing twelve-foot tall mechanical woman set on a twelve-foot-wide cart pulled by sixty men. Throughout the procession, the yellow-robed giantess’ movement cycle comprised a rise to standing, the pouring of a libation of milk from a gold phial, and a return to the seated position. One can only imagine the thrill in the populace at such a sight: the familiar made enormous.

One account, unverified by any other contemporary report, describes an automaton used for political effect (Canfora, 340). According to Appian of Alexandria, an automaton was used in the death-rite of Julius Caesar, apparently under Marc Anthony’s orders. The body of Caesar was brought through Rome, to the plaza where Marc Anthony would ultimately give a short speech. Marc Antony held up Caesar’s blood-soaked purple toga, which naturally gave rise to great anguish from the crowd. Then much to everyone’s surprise, a wax effigy of Caesar was raised from the bier – not by human hands, but by hydraulics. The effigy then rotated to display the wounds on its realistic body. Appian reports that a riot then ensued (2.147). Given the existence of mechanical spectacles like *Nysa*, it is plausible that such an automaton could have been built.

However, from the majority of documented early automata, we can infer that automata were primarily intended for light entertainment. Hero of Alexandria set humanoid machines in more complex vignettes than his predecessors: for example an automated theatre and a model of Hercules who releases an arrow from his bow, narrowly missing a hissing snake. In several designs on the theme of libations, male or female characters would pour libations on fires, altars or other receptacles. Satyrs pour water from carafes or waterskins into pools and washing tubs. Singing birds and other

natural events were also favourite designs. Hero's use of nature and mythology influenced automata design henceforth. In further sections, we will see that, as his books *Pneumatica* and *On Automata-Making* both contained diverse designs with surprising modernity, they formed the foundation for mechanical amusement from the fourteenth through the seventeenth centuries.

Pneumatic and hydraulic entertainment technology also rigged forests, ships, and lakes to appear, disappear, drain, fill or collapse with dramatic effect during gladiatorial combat (Hammer, 64). While these spectacles leveraged organic human drama for their primary impact, Hammer has indicated that the artificial reality created by technology was a component of their success. In this example, technologies that imitate nature are part of a larger story, that may not only have entertained but also reflected a Roman preference for the artificial over the natural, and control over nature (Newmyer, in Hammer, 64).

These examples show that automata depicted various themes for multiple purposes. From small-scale to legendary in size and subject matter, mechanical humans were displayed in antiquity on special occasions and for audiences both elite and popular. In addition to technologies with obvious utility, mechanics in classical times built self-moving machines to embellish temples, theatre and spectacle for both the public and the private entertainment of wealthy classes.

By inspiring wonder, technological spectacles in Greek and Roman society celebrated patrons and the state even as they celebrated the gods. Advances in technology played prominent but separate roles in Philadelphus' procession and at Rome: "Alexandria exploits the artificiality of an automated colossus; Rome appears to work miracles by making elephants fly" (Coleman, 58). Humanoid self-moving machines supplemented parades of puppets, wild animals, and masses of costumed people at public events such as festivals, competitions and theatrical spectacles. The social institutions where technological spectacles were displayed supported or promoted political and economic power to a mass populace (Hammer, 78).

Mechanical wonders were so important to the society that when Pappus of Alexandria (fourth century CE) identifies the most valuable mechanical arts, he included

wonder-works amongst pulleys, instruments for war, machines to transport water, and cosmic models. Wonder-works as a category comprises devices that “seem to imitate the motions of living things by sinews and ropes”, water clocks controlled by floats in water, and self-opening temple doors (Walbank, 191). The marvellous, exciting automata of Greece and Rome were, in Pappus’ estimation, as valuable as irrigation.

2.1.2. Medieval Islam

Like the Ptolemies, the Abbasid caliphate (758-1258 CE) actively encouraged research and development of science and technology through the systematic translation of Greek, Sanskrit, and Chinese texts. The documents were housed at a library and associated research centre, the Treasury of Knowledge and the House of Wisdom, respectively, in the ninth century. In the Treasury and the House, automata designs were stored.

The Banu Musa brothers, Jafar-Muhammad, Ahmad and al-Hasan, designed marvellous entertainments for Abbasid Caliph al-Mamun. Their manuscript, *the Book of Artifices*, describes 100 elaborately decorated hydraulic and pneumatic toys. Of these, 25 are directly linked to designs by Hero, Philo, and Ktesibios (Nadarajan, 2007). A mechanical tea-girl, shape-changing fountains, self-playing organs, and beverage dispensers replete with automata of people, birds and animals number among these amusements for al-Mamun’s court.

Two centuries later, Hero of Alexandria’s designs were again reinterpreted by Badi’ al-Zaman Abu-'l-'Izz Ibn Isma'il Ibn al-Razzaz al-Jazari. Al-Jazari served in the court of the Artuqid kings of Diyar-Bakir, Turkey, during 1174-1200 CE. He authored several texts, such as *The Book of Knowledge of Ingenious Devices* and *A Compendium on the Theory and Practise of the Mechanical Arts*, which include detailed designs and instructions for entertainment automata. The themes are by now familiar: mechanical servant who dispenses beverages, self-trimming lamps, water clocks.

Al-Jazari’s machines use an aesthetic language that, like the Greek wonder-works, places emphasis on spectacle over mechanics. Illuminated pages of *Compendium* depict elaborate goldwork, fanciful subject matter. The Elephant Clock is

an imposing sculpture with multiple moving parts. On the hour, a bird sings, Chinese dragons move, and a mechanical man bangs a gong. Al-Jazari expanded on Greek musical innovation by designing programmable music players.

Humanoid automata depicted many kinds of characters such as musicians, and servants. Even a functional machine such as one that measures bloodletting is embellished with a pair of automaton scribes. One of the scribes entertains the patient, the other moves for the phlebotomist's enjoyment. In addition, at intervals based on the amount of blood let, doors open to reveal messenger characters whose placards identify the amount let. This was a special type of entertainment: comfort for the sick.

As was common in designs for courtly audiences, these innovations were not only technically advanced, but also lavishly embellished luxury entertainments. Quranic perspectives about scholarship, science, and the interpenetration of Allah in all parts of existence informed the design of these machines (Nadarajan, 2007, Al-Hassani, 2001). Therefore, while the Islamic automata may share an external luxury aesthetic with later-period European devices, the experience and interpretations were probably distinct. A European automaton may be interpreted as a celebration of man's achievement, whereas an Islamic automaton may be perceived as a conduit for the will of Allah (Nadarajan, 2007, 14). Cultural perspectives about beauty and pleasure are informed by religious and philosophical views, but individuals from these different cultures both created objects of beautiful, entertaining utility.

2.1.3. *Sixteenth Century Gardens*

Hero of Alexandria's texts were translated into Latin in the mid-sixteenth century, leading to a vogue for automata installations in gardens. Hydraulic automata had a strong presence in Mannerist gardens of the late sixteenth and seventeenth centuries. Salomon de Caus and other garden designers referred to Hero of Alexandria's reprinted texts for methods and inspiration for mechanical vignettes. Seventeenth century pleasure gardens used hydraulics for monumental fountains, surprise waterworks, and to rotate statues or move mechanical animals in artificial grottoes.

It was not unusual to go into a garden and see something mechanical moving. Shakespeare's *A Winter's Tale* memorably concludes with the revelation that Hermione is disguised as a statue in a garden grotto. Even her movements would not have been surprising for an audience effectively saturated in mechanical movement. At home, at church, and in gardens, artificially moving objects had become popular. Clockworks had been developing alongside hydraulics, exposing audiences to an even wider variety of mechanical movements.

2.2. Clockwork

2.2.1. *Development of Clockwork*

In medieval Europe, clockwork provided the power for self-moving machines. Automata were attached to Church-owned timepieces. Carrying on the tradition of the Roman water clock, community timepieces were decorated with automata that modeled and affirmed the relationship between the cosmos, daily life, and the Christian theological framework of medieval European existence (Mayr, de Solla Price).

The first major development of clockwork technology was the invention of the verge and foliot escapement sometime in the late thirteenth century. The verge and foliot escapement is an oscillating control that formed the basis for all timepieces that followed. Its application spurred a leap in technological development, resulting in the invention of the pendulum or weight-driven clock and then the spring-powered clock over the course of only two or three generations. This enabled the invention of truly mechanical clocks independent of continuous flow mechanisms such as water. The escapement enables the control of time – and therefore pacing of movement - for whatever is being motivated.

Medieval European clocks with automated embellishment have been documented from the thirteenth century. *The Portfolio of Villard de Honnecourt*, c.1220, comprises a hodge-podge of drawings that captured the author's interest as he traveled in France, Switzerland, and possibly to Hungary. He depicted an early escapement mechanism in a drawing titled "How to make an angel keep pointing his finger toward the Sun". He did not depict the angel. On the same page, he showed an automaton of a bird, with jointed

wings. Mechanical characters such as those depicted by de Honnecourt were commonly found on large institutional clocks, such as the first Strassbourg Clock, built in the fourteenth century. This monumental clock is roughly the size of a cathedral wall. It contained an astronomical calendar, automata depicting animals, saints and the life of Christ, among other things. Such a clock did more than keep time. It represented the universe. Still operating today, the clock has undergone several restorations since its initial construction.

In general, popular and luxury automata were designed and built by horologists and jewellers. The growing demand for clocks and watches led to the establishing of clockmakers guilds across Europe in the mid-sixteenth century (Cohen, 137). By the eighteenth century, horology as an independent field had a sound foundation of roughly three to four generations of expertise.

The possession of ever-smaller and elaborate timekeeping devices was associated with notions of autonomy, individuality, predictability, wealth and progress (well documented by Cohen, Mumford, Maurice and Mayr). As a meaningful possession, clocks had significant cultural currency that contributed to their success in the consumer market. The clock faces that counted the hours, days, phases of the moon et cetera, were buried in elaborate decoration and automated vignettes. In the design of these clocks, time was embedded in representations of the experienced world. The passage of time was marked by actions and sounds such as the flogging of Christ, the singing of a mechanical bird, or the procession of saints.

Spring-powered, interlocking geared wheels at the heart of clockwork technology were used to motivate a variety of devices other than clocks. Machines using this technology could repeat a simple sequence of events, but more complex repetitions required the development of a programming, or information, technology. This technology had already been use in musical devices since at least the end of the thirteenth century. The carillon employed a rotating cylinder fitted with pins that rang bells in a pre-set order. By the seventeenth and eighteenth centuries, music boxes, musical clocks, 'serinettes' and later flotenuhren used pin and cylinder programming to control metal combs, flutes and mechanical organs within musical clocks and automaton cases. This

programming tool was also used to control the movements of complex automata both attached to and independent of clocks.

2.2.2. Early Modern Automata

In the sixteenth century, large-scale public festivals celebrated the arrival, birth, marriage, or death of important political figures and were often tied to saints' days. Processions, pageants, theatre, temporary architectural features, music, feasts and other entertainments were all components of such festivals. As in Ptolemaic Alexandria, automata sometimes augmented the experience.

Parade floats in celebration of the arrival of Camilla of Aragon, bride of Costanzo Sforza, to Pesano, Italy in 1475, included a ship on wheels, a ball depicting the earth, and were intended to be an evocation of "cosmic harmonies, favourable planetary influences, and other elements of the magical universe" (Grafton, 49). At a banquet in Camilla's honour, dioramas of her new lands were wheeled in, followed by a lifelike automated camel. The dramatic effect of "organically correct movements carried out by replicas of animals" was "captivating" to the public, even a sophisticated one (Grafton, 50). The spectacle was for the local community and for the privileged guests.

Similarly, Duke Philip the Good of Burgundy supplemented his remarkable menageries, collections of wonders, and human oddities with displays of automata. Most famously, the extravagant Feast of the Pheasant (1453) was intended to influence the Duke's peers towards participation in a crusade against the Ottomans. Although the good Duke did not achieve his goal, he did manage to impress many peers with the displays of automata, giants and dwarves.

Paduan engineer Giovanni Fontana's treatise *Bellicorum instrumentorum liber*, c. 1420, includes designs resembling those of Philo of Byzantium and Al-Jazari as well as machines for war and spectacle. Fontana does not distinguish between automata and large puppets (Grafton, 56), because his focus was on spectacle. For example, he includes a puppet of a camelid driven by a clothed primate twice the height of a human being. Although the *Bellicorum* includes a rather pleasant tightrope-walking toy and an automaton of Mary Magdalene, for the most part the humanoid machines are the stuff of

nightmare: nude devils with many mouths and a horned woman who spits fire from her mouth and ears as she races along a track.

Fontana's designs attempted to enthrall the public, and then to disenchant them (Grafton, 59). A strong concern amongst fifteenth century intellectuals was the sway superstition still held over the populace at large. Pagan ideas remained strong about mage-like characters (or charlatans) with the ability to create supernatural life forms. Beliefs such as the golem, mandrake root, and ensouled statues continued to undermine humanist reason. Fontana argued that a master of optics, or a master of engineering, could easily replicate any of the omens or signs that created hysteria amongst the uneducated mass. His devil-automata attempted to prove that engineers could also exert "human power over nature", to argue against superstition by presenting animated depictions of supernatural demons (Grafton, 56).

The public could be enchanted by these artificial renderings of the extraordinary. There is an element of showing off to the early modern displays, an effort to not only display the object, but also to display some other value. For Fontana, the terrifying mechanical devils could show off the skill of man even as they highlight the foolishness of peasants. For great lords of Italy and Burgundy, an extravagant show could draw attention to their own glory. As originators of the extraordinary, they became so themselves.

2.2.3. Asian Automata

It should be mentioned that China did have documented mechanical automata stretching back at least to 200 AD. The "south-pointing chariot" of this period featured a god-like figure atop a container, who continuously points south with the help of a series of differential gears as the chariot moves. It operates, not only as a marvelous object, but a non-magnetic compass, indicating south as did other Chinese compasses. South-pointing Chariots were built from 200 to 1300 AD (Yan and Chen). Ma Jun, the third century Chinese mechanic who was apparently responsible for the invention of the south-pointing chariot, also made complex clepsydra.

The *Liezi*, written around the third or fourth century BC, tells the story of the presentation of a magical android by engineer Yan Shi to King Mu of Zhou. The android could walk, nod, pose, sing and flirt by winking. Its organs were linked to the senses according to Chinese medical knowledge (heart controlling speech, liver controlling the eyes, kidneys controlling movement) and could be removed to demonstrate their impact. The android of this tale operated as both a social and a medical simulation. There is no evidence that such an android was actually built at this time, but it is interesting to note that the possibility was contemplated.

During the sixteenth century, Portuguese ships brought clocks and automata to Japan. The Japanese interpretation of the European automaton was the *karakuri ningyoo*: automated ceremonial dolls displayed for festivals. The oldest extant *karakuri* is a tea-serving doll dating back to around 1573, with very similar structural design to contemporary Spanish designs. Human head, molded hands and feet are attached to a cone-shaped base that conceals the geared works. Clothes cover the base, hiding its mechanical nature. The clothes add realism and assist in the suspension of disbelief despite the small size of the automaton. The European automaton is usually triggered by a switch hidden in its base, but the *karakuri's* motion begins when a teacup is placed in its hand. The former creates an illusion of magic, the latter an illusion of relationship.

Japanese automata from the Edo Period (1630-1850) did not develop much in design, largely as a result of the ultra-conservative Tokugawa regime. This regime suppressed technological development and the western influence, but supported religious and Japanese cultural expression. The *karakuri ningyoo* and Japanese clocks were competitively designed by communities in efforts to outdo each other within the confining aesthetic regime. Overall, *karakuri ningyoo* were intended to play an interactive role with humans in society, their actions triggered by social interaction with a human. For this reason, *karakuri* may be considered ancestors of today's artificially intelligent robots.

2.2.4. Extant early modern humanoid automata

There are currently several extant entertainment automata of the late Renaissance, including late-sixteenth-century lady musician automata. Some of them

are lute-playing ladies (see Bedini, Fig. 5 and 5a for examples). *The Lady from Vienna* may have been constructed by clockmaker and engineer Juanelo Turriano (1501-1585). Turriano worked for both Emperor Charles I and King Philip of Spain. Like Hero of Alexandria, Turriano's devices ranged from the practical to the spiritual. As a hydraulics engineer, he built a device known as the "dancing machine" which lifted water 90m above the River Tagus to the city of Toledo. As an entertainment engineer, he constructed a number of android automata, including musicians that play lute or drum, and an android that begs for money.

He also may have been the creator of an extant automaton monk currently housed at the Smithsonian Institution. Heralded as one of the earliest surviving examples of a program-controlled self-acting machine by Otto Mayr, this 16-inch-tall clockwork character is "a direct predecessor of the eighteenth-century automata of Vaucanson and Jaquet-Droz" (Mayr, in King 267). There are two other extant monk-automata of this period. Both hold small bells in their hands, only one other one walks. Elizabeth King's analysis reveals that the Smithsonian automaton's features are consistent with images of Diego de Alcala, a fifteenth-century Franciscan monk. This monk is a diminutive mechanical duplicate of a real person, now long-dead.

The monk operates by a mechanism hidden within its body. The wind-up doll begins its action sequence when a latch in its base is released. It turns its head and takes eight steps. Its mouth opens and closes, it bends one arm and strikes its breast, it raises the cross to its lips. Then with arms raised, the monk turns to the right and begins again. This "explicit performance of authorized and orthodox gestures of Catholic prayer" has led Elizabeth King to interpret this object as more than entertainment (King, 278). Perhaps, King suggests, this is an extension of the already mechanical repetition within "trancelike performance of prayer, incantation" (278). King's research into a sixteenth century mechanical monk suggests this device was not only communicative but also demonstrative. She suggests that many devotional rituals involve repetitive actions that, but for the needs of organic bodies, could be enacted in perpetuity. She goes so far as to interpret the mechanical monk as an experiment in perpetual prayer. The monk may have been an attempt, not to amuse a king, but to satisfy God. Whether this was the intent of its designer or not, what is obvious about the monk is that it is an evocative

piece. This object was designed to produce a response that is not limited to technological interest.

2.2.5. *Luxury Automata*

Automata in the sixteenth through mid-eighteenth centuries functioned as luxury currency as well as entertainment. European elites donated automata of animals to the crowned heads of other nations such as Turkey and China in an effort to display wealth and make diplomatic inroads. For example, a 1774 silver swan from James Cox's workshop, which still delights audiences daily in Teesdale, England, catches shimmering fish to the sound of ringing bells. The trade in elaborate automata "oiled the wheels" of the tea business, which languished once Bengal opium and Indian cotton entered the European-Asian economy (Schaffer, 56). Automata were also used to promote the supremacy of the Christian worldview by Jesuit missionaries in China (Maurice, 28). Automata and mirabilia were also used, as in the above examples of Constantine Sforza and Philip the Good of Burgundy, to demonstrate access to resources and expertise (Daston and Park, 103).

James Cox was an English horologist whose workshop produced many fine mechanical toys for both London audiences and the Chinese court. While his name was signed to each gilt and bejeweled object, he did lack the goldsmithing skill to embellish these objects. He was known to have employed hundreds of jewelers to produce his baubles (le Corbellier, 320). The museum was established in an attempt to recoup his investment because luxury automata had saturated the Chinese market and his shipment was turned away (Maurice, Le Corbellier, Pointon). He exhibited 23 mechanical objects at the Great Room in Spring Gardens in 1772. The entrance fee of a quarter guinea (5 shillings 3 pence) was roughly 3 weeks wage for a housemaid. Cox's advertising stressed the high cost of production and the economic value of his exhibition (Pointon, 434). In 1773, he added another 35 to the collection after receiving a loan from King George III.

Cox's Museum was a direct competitor of Merlin's Mechanical Museum, which displayed a variety of amusing and scientific machines and had been established 10 years previously near Hanover Square in London. Merlin's Museum included the silver

dancing automaton purchased and restored by Charles Babbage – inventor of the Difference Engine – in 1834 to be displayed in his own collection.

Eighteenth Century clocks and watches were embellished with lavish goldwork, jewels and automata. For example, one pocket watch by the Jaquet-Droz atelier features automata of miniscule gold birds who flap their wings and trill a song at the hour. As had been done in previous centuries, horologists also used their technical skills to construct mechanically-motivated trinkets with no utilitarian value. Although individual horologists did sign their name to the various products from their ateliers, it is unlikely any single person had the wide skill base to construct an automaton or automaton-clock.

Klaus Maurice and Otto Mayr's *Clockwork Universe*, the catalogue for an exhibition of German clocks and automata from 1550 to 1650, illustrates a variety of entertainment machines available during this period. While some were clocks for enjoyment in the residence or business, others were entremets, table toys for the amusement of guests between courses. A woodcut depicting a table covered in models shows the range of decorative table accents available in the late-sixteenth century (235). Automata of castles with little trumpeters on the ramparts contained miniature organs to play multiple songs. Automata of Diana riding a stag could roll across banquet tables in a mid-seventeenth century drinking game. In the collection there is also a preserved bear containing an automaton that causes the bear to drum. According to Maurice and Mayr, stuffed-animal automata were a common entertainment of this period. When viewed with an anachronistic eye, this bear strikes one as a proto-cyborg: a seamless marriage of organic housing and mechanical interior.

Gilt and bejeweled clocks outfitted with automata of exotic, animal, and mythological themes are featured in the collection. Thirty-five of the forty-nine figure clock automata have eyes that move when the internal clockworks are in motion. Most figures have additional movements controlled by the striking train on the quarter, half or hour. Lions that roar, birds that sing, mahouts that pull their elephants' chains, and other movement vignettes were all features of the clock trade in the late Renaissance.

Clock automata may have been prominent in relation to the depiction of time in part because until the eighteenth century clocks were markedly inaccurate. Most

seventeenth century clocks had to be wound once an hour to stay on time. The clock, therefore, was an “elaborate object of decorative art” (Mayr, 1), but required attention to maintain its function. The clock’s incessant need for winding, its pervasive tick-tock sound, and its rapid rise to ubiquity may have contributed to its symbolic impact (Cohen). Symbolically, time keeping was secondary to the clock; it was a mechanical tool for the spirit rather than one for the body. As a depiction of temporality, it called attention to the passage and use of time, served as a *memento mori* and a model of the world (Haber, 10).

Automata were often more prominent than the clock face itself. For example, James Cox designed a “Peacock Clock” for Catherine the Great of Russia. This clock, still operational today, depicts a larger than life scene: a golden forest replete with flora and fowl. A dragonfly rotates to identify the seconds. A gilt peacock raises its tail and rotates on the hour. A rooster crows. One is hard-pressed to locate the clock face on this spectacular machine. The design of monumental astronomical clocks like the Strassbourg Clock, and of smaller table clocks such as those featured in *Clockwork Universe*, use automata to supplement depictions of saints’ days, the cycles of the moon, sun and eclipses (19-year eclipse cycles were known as dragon years). In many of the extant designs, the clock faces are so small that it almost appears the device is an “automaton with clock” as opposed to a “clock with automaton.”

2.2.6. The automata of Jacques Vaucanson

The “defecating duck”, as it came to be known, purported to be a demonstration of a waterfowl’s digestive system. Like other seventeenth and early eighteenth century automata, the duck was intricately constructed. Four hundred parts comprised the duck’s wing alone, which the duck flapped from time to time. Its action was to sit up, walk and take a grain of corn from a receptacle. The duck swallowed the corn and, a few moments later, performed a reeking excretion. By viewing through perforations in the duck’s feathers, audiences could watch the organs at work. Beyond scientific interest, the delight sparked by this duck was in its boundary crossing: a mechanical object

performing the basest of animal functions, and a courtly audience entertained by a fart (Riskin, Wetware, 104).

While the duck merged organic and mechanic divisions, the Pipe and Tabor Player (1737) reaffirmed these boundaries. This automaton executed twenty tunes at superhuman speed. Less discussed by scholars than the other two automata of Vaucanson, the Pipe and Tabor Player seems to demonstrate the supremacy of the machine. There was not an illusion of life or lifelike action. As advertised in the London Magazine, the Pipe and Tabor Player's performance promised to succeed in "outdoing all Performers on the Instrument" (*London Magazine, or the Gentleman's Intelligencer*, Vol 13, pg 512). This was the articulation of machine-ness, a machine that could surpass human ability (Altick, 64).

Vaucanson's greatest musical automaton, the Flutor, was presented to the Academies des Sciences in 1738. The design of the Flutor's case was inspired. He chose a well-known statue by Antoine Coysevox, "Faun playing the Flute" (1709) then displayed in the Tuileries garden. The original, now housed at the Louvre, juxtaposes the satyr's muscular and brutish form with the delicacy of fingers lifted and lips pursed as if to gently blow into the transverse flute. The satyr's facial expression conveys peace and concentration, and looking at the statue one is inspired to imagine a woodwind tune. Vaucanson's wood rendition of the sculpture was painted white to resemble Coysevox's marble statue. Just as any statue in an Enlightenment garden might be expected to move, this sculpture would be animated. However, Vaucanson escalated animation from simple rotation to a simulation of human culture. Vaucanson's faun did not appear to play the flute with the nuance of a human performer: *it truly did*.

Bellows within the statue's base pushed air through tubes in its throat. Unlike any other statue before it, this faun breathed and performed musical compositions. This faun's fingers closed over the holes in the flute, and his mouth, tongue and glottis executed the precise shapes necessary to produce music from the instrument. He covered his flute player with skin to ensure the mechanical hands would be able to close flute holes. The flute player's lips could move in four directions and he was able to play twelve different songs by manipulating air, a mechanical tongue, fingers and lips.

This was never-before-seen verisimilitude in behaviour and imitation of art in form. The faun's design layered cultural signs: technology in art's clothing, sculpture depicting myth, signs of life in an unliving object, a mechanical person executing the quintessentially human action of performing music. The faun broke through conceptual boundaries separating life, machine, and humanity.

To be able to invent these devices, Vaucanson depended on the patronage of several individuals. He first received financial support from Parisien financier Samuel Bernard, which funded some of his education and research into medicine and mechanics. The Canon Jean Colvée loaned him money for building automata, but financial support for the Flutor was ultimately received from Parisian Jean Marguin.

Vaucanson's inventions were well received by courtly audiences as they visited salons across Europe and Great Britain. His ability to translate organic processes into mechanical ones made him a favourite of subscribers to materialist natural philosophy. Frederick II of Prussia was delighted by the automata and offered Vaucanson a position in his court. Instead, Vaucanson was offered –and accepted - the position of Silk Inspector in Lyons by Louis XV of France, charged with revitalizing the silk industry through mechanization. He developed the first automated looms and designed industrial systems for this industry against heavy opposition from skilled weavers. There is no evidence that he built any other lifelike machines. His daughter, the grand-daughter of a glove-maker, married a count.

Vaucanson's machines were unique amongst automata because they emulated both internal and external life. The duck's behaviour was naturalistic as were its biological functions; the flute player's mouth expelled air. He used materials that were able to closely duplicate the texture, elasticity and function of the living model. To simulate human fingers, he covered the Flutor's fingers with skin. In contrast to other models of the circulatory system of the same period that used glass tubes and coloured water, his used flexible rubber tubes and a viscous, blood-like fluid. While his goal to build a fully functional model of the human body was never realized, his inventions constitute an effort to simulate internal and external life that has yet been unmatched.

The simulating machines built by Vaucanson, that carry out internal and unseen functions, were markedly different from those built prior to and after the eighteenth century. Simulations of human functions were presented by many individuals in public exhibitions and for assessment at scientific academies such as the Imperial Academy of St. Petersburg and the Academie des Sciences of Paris. Von Kempelen and others worked on manipulating reeds and tubes to replicate human speech through the 1770s. Although Abbé Mical's speaking machine was contained in a humanoid housing, Von Kempelen's speaking machine was housed in a box without decorative features. While other automata demonstrate or mime actions associated with living things, the simulating machines performed them in the same manner of the biological original.

His skill enabled him also to remove life from action: he invented the first automatic loom (later to be perfected and marketed by Joseph Marie Jacquard). The loom used the same technology as the Flutor, 'reading' a programmed, rotating drum. Nowadays, Vaucanson is also credited with having invented the first working pedagogic medical simulator (Moran).

Vaucanson's inventions engaged his audiences on multiple levels: as artistic, entertaining, and scientific models. By combining art, science and engineering, he diversified his pool of potential audiences and increased his opportunities for display and international renown. The machines he built were about more than skill. His goal was to build automata that could be used as diagnostic simulators. He used automata to formulate and validate theories of digestion and musical performance (Fryer and Marshall, 267). Additionally these devices served as "philosophical toys" that inspired essential questions about the nature of life (Riskin).

2.2.7. *Extant androids of Pierre and Henri Jaquet-Droz*

Built in 1768, the three automata currently displayed at La Musee des Arts et des Sciences in La Chaux de Fonds, Switzerland, are some of the most exquisite surviving and still-operating automata. All three forms are made from wood, paper maché and leather, enclosing wind-up clockworks and rotating programmable cams. They tick loudly while operating. Diminutive but near-life size, the three androids are designed to look like juveniles: a girl of "ten or twelve years of age", a boy of two, and another boy. These

inventions do not attempt to replicate internal biology. Rather, they represent culture and emotional display.

The draughtsman, as it is called in the exhibition prospectus,

represents a child sitting on a stool, drawing with a pencil on tablets. This figure executes very neatly some small drawings, of which it first makes the outlines, observing which strokes should be strong, and which light; it afterwards shades them, and finally retouches and corrects them.

In the advertisement's description, the suggestion of life is intermixed with the action. The representation of a child "observes", pauses by taking "its hand off now and then, as if to get a better view of what it has done, and blows off the dust formed by the action of the pencil. The various motions of the eyes, arms, and hand imitate nature exactly." In the advertising copy, the imitation of nature is made complete by the suggestion of thought.

Similarly, the writer is a

figure representing a child of two years of age, seated on a stool, and writing at a desk. This figure dips its pen in the ink, shakes out what is superfluous, and writes distinctly and correctly whatever the company think proper to dictate, without any person's touching it. It places the initial letters with propriety, and leaves a suitable space between the words it writes. When it has finished a line it passes on to the next, always observing the proper distance between the lines: while it writes, its eyes are fixed on its work, but as soon as it has finished a letter or a word, it casts a look at the copy, seeming to imitate it.

Some false advertising may be at play in this description, for there is no mechanism for the writer to take dictation. On request, the writer's script can be programmed through adjustments to the cams in its back. The implications in the copy again are of a mixed mechanism and sentience linked to the action of the eyes. That the figure may somehow 'know' how much ink to shake off its pen, that it demonstrated observation, concentration, avoidance of error, and the effort to copy a text, is essential to its draw as a spectacle. That they note the automaton writes "correctly" carries the implicit suggestion that it may be able to make a mistake.

The lady musician or *la musicienne*, as it is known, is a representation of

a girl of ten or twelve years of age, sitting on a stool and playing on a harpsichord. This automaton, whole body, head, eyes, arms, hands and fingers have various motions, all which appear natural, performs several airs in two or three parts with great precision; the head has every natural motion, and the eyes look indiscriminately on its hands, the music, and the spectators; the body is flexible, and inclines sometimes to see the music nearer; the bosom also rises and falls, to imitate respiration.

She is dressed in fashionable contemporary clothes. Golden curls frame her face. When started, she appears to breathe and then begins to play one of five tunes on her organ. Her hands are small and realistic but contain articulated brass mechanisms that enable movement. Her blue eyes follow the motions of her hands and her chest moves as if breathing. When her performance is over, she turns her head to the audience and bows. This female representation does not, in the advertising copy, demonstrate the skills of observation and imitation, consideration or measurement. Instead, *la musicienne* is an essentially feminine performer: indiscriminate, aware of self and audience, precise, natural, and emotional.

The advertising copy suggests artificial intelligence but never suggests artificial life or personhood. The copy is clear in promoting these androids as imitations of life's natural actions through mechanical means. The use of object pronouns throughout the descriptions reinforces the reality that these machines are not alive. They are not "he" or "she" with thoughts and feelings, but "it" with imitations thereof. In contrast, consider the same brochure's description of an automaton of the Swiss countryside. This machine animated a variety of pastoral depictions of shepherds and shepherdesses engaged in labour and leisure. The copy describing this device uses personal pronouns throughout. Thus the shepherd meets a shepherdess and "he approaches her and plays a tender air".

The pastoral automaton is effectively a mechanical theatre in the long-established tradition of entremets and monumental clocks. As such, it demands engagement from its audience through a willing suspension of disbelief. It is also less likely one could imagine the miniscule shepherds and shepherdesses being mistaken for living beings. The little automatons resemble tiny actors in a play; they behave like a character and are accepted as such by the audience.

These automata toured as spectacle entertainment largely to promote the Jaquet-Droz atelier's other consumer products: elaborate luxury time pieces sold in La Chaux-de-Fonds and in London by their agent Leschot and in La Chaux-de-Fonds. The mechanical precision of the draughtsman's depiction of "Mon Toutou" (my doggie) demonstrated the Jaquet-Droz' technical skill in a unique way. Similarly, the lady musician's performance is an exercise in mechanical precision. It can also be read as an extension of Vaucanson's visual argument in his Tabor Player. This machine may indeed outplay a human in speed and accuracy.

The same mechanisms enabling movement of the lady musician's hands were transferred to the creation of realistic prosthetic hands. The Jaquet-Droz family bridged the man-machine gap, creating a mechanical interface where a human one had been. They were not removing the human being from the world of production as much as using available technology to replace missing organic parts.

2.2.8. *La Joueuse de Tympanon*

Another surviving musical automaton was built by watchmaker Pierre Kintzing and cabinetmaker David Roentgen in 1785 for Marie Antoinette. This 18" doll, called *La Joueuse de Tympanon*, is set on a cabinet that conceals her clockwork and supports her instrument, a one-metre-long dulcimer. With her tiny hammers, the finely dressed blonde plays eight songs.

Before she begins, she pauses over the strings as if imagining what to play. In this moment where movement is absent, she appears utterly lifelike. There is something about the pause, as if it has been designed to match the amount of time a skilled performer takes to make a decision. Although this doll does not breathe or bow, her head moves as if she is paying attention both to her instrument and to the audience. Charm exudes from its action in both the timbre of the instrument and the beauty of the machine.

There is a striking difference between the Lady Musician and *La Joueuse*. Although the Lady Musician is more life-like in scale and movement, the music she plays is less enjoyable. Her organ's tones are shrill and piercing and the music is executed

with unrelenting speed. She plays compositions by Henri Jaquet-Droz, who had studied music but clearly had more of a talent for clockworks. She breathes, sighs and looks, but demonstrates a truly “robotic” performance.

La Joueuse, on the other hand, plays music that is actually pleasant to listen to. One of the pieces she plays is the “Armide” by Gluck. Her instrument has a pretty, ringing sound, and there are pauses between the notes that imply musicality. Wonderment at the technology gives way to delight. *La Joueuse* is truly a gift for a decadent queen, while the Lady Musician is the demonstration of technical ability first, and musical ability last.

2.2.9. Attendance and finances

Records of attendance at ancient spectacle events are non-existent, but it is reasonable to surmise that for a major public procession the general populace from most social strata could have been in attendance. Access to court spectacles was sometimes limited to courtly attendees and servant classes, however some were open to the public. There have not been studies of audience composition for the commercial eighteenth century exhibitions. In addition, primary source records may not have been kept regarding ticket sales in the grand salons of London and Paris. By the advertised entrance fee, we know that London exhibitions were probably out of the range of subsistence wage earners and well within the reach of the middle and noble classes. In London an insatiable thirst for exhibitions was common across all classes (Altick, 4). In La Chaux-de-Fonds, Switzerland, common folk lined up with nobility to see the Jaquet-Droz automata from six in the morning until eight in the evening (Metzner, Chapter 5).

By the early eighteenth century, android automata were one component of a vast selection of spectacles available to novelty-hungry audiences. The historical audience of android automata was composed of those who provided financial backing for their construction, invitees to elite events or locations, members of the paying public, and community participants in public spectacles. Automata appeared beside hot air balloon exhibits, panoramas, indoor fireworks, public anatomies, menageries, and oddities of the human race. These individuals were consumers who made choices on how to spend their money and their time; although audiences tired of some technological displays such

as ballooning, the almost continuous exhibition of eighteenth century automata over the last three centuries shows the success of lifelike androids.

Those cultures that placed high value on knowledge, science and technological development have also been good markets for mechanical showpieces such as android automata. These have had enduring popularity across many parts of society, linking art, science, philosophy, religion and entertainment in a meaning-laden mixture. There were multiple settings and possible associations, from the global to the domestic, attractive to audiences. Some of the most fascinating androids have been designed to closely resemble human form, affect and action. These androids, like Vaucanson's Flute Player and Jaquet Droz' juveniles, were displayed to the public at Covent Gardens in London, Tuileries Gardens in Paris, scientific societies such as the Paris Academie des Sciences as well as to the courts of King Louis XV of France, King Frederick of Prussia, and the Qianlong Emperor of China.

In the scientific and philosophical context, androids were used to model biological principles and also render an important argument about human nature and uniqueness. As an analogy, the conceptual android could demonstrate mental models related to human agency and the existence of a soul. As a physical model, the android could demonstrate internal processes. This may seem enough justification to consider androids as technological and scientific models, but they were still primarily displayed in entertainment settings for emotional effect.

2.2.10. *Nineteenth century automata*

By employing hundreds of staff and producing hundreds of automata, James Cox's atelier had come close to mass production in the mid-eighteenth century. This model was again applied in nineteenth century automaton construction. Costs for production decreased and between the 1840s and the 1860s, the cost to purchase automata decreased from thousands of francs to just over eight (Riskin, Wetware, 101). Like Cox's designs a half century previous, automata by Gustave Vichy, Jean Eugene Robert-Houdin and many others represented a fantastical world populated by exotic, oriental or magical characters. The circus and magic show, and the wonders of P.T. Barnum, were inspirations and venues for these automata.

There were also hundreds of nineteenth century automata that depicted the performance of music, writing, tea service, and dance. The materials and mechanisms remained the same as in previous centuries. The depiction of performance was not a simulation or model of the action. The mechanical writer only mimes writing. The mechanical woman moves her hands as if to knit, but lacks both the dexterity and the feedback controls to actually manipulate yarn. The musicians are set atop music boxes that emit music. The violin or flute is a toy suitable for a mime, not for performance.

The methods for such imitative android machines were ultimately employed in the familiar wind-up tin toys of the past century. The amusement park usage continues to this day, in animatronic androids displayed at Disney and other theme parks.

2.3. Animatronic

The androids of today persist in similar venues to those of the past. Mechanical spectacle continues to entertain audiences. The “Walking with Dinosaurs” show features life-size animatronic dinosaurs. Disneyland has hardly abandoned imitative androids: they’ve come a long way since “It’s a Small World’s” depiction of a peaceful multi-ethnic world. Now they display the most life-like replica humans in some of their exhibits, and have hired pioneers in the animatronics industry such as David Hanson.

The power source for androids today is electrical. Their movements are controlled by circuitboards and frequently the most advanced ones are still attached by cables to computers that either control or record their actions and interactions. Most androids the middle classes have access to are toys, produced for children or for the amusement of adults. The machines considered remarkable in their time are today commonplace, wonderful mostly to children as they walk, excrete, cry and speak.

Android design continues to be divided between hyper-realism and a loosely representative style. An example is Honda’s ASIMO demonstration android, the first to conduct a symphony orchestra. ASIMO is designed to resemble a diminutive astronaut. The visor of its helmet covers the area where a face would be, leaving its features to the imagination. Similarly, Hanson Robotics’ commercial ‘child’ android Zeno has physical proportions, large eyes and gravity-defying hair consistent with the Asian *anime* cartoon

style. Both androids contain some of the most advanced artificial intelligence software, enabling these machines to recognize faces, complete multi-step tasks, and, in Zeno's case, mimic emotions and facial expressions.

Verisimilitude today continues to appeal. Today's audience can intimately engage with lifelike human models. Available on the market today are "Reborns," indistinguishably realistic dolls handmade to look like real babies, or "Real Dolls," equally realistic male or female sexual companion dolls handmade to order. Reborns are outfitted with breathing mechanisms, and German firm First Androids has added a pulse, breathing action, and vocal response to their fantasy sexual companion dolls. It seems only a matter of time and financial resources before movements and basic artificial intelligence is added to these dolls.

In the meantime, hyper-realistic androids are being developed around the globe, notably in Japan, the United States, Canada, and Denmark. Their creation requires the collaboration of psychologists, sculptors, engineers and artificial intelligence specialists. In contrast to all the androids prior to this period, these "partner robots" are designed to integrate in the human world. They are the size of average humans and will one day be capable of bipedal locomotion and sufficient manual dexterity to enable them to travel throughout our world and use our tools. Partner robots, 'act-droids', and other realistic humanoid machines have motion sensors in their eyes, touch sensors under their skin, can store information, form emotion-communicating facial expressions, and carry basic conversations. It is common for these realistic androids to be molded from a real human being.

The term "geminoid" is a compound of 'gemin' for twin and '-oid' for shape, and was first used by Hiroshi Ishiguro to describe an android duplicate of himself. The geminoid project was commenced in Kokoro, Japan, and, like the philosophical toys of the eighteenth century, hopes to answer key questions about being human that bridge science and philosophy (<http://www.irc.atr.jp/Geminoid/overview.html>). The Geminoid researchers in Japan and Denmark seek to use communication between the human and android twins to know more about the nature of 'presence', 'identity', 'relation' and 'human' (<http://geminoid.dk/>). The project molds skins from real people, and has duplicated at least two women, a child, and two men. Realism is in part attained through

irregularities: real people have slight asymmetries in their faces and pores which can be duplicated through the molding process, and living beings have variable movement and breathing actions which can be mimicked through programming.

Hanson Robotics offers “identity emulation,” a process by which a silicon skin molded to resemble a real person is applied to a mechanical frame. The result is a replication of a human, with luminescent, glossy skin, moist eyes and artificial intelligence. At this time, other than Zeno, Hanson Robotics has produced primarily android heads with artificial intelligence. For the most part, these heads have combined art with nature. They include one of Albert Einstein, a girlfriend of David Hanson, and (ironically) Philip K. Dick. In 2008, David Hanson and musician David Byrne collaborated on a singing android dubbed “Julio.” The android was exhibited at the Museo Nacional Centro de Arte Reina Sofia in Madrid, Spain, for an exhibit titled “Machines and Souls. Digital Art”.

Today’s realistic androids are modeling and participating in human culture. They mirror the performances of the lifelike androids of the eighteenth century, demonstrating actions that we associate with human beings. Geminoid F, a copy of a living 20 year old anonymous female, performed in a 20-minute play as a helper android assisting a terminally ill human woman. Julio sings a passionate song about how nothing will ever be the same again. Canadian android Aiko responds to touch and describes feeling pain. Most of them respond to facial expressions with expressions of their own.

These robots still lack when compared to the eighteenth century androids. They are faithful representations of their templates, but they remain puppet-like. Of the countless video footage that I have watched of modern-day robots on display, they remain most excellent mimes, remarkable puppets. The eighteenth century android, if it spoke, would speak from its mouth. It exhales. An eighteenth century android who sings was never made, but if it did, the voice would come from within. In modern androids the voices are invariably piped in through speakers.

An acting droid is not ‘acting,’ it is following a series of commands as it does in a non-acting period. To act is to be something one is not. To act, the droid would have to

know itself. Otherwise, it is just a puppet. Yet an audience faced with something of such realism is hard pressed not to sink into a fantasy of anthropomorphism.

Approaching these machines literally is one of the few methods we have to avoid being distracted by their realism. The fantasy of anthropomorphism is simple with artificial life. It is all too easy to be enchanted by a powerful song sung by a trained singer. If the voice appears to come from a machine that straddles the edge of life, the experience can be all the more enchanting.

These machines and their eighteenth century ancestors both represent the height of technological development of their time. The eighteenth century androids performed human cultural products and represented human emotions. The twenty-first century androids mimic human cultural products which are produced elsewhere and also mimic and represent human emotions. Eighteenth century androids appeared to feel emotion, and sighed. Twenty-first century androids use their eyes to 'see' and determine what emotion to mimic. The artificial intelligence of the eighteenth century androids was implied but non-existent: that of the twenty-first century is embedded. In 1954, Norbert Wiener imagined that if a machine's body duplicated human physiology, it may be possible to also duplicate the human intellectual capacity (57). This imagining gains a prophetic character when we consider the possibilities unlocked by the addition of artificial intelligence to a humanoid form capable of sensing and storing information.

Some histories of computers and industrialization argue that automata were integral players in the development of technology. Otto Mayr describes early automata as the first examples of feedback control mechanisms (King, 267). Derek de Solla Price (1964) goes as far as to call automata the "progenitors of the Industrial Revolution" (10). He suggests that scientific advances are first introduced in playthings and "impracticable scientific models and instruments," and complains that there has been a "private, somewhat peevish discontent" amongst historians of technology that "the most ingenious mechanical devices of antiquity were not useful machines but trivial toys" (15). Silvio Bedini (1964) considers them the "first step in the realization of his [man's] dream" to attain the abilities of animals (24). He suggests that the imitation of life, and not the satisfaction of humankind's needs, was the inspiration for the first complex machines. Imitation of life in the form of "biological automata, of astronomical clocks, and of the fine

mechanisms” laid the technological foundations for development of functional, decorative, religious, and entertaining inventions (40). Bedini speculates that historical automaton builders may have “secretly nurtured an ambition” to create artificial life by “a combination of alchemy and mechanics” (40). While there are clear links between the automaton builders and new technologies, Bedini and de Solla Price only succeed in demonstrating that historical automata were built by the same men who were pioneers in cybernetics, programming, timekeeping and instrumentation.

More recent histories of technology find relevance for automata by linking these inventions, especially those of Jacques Vaucanson, to the development of computers and computer programming. Vaucanson used the same programmable cams in his automata as his automated loom. His loom was the inspiration for the Jacquard loom, which substituted punch cards for cams. By the end of the nineteenth century, an electrical binary coding was invented as punched cards and electricity were used to tally the American census. As computers have gained a central economic and social role in our society, historical androids have gained a new significance.

3. Chapter 3 – Spectatorial Attraction – the Popular Android

At his desk, the schoolboy considers, then turns his attention to the page. His pencil's light, deliberate strokes depict a woman in profile with a slight smile. Every once in a while he blows the charcoal dust off the page. When he is done he looks up. When I first saw this Jaquet Droz android in action, I could not believe my eyes. Again and again I watched the video, eagerly drinking in the sight of a machine that looks like a boy and draws pictures with such precision just as boys of its day would have done. When I tired of this one, I excitedly wanted to see more.

Some types of spectacles have had staying power across the centuries, remaining of interest despite transformations in technology and worldview. Distortion of scale, such as very large or very small things, is one example of a spectacle type with great longevity. Similarly, self-moving replications of living things have had long-term appeal as entertainment.

The preceding chapter lays out a general history of automaton technologies and introduces example androids. The historical exhibition context and imagery tells a story of wealth and beauty. The machine demonstrates varied themes, for example a magic show, a swordfight, or a prayer. However, the machine is also a depiction of a type of person completing an action, for example a clown, a giantess, or a child. The audience is able to locate their experience of the android in realism or fantasy by referring to the materials, the depiction, and the demonstration. These entertainment products will be discussed in this chapter, which seeks to explore the attraction to androids associated with pleasure, beauty and curiosity.

There are three main components to the appeal of the android: the experience of wonder, aesthetic pleasures of beauty and novelty, and their communicative intent.

In the current section, I consider their attraction in terms of beauty, wonder, and pleasure. I begin with a few androids from literature that demonstrate fluidity of roles they were imagined in. I then proceed to discuss pleasure, luxury, and novelty in historical android design. Finally, we explore the role of wonder in the android spectacle experience.

3.1. Creation myths and androids in literature

One's experience of a cultural product is informed by many factors. The beholder's own knowledge of the topic, the object's aesthetic design, and the beholder's emotional engagement with the object may all impact response. In addition, the cultural context of display and interpretation can compound the response as the object dovetails with known metaphysical arguments, fictions, or fantasies.

Android automata reference a conglomerate of cultural signs. Some of the most ancient come from myth and legend, others are newer contributions to an already rich resource. Although today we have many stories that link androids to terrible outcomes for the human race (consider *R.U.R.*, *Blade Runner*, etc), historical audiences did not have these associations. Therefore, we should not anachronistically imagine these myths existed for the beholders of Vaucanson's Flutor or similar androids. It was not until the first decade of the nineteenth century that the first trickle of dark stories about artificial life began to appear in Europe, and not until the early twentieth century that fictional androids pose a danger to humanity.

Most human creation stories begin with life that has been intentionally created by a divine being or event. In many, such as Biblical and Quranic creation myths, the construction of man is a deliberate act by a divine being. "Life" is something with a sacred origin, not to be taken or given lightly. The creation of mechanical people is a different category. With the exception of Hephaestus, who built mechanical assistants, divine beings generally have not been associated with building humanoid machines.

In the Greek view, the boundary between fiction and reality remains intact. Homer's descriptions of artificial servants of Hephaestus is clearly mythological fantasy. Similarly, Aristotle's famous suggestion that "if every tool could perform its own work

when ordered, or by seeing what to do in advance[...] masters [would have] no need of slaves” (Politics, 1253B 35) would have been a preposterous imaginary future. The creation of mechanical people is an act of extraordinary men (Berryman, 2003); the impossible is achieved through skill, not magic.

We have already seen that those who created mechanical humanoids achieved fame and sometimes employment as a result of their ingenuity. The association of ingenuity with artificial life was also imposed on individuals known for the philosophical arts. Albertus Magnus reportedly constructed a bronze head that could answer questions. Leonardo da Vinci and René Descartes, both legendary figures in art and science, were known to have built complex automata of humans and animals. Even Thomas Edison, who did not build androids, could not escape this association. In Auguste Villiers de l’Isle-Adam’s 1886 science fiction novel *Eve of the Future* imagines him as the inventor of an android duplicate of a deceased woman.

Direct experience of mechanical self-movers is not necessary for these devices to have a popular presence. Audiences of medieval French romances would not have had exposure to automata, but may have known about their existence in the Abbasid Empire (Truitt). To the French audience, automata would have been a plausible inclusion in fantasy.

Automata of medieval fiction referenced notions of magic and mystery, the unknown and the unexpected. These fictional automata presided over liminal spaces such as thresholds, bridges, and tombs (Truitt, 172). For example, the gold maidens and youth of the *Chambre des Beautés* provide medical aide, entertain with music and acrobatics, and instruct people on courtly behaviour (*Roman de Troie*, described in Truitt). They functioned in part as protectors of moral or social values, and as guardians or messengers from magical worlds (Truitt, 168). They were depicted in a positive – but unfamiliar – light. Yet automata in French romances could also come from untrustworthy sources such as the exotic (Islamic) east or illicit (necromantic) scholarship (Truitt, Kang). Imaginary machine-men of fiction are located in thresholds and created by threshold-crossers. Their bodies fill the space between man and machine.

As mechanical and especially clockwork technologies became more commonplace, so did machine people in literature. Analogies between man and machine peaked in the seventeenth century in concert with the dominant mechanist perception of the world. Mechanical metaphors of a “clockwork self” were applied with a wide range of characterizations, from the undependable (a reference to the inaccuracies of clocks) or thoughtless, to the endlessly repetitive and the dependably moral (Cohen). Physical analogues between clocks and humans such as between the face, hands, and heartbeat (ticking) became conventional by the seventeenth century (Cohen, 139).

As they had become ubiquitous in everyday life, mechanical inventions permeated English literary products in the seventeenth century (Cohen, 142). The individual and the mechanical converged in language, form, and philosophy. Mechanical people, timepieces that look like people, and the mechanistic anatomy, and literary metaphor developed concurrently (Cohen, 141).

The ubiquity of technology is seen in Shakespeare. In *A Winter's Tale*, Hermione hides in plain sight as a garden automaton. In *Hamlet*, autonomy is at question, perhaps rendering mankind but a “piece of work” in the mechanical sense (Maisano, 69). The metaphoric mechanical person in Shakespeare and Jean Paul comments on clockwork's permeation into culture much in the same way the ‘cyborg’ of the 1990s was considered a comment on the ubiquity of computers in our society (Cohen, 17). Natural philosophers could see similarities between clockwork and the autonomic nervous system. The metaphoric android was prominent in metaphysical inquiry throughout the seventeenth and eighteenth centuries.

In seventeenth and eighteenth century literature, as in its philosophy, mechanical life appears to have been associated with essential questions about humanity and its prospects. Jean Paul's 1786 satire “Humans are Machines of the Angels” highlights the confusion caused by a society that has idealized mechanical, operations-based humans (Voskuhl, *Motions and Passions*, 303). In a story more akin to a late-twentieth-century movie plot, it is revealed that human beings are themselves automata, built by angels to serve their needs. Despite their divine origins, however, Jean Paul argues that humans are superior to their machines (Voskuhl, 302).

In the late eighteenth century, at least for one writer, there was a plasticity of perspective about the future of artificial humans and their creators (Douthwaite and Richter, 393). Francois-Felix Nogaret's *Le Miroir des événements actuels, ou la belle au plus offrant: Histoire à deux visages* (1790), it is science and technology demonstrated with androids that can win the hand of the princess Aglaonice. The android flautist wins her heart, and his inventor wins her hand and the throne of France.

Le Miroir was a political brochure that hoped "the Revolution might spark a renaissance of artistic and scientific invention" (394). It proposed a connection between the creation of affective androids and the ability to improve a nation's financial and technical prospects (Douthwaite and Richter). In 1795 and 1800, Nogaret published further versions of the story, now a conventional romance, titled "Aglaonice ou la belle au concours". He reframed the inventors as lovers rather than reformers (384), and of the androids as trite amusements that "smacked of old regime gentility" (399). Over the course of less than a decade, then, for Nogaret and perhaps his paying audiences, the appeal of mechanical invention transformed significantly. Redemption of a society and economy could no longer be achieved with technological spectacle.

In these examples, fictional androids are not specifically terrifying intervenors. Rather the mechanical person prior to 1800 signifies the ambiguous threshold between magic and mechanism. As a mechanical device it signifies the achievements of man. On the threshold between real and dream, the android is distinct from humanity by its excess of skill and beauty and its lack of soul. It signifies the physical presence of the magical, the incomprehensively complex, the impossible.

Whether a mysterious inhabitant of a magical world or the achievement of a superior mechanic, the idea of the android has had a persistent life of its own that overlaps its realization. The android is experienced through rich layers of meaning built from the combination of its metaphoric and its semiotic expressions as both a physical and a literary object. These layers inform the audience's response, calling to mind the remarkable mechanics of legend, the grey borderlands between machine and person, and the hopes of a bright future.

Product experience is informed by the aesthetic design, the subject's history and experience, and the emotional engagement with the object. The android's layers for interpretation may include its similarity or difference with other nonliving exhibits the individual has seen, may connect with a metaphysical argument, may inspire a fantasy, or may call to mind a story he heard a long time ago. The individual may experience a moment of surprise and fascination called "wonder."

3.2. Wonder

The methods and themes of early modern automata building were based on the translated texts of Hero of Alexandria. These works had a formative impact on the development of automata in Europe as they traveled through medieval Turkey and into sixteenth century Italy. The influence of Hero's designs is evident in their consistent reproduction from their development in 75 AD to their implementation in seventeenth century grottoes. For example, the singing birds at the Fontana della Civetta (1581) in Tivoli, Italy are obviously a heronic design. The confluence of the translation of his work and the advances in fine machinery resulted in the burst of ingenuity of the sixteenth through eighteenth centuries automata design.

Hero's texts did not only include information about how to build marvellous objects. They also included information about the display, design and presentation of automata to audiences that influenced sixteenth and seventeenth century grotto and automata designers. The texts contain a perspective about the intended effects of automata that also travelled with the development of automata. His *Automata-Building* and *Pneumatica* also appear to consider luxury or entertainment machines on a par with machines of more obvious utility (Tybjerg).

By juxtaposing useful and wonder-provoking machines in his texts, Hero implies that these two categories are not exclusive (Tybjerg, 448). Machines can be both useful and wondrous. The mechanic is a designer as well as an inventor: Hero determines the use of the machine by the design of the case. The same technology that draws water for fire protection in miniature becomes a pump for perfume. The focus is on what that technology can accomplish, what effect it has in its different forms.

Hero's presentation of mechanics shows that these effects are not to be regarded "merely as entertainment" (Tybjerg). The beholder goes through a learning process as he views automata. In this model, the machine's case and action attracts the first order of wonder. Whether it is the flute-playing faun, a child drawing, or a gold statuette of Diana on her stag, the form and its movements are the focus. There might be a gasp of surprise or a widening of fascinated eyes. The object may have beauty or be extraordinarily large or small; it may be hyper-realistic or it may seem as something from a dream. "The eye of the inexperienced is struck with amazement by these things; for such persons marvel at everything that takes place without warning, because they do not know the causes" (Seneca, Ep. 88.22). It is remarkable.

For Hero, the next stage is one of inquiry where the audience acknowledges that the wondrous object before them is not magical, it is a machine made by a man. "We will wonder at things which, when we have proved them, are contrary of what is known to us" (Hero of Alexandria, in Tybjerg, 449). They then move from experiencing wonder as a sensation to actively wondering about the object. The audience moves from wondering at the effect to admiring its cause: the maker. In Hero's view, the goal is to illuminate the achievement of a specific individual, to move from "isn't that amazing" to "isn't its creator amazing".

Heronic wonder has two functions. The first, as described above, is to promote the originator of the wonderful device. This enables the originator to gain clients and influence, as Vaucanson enjoyed following the display of his automata. The second function is to spark intellectual movement. Wonderment is not the goal. It is a transitory period between stages of knowledge, part of a process of understanding that moves from the magical to the mechanical and scientific.

Producing wonder is also a way to "create an image of expertise" which supports the theories underpinning the objects (455). By hiding the works inside the case, Hero creates a "boundary between the spectacle and the mechanism that controls it" (457). In this way he privileges the elite who can perceive the causes behind the spectacle. The Heronic wonder-work, then, is a machine that by ingenious design and mysterious operations, elevates the mechanic to the status of a god. I cannot imagine a single android that does not simultaneously showcase itself and its maker.

Even though Hero's expertise was practical rather than mathematical, in a Greek model it can be justified as cunning intelligence, *metis*, exemplified by Hephaestus, Athena, Odysseus and Prometheus. This elevation of entertainment is done in two ways: firstly through language in treatise form, and secondly by using mythological and sacred subject matter in the automata depictions themselves. "Wonder associated with myths is translated into the wonder sparked by the exhibition of mechanical skill and expertise" (Tybjerg, 462). Against sixteenth and seventeenth century detractors of automata's value, mechanics sought to justify their craft by suggesting that automata elicit a special response associated with knowledge (Marr, 151). Sixteenth century automata and garden designer Salomon de Caus also sought to dignify his trade by invoking imagery of Archimedes, Hephaestus, and the elements in the Frontispiece of his treatise (Marr, 156). Hero and android makers after him linked entertainment engineering to a higher purpose, whether it is experimental (as with Vaucanson's Flutor), educational (as with Fontana's devils), promotional (for Jaquet Droz), or philosophical (as with Ishiguro's Geminoids).

Although today wonder is a close relative of credulity, in pre-nineteenth century Europe the sensation was a cultivated response. From the medieval period and into the early eighteenth century, wonder served as a gateway to analytical thought as well as to delight (Daston and Park). Elite audiences engaged in a refined curiosity, demonstrating their ability to appreciate the unusual and gain useful knowledge therefrom. Wonder could "evoke awe, destroy previous conceptions, blur the opposition of nature and art, and provide tantalizing hints regarding the true order of nature" (Nadis, 8). In Plato's *Theaetetus* and Aristotle's *Metaphysics*, wonder is the source of philosophy, inquiry and knowledge. Francis Bacon considered this response to lead to intellectual and scientific investigation (*Organum*). Wonder in this sense is a question asked by both reason and passion in one voice.

Wonder could be evoked by unusual events, objects from nature or by man-made items. "For all men begin, as we said, by wondering that the matter is so (as in the case of wondrous automata or the solstices, or the incommensurability of the diagonal of a square with the side; for it seems wonderful to all men who have not yet considered the explanation that there is a thing which cannot be measured even by the smallest unit)." (Plato, *Theaetetus*, in Tybjerg 463).

Anatomically-informed simulations of living things such as the lifelike automata of Vaucanson in this context were designed to engage both reason and wonder. The Flutor was designed as an analytical model of the air- and mouth- movements required to play the flute. Other projects, such as speaking, bleeding, and digesting machines, investigated functions of the human body that could not be explored through anatomization alone. They impressed the scientific community first through artistry, then through reason.

Excitement about new discoveries in science and global exploration, largely due to developments in fine technologies such as astrolabes and microscopes, translated to a new enthusiasm for scientific and artistic spectacle in the seventeenth to eighteenth centuries. Many lucrative and exciting offerings became available to the mass public. Yet the popular nature of scientific curiosities did raise concerns that the “trivial thirst for mere novelty” was distorting science in favour of fashion (Terpak, 523). In addition, opportunities for individuals to unite in common experiences were also opportunities for the Estates to level in a democratizing and revolutionary manner (Goodman). The new mass culture downgraded the educated curiosity by the few into an ignorant wonder by the public at large (Daston and Park).

One goal of automata building, drawn from Hero, Aristotle and Plato, may indeed have been to elevate the knowledge of the viewer through wonder and surprise. In a spectator culture driven largely by novelty and aesthetics, it is difficult to imagine audiences remaining with individual automata long enough to build knowledge. However the partial failure of this goal to be met from the mid-eighteenth century onwards does not appear to have impacted the success of automata as entertainments. More is at play than wonder.

3.3. Pleasure

The experience of aesthetic pleasure can be said to be a combination of “sensuous delight, meaningful interpretation, and emotional involvement” (Hekkert, 159). Positive sensual response to aesthetic beauty may be a by-product or reward for perceiving patterns, simplicity, unity in variety, and congruent quality, which could have

contributed to the evolution of human beings by informing us about the nature of what we behold. Unity, symmetry, and pattern predictability all help us to identify secure locations and safe species (Hekkert). These principles, though their impact on individual response may vary, can be considered universal due to their contribution to the evolution of human beings.

With all the attention to beauty in historical android design, and, to a lesser extent, in modern lifelike androids, it is obvious that aesthetic experience was a key concern for automata makers. “Al-Jazari was obviously more concerned with creating an aesthetic experience one could dwell upon” (Nadarajan, 2007, 14). Nadarajan proposes that aesthetically pleasing technologies are “not an instrumental object first and then a pleasurable object also”. Form, functional capacity, and pleasure are indistinguishable from one another in such machines. Automata were not only beautiful, but their motions were enjoyable as well. Lifelike, precisely-timed movements, and a variety of subject matter all contributed to pleasure for the audience (Marr, 161). The pleasure stimulated by fine craftsmanship was even criticized for inspiring vain or useless curiosity (Marr, 162). By design, these technological wonders produced many sensory pleasures in their audiences (Nadarajan, 265).

As described in the previous chapter, automata were used in extravagant events that established a communal context for automata associated with celebration, fantasy and leisure. Automata of humans and animals have often been components of a *mise en scene* of power and resources, one more marvel in a sea of unusual and surprising entertainments. When displayed at the English summer fairs at Covent Gardens and Vauxhall Gardens in the late eighteenth century, automata of all kinds were part of a conglomerate of spectacles that referenced notions of technological progress, fantasies of wealth, and awe-inspiring beauty (see Altick, Terpak, Daston & Park). Similarly, parades, banquets and processions were venues where androids performed amidst puppets, parade floats, exotic animals and plays.

Mechanical humanoids also competed for audiences with exhibits of exotic foreigners and human monstrosities and other non-living spectacles. Common at the time were tableaux and wax displays that, in general, depicted dramatic or bloody scenes from biblical or martial history. Some waxworks employed automata to

humourously surprise audiences such as one at Mrs. Salmon's which kicked guests on their way out (Altick, 52). Écorchées, wax anatomizations, and autopsies were also popular spectacles that featured macabre, non-living human depictions. Yet androids, for the most part, were beautiful and life affirming.

Culture and personal experience inform one's interpretation and emotional involvement of an aesthetic object. Pleasure is powerfully influenced by the imagination and essential beliefs held by beholders. "Imagination serves as a tool through which to achieve certain forms of transcendent pleasure. We have the power not only to try to connect to a deeper reality, but to envision what this reality might be." (Bloom, 2010, 221). Our experience of an object is informed by a set of characteristics so deeply linked to that object it becomes essential to its nature. The object is loved, not for its exterior, but for its essential nature that the beholder connects to. A child's favourite toy, once lost, cannot be replaced because even if identical, the replacement has not been imbued with whatever unique essential nature was applied by the child's imagination. So too, Bloom argues, objects are imbued with value based on various factors. For example, the sudden increase in monetary consideration paid for art by a recently deceased artist may indicate that death alters the value of one's possessions and creations. Bloom's research shows that our enjoyment of people, places and things has more to do with how we have applied value to those objects.

The eye is more than satisfied by the display of automata, but the mind, too is engaged. For a seventeenth century automaton viewer, there was a conceptual enjoyment at play: delight in awareness of "an infinite number of Strange Motions, which appeared not at all to the eye" (Jacques Gaffarel, 1630, in Marr, 161). Similarly, the automaton clocks of Al-Jazari would have been an enticing way to experience time (Nadarajan, 265). The "automotive pleasures elicited by their movements provided one with a sense of the passing of time as such," altering the experience of time for audiences. In other words, automaton clocks created pleasurable events out of the continuous flow of time.

That automata were enjoyed by their audiences is supported by their consistent use as entertainments over the past four hundred years. It is also supported by documented audience responses. The audience "gazed with feelings of partial awe and

entire amazement” on the Chess-Playing Turk (Ohl and Arrington, 61). Jacques Gaffarel described his spirits as “ravished with the sight” of “admirable inventions of some certain instruments, Images, and Figures” (in Marr, 161). Reported in Paris and syndicated to London and Philadelphia, the viewer of a French automaton violin player found the performance so extraordinary he “felt as if I was lifted from my seat, and burst into tears – in which predicament I saw most persons in the room” (The Parlour Review and Journal of Music, 1838, Volume 1, No. 5). Charles Babbage found the silver dancer automaton “irresistible” (in Schaffer, 1996, 55). Audiences appear to have been “enchanted” by *La Joueuse de Tympanon* and *La musicienne* (Voskuhl, 304). Kang uses the term “captivated” numerous times when describing audience reactions. Even the audience subjected to the unbearable stench from the Duck’s artificial flatulence wrote, “we wish to express to the artist-inventor the pleasure which this demonstration gave to us” (Gaines, 202).

Audiences were overcome by artificial life. Such an intensity of response was frequently associated with the experience of moving automata (Marr, 161). This evidence, above all, indicates that historical automata were stimulating entertainment objects that powerfully affected their audiences on a visceral level. There was something sublime in this viewing.

3.4. Aesthetic Style: Luxury-novelty

Androids produced pleasure in audiences on a sensory aesthetic and an intellectual basis. At first blush, they appear as technological wonders, but it is worth taking a moment to consider the lack of actual development in android technology over the centuries. The basic methods and materials remained consistent with very few developments after pin-and-barrel and escapement mechanisms enabled timing and programming of action. The specific mechanisms that enabled action were also, with the exception of machines exhibited to academies of science, hidden from view. It is evident that the aesthetic design, depiction of subject matter, and association with celebration was key to androids’ ongoing success as entertainments.

English audiences of the eighteenth century were consumed with a “restless pursuit of novelty” (Berg, 19). Novelty of design added special value to exhibits (Pointon, 425). The audience’s imagination was fired by exotic imagery and excited by new possibilities for technological progress (Altick, 64; Cohen). Automata makers were successful by exhibiting and selling a wide variety of depictions within the luxury design style. James Cox’s elaborate automata were things of pure and exotic beauty that possessed a global cachet resulting from his association with the Chinese Emperor. Baroque aesthetics involved an “obsession with wonder and novelty, surprise and pleasure” (de Renzi, 10). Though the internal technology did not change, each piece comprised a new combination of gold and sparkling gems, tinkling bells, and pastoral or exotic depictions designed to please the eye, the ear and the imagination. They engage an audience in a first order of delight; even today, online videos capture the audience’s joy at the operation of James Cox’s golden and bejeweled *Peacock Clock* in the Hermitage Museum of St. Petersburg.

There is irony that images with simple, repetitive action would be of interest to an audience obsessed with novelty. However like other technological spectacles of the eighteenth and nineteenth centuries, such as microphotographs, panoramas, and magic lanterns, audiences were attracted by familiar subject matter presented in new, mechanical ways. Aesthetic pleasure arises in part from identifying similarities and patterns amongst objects (Hekkert, 166). For some members of an eighteenth century audience, the congruence between a mental model of a mechanistic world and a mechanical model of an organic figure may have been gratifying. Multiple variations on a mechanical theme in general would have also stimulated the satisfying action of compare-and-contrasting.

These luxury spectacles were gilt and decorated entertainment devices not intended to mimic living. They operate as beings from a dream, carrying out the actions of living things within the trappings of a wealth fantasy. The silver swan catches a glittering fish to the sound of tinkling bells. The gilt boy’s pineapple opens to reveal singing birds. The product is one of delight and wonder. The moving image of dream is no intervenor in the role of humanity. It is a diversion, and nothing more. It may charm, but it is unlikely to produce the sublime enchantment described in the previous section.

Automata designed for the luxury-technology market lasted only a few years in the grand salons of Paris and London before being replaced with new iterations. Spectacles that attracted audiences on the basis of novelty faded from public view quickly unless they had content that could change. Ballooning as a mass spectacle sustained widespread interest for less than a decade. Slide-mounted photographs (microphotographs) were an equally brief trend. Even academic interest in these fleeting popular amusements has been low to date.

3.5. Aesthetic Style: Lifelike-Domestic

In the eighteenth century, the mimetic potential of automata began to be realized. Verisimilitude in behaviour, construction and design was the result of cross-discipline collaboration from fields beyond horology and jewelry, such as anatomy, art and medicine. They created unusually realistic life-simulations like the Lady Musician and Vaucanson's Flutor, machines that breathe and purport to humanness by virtue of their actions. Lifelike androids had colour in their cheeks, breathed, and sighed. They gave the impression, not only of life, but of conscious life. Were it not for their small stature, they could sustain an illusion of life for the time it takes to take a second glance. Lifelike androids of this period are secular characters engaged in peacetime activities, bearing little thematic relationship with competing tableaux of soldiers, saints or devils. Their depictions can be described as domestic in nature, a scene one could expect to be played out in one's own home.

The lifelike androids of the eighteenth century depicted realistic, though diminutive, people doing ordinary actions. For example, the androids by Jaquet-Droz complete activities of educated and accomplished young people. Their behaviour is encoded to match that of living people and thus be understood. The Lady Musician's performance is, literally, a text-book performance that matches recommendations for emotive performance by C.P.E Bach (Voskuhl). Similarly, *La Joueuse's* bowing, eye movement, and expressive pauses lend realism to her performance.

Mechanical models represented well-known objects, animals or mythological forms in a spectacular way, producing pleasure. The sixteenth to eighteenth century

depictions by historical androids are focused on cultural activities such as drawing, writing, and performing music. Secondary actions in the androids are breathing, sighing, eye movements and pregnant pauses. The secondary actions add realistic movements to already realistic forms. Nineteenth century lifelike androids added smoking, sleeping, sewing and laughing to their depictions of everyday life. Today's androids have lifelike appearance down to their pores and sing, question, and respond. The entertainment value of this type of pleasure has outlasted cultural and technological changes.

Lifelike historical androids were reproductions of idealized individuals and experiences in three dimensions and real time. They rendered an everyday experience, formerly lost in the recesses of memory or translated into static image or word, into a spectacle with the potential for infinite repetition. The lifelike androids had the capacity to mythologize and mechanize life, to make the domestic and ordinary fascinating. They "retained their wondrous aura" and represented the "marvels of the machine in the everyday world, devoid of preternatural magic" (Kang, 121).

It should be obvious that historical androids could not be mistaken for a living human being. They were smaller than average people. More importantly, they lacked the complexity, variation and fluidity of motion possessed by all living things. Essential to the audience's enjoyment was the notion that the illusion of liveliness was created by technology (Schwartz, 153). The smallness of these androids assists in the awareness of technology, the dance between the illusion of life and artifice. While the natural child or duck may not have been wondrous, automata of the same were triumphs of ingenuity and a firm dismissal of utility (Daston and Park, 287). Lifelike imitations of nature and culture were astonishing to audiences (ibid). The audience engages with something familiar and domestic, presented in a novel and surprising medium. In the seventeenth and eighteenth centuries, this may have contributed to their continued success as exhibits when androids seemed to illustrate materialist arguments with respect to the soul's physicality.

Like luxury automata, lifelike androids appeal because of their workmanship and subject matter depiction. In the eighteenth century, all automata were unique, hand-made artisanal products. Mass production that resulted in multiple identical automata did not come about until mid-nineteenth century Paris at the studios of Roullet-Decamps,

Vichy, and others. The luxury and the lifelike androids were both high quality objects that delighted audiences.

Verisimilitude, it turns out, has staying power. Those androids that toured for the longest periods were more lifelike in looks or action than those that were successful only on the basis of design novelty. The three extant Jaquet-Droz automata have been displayed on an almost continuous basis from 1774 to the present (<http://history-computer.com/Dreamers/Jaquet-Droz.html>). Vaucanson's duck, Pipe-and-Tabor Player, and Flutor were displayed from 1739 until around 1805. Baron von Kempelen's Mechanical Turk toured from 1770 until it was finally revealed to be a puppet in 1820. The length of these tours is a testament to the continued delight and interest audiences had in these automata.

Wunderkammern, "informal centers where like-minded men of inquiring bent could meet, compare notes, exchange specimens, and, in effect, pursue their education" (Altick, 10), and later museums, were one of the many locations automata could be found. Automata reigned supreme amongst the various artefacts in *Wunderkammern* "because they seemed to possess Aristotle's first and foremost hallmark of the natural, an internal principle of motion" (Daston and Park, 281). An object with the ability to walk or dance "seemed to border on artificial life" to those steeped in the medieval Aristotelian tradition (Daston and Park, 281). It was verisimilitude of action and design that attracted audiences: ever more exact imitations of nature's products hybridized art and nature.

I have come to believe that lifelike androids are more fascinating to audiences because of an ambiguity inherent in their design. One has a sense they are more than what they seem and less than what they could be. These objects draw a peculiar visual analogy between audience members and androids that encourages the beholder to reflect, not on fairy tales come to life, but on everyday experience rendered mechanical. This transformation of the familiar stimulates the mind and heart in unexpected ways.

3.6. Leveraging the Effect

In this section we have explored the appeal of the android, as an object that has interested audiences and produced intense reactions in its viewer. Like a painting, or a

film, the depiction attracts more attention than the technology. Technological innovation is only one small piece of the attraction to automata. Audiences did not attend automata shows to see gears in motion. Clockwork and hydraulic mechanisms are hidden inside the case or otherwise out of view. Instead, they came for the exterior depictions, seeking surprise, novelty, beauty, verisimilitude. To satisfy an audience of automata that may be lukewarm or pleasantly surprised by automata, like that depicted in Fanny Burney (Burney, Letter XIX), ever-new designs with virtually identical internal works were created. And so the automaton sits firmly as an aesthetic rather than as a technological object. The object evokes a response and the image transcends the medium.

The evocative powers of lifelike and luxury automata have been leveraged to form relationships, build knowledge, and demonstrate ideas. When prestigious expenditure was a standard aspect of early modern courtly relationships (Breuttner, 602), automata were components of competitive gifting and elaborate banquets. Both James Cox's automata for the Chinese emperor and those commissioned by Duke Phillip the Good of Burgundy fit into this category. Relationships between powerful bodies were negotiated, in part, with the assistance of objects that delight. The wonder evoked by these objects encourages audiences to associate their creators or patrons with wealth and the power to achieve the impossible.

Demonstration of ideas has long been a part of automata design. From Philo and Hero's demonstrations of hydraulics and pneumatics, to Vaucanson's demonstration of chemical digestion, automata have been used to make abstract notions concrete. The excitement of an audience faced with a remarkable device is easily transferred to excitement about the thing it is demonstrating.

Honda's ASIMO robot serves as the ideal transmitter of the notion that Honda is an advanced leader in the technology industry. Similarly, in the seventeenth century, the Jesuits had become "major suppliers and collectors of natural and artificial wonders", using machinery and spectacular devices to promote the supremacy of a Christian worldview (de Renzi, 10). They presented new tools, such as astrolabes, automata, and magic lanterns, in a parade of wonders intended to seduce communities in Europe and Asia (de Renzi, 10). The potent combination of science, religious mystery, and visual and aural beauty was united in automata.

In addition to stimulating associations with wonder, knowledge, and prestige, automata as moving images are part of a category of objects collected and designed for a communicative purpose. They produce an effect in the audience that may encourage inquiry or that may further entrench the separation between the ignorant and the knowledge elite. Their depictions guide the audience towards a conclusion designed by their maker.

The two styles of automata, verisimilitude and luxury, were developed and displayed concurrently. Regardless of which style was used, automata were both beautiful and interesting, employing a variety of tools to maintain interest and bring paying audiences back for more. They used surprise, timing, aesthetic beauty, accuracy of depiction and even humour to entertain. Verisimilitude teases audiences with an unspoken promise – that there may be something more than meets the eye. Like other enigmatic works of art, lifelike androids make a mysterious proposal, attracting audiences to a question rather than to an answer.

4. Androids – Mechanism and Metaphor

Since antiquity, technological parallels have also been employed to explain organic processes. The use of technological parallels to explain organic processes does not necessarily indicate a belief that organism and technology are equivalent (Berryman, 2003, 360). Mythological and theoretical substances like Aristotle's *pneuma* place no constraints on how something may work. In contrast, mechanistic explanations may be informed by knowledge of actual machines. The analogy drawn with mechanical tools "has considerable power to direct investigation away from some answers and toward others" (362).

Mechanical entertainments and monumental clocks, as described previously, depicted the world and its contents. Clockwork technology is by nature regular and controlled, without the capacity for the random and unexpected. The depictions of nature and human society were also depictions of an idealized world made orderly by human control. Many philosophers found this attractive. With arguably the greatest impact, however, René Descartes was inspired by these depictions. He found automata to be a physical reflection of his own mental model of a mechanistic body, suggesting in *Discourse on Method* that this model should not appear strange to those who are acquainted with automata. It may be of interest that mechanical entertainments for elite gardens and banquet tables became popular in the same period that the mechanistic worldview was most dominant. Mechanical models for entertainment co-emerged with mental mechanical models for physiology throughout the early seventeenth century.

Because mechanism and automata have been so well described by others, this chapter only briefly addresses some of the principles of materialism and vitalism before focusing on music-playing automata and the musical automaton-man as a nexus for such debates in the eighteenth century. Eighteenth century baroque music, musicianship, and musician automata were interpenetrated by mechanist philosophy. Although musician androids were designed with entertainment as a primary focus,

fundamental arguments about the distinction between human and machine rebounded from these devices. By the time very realistic androids were playing music, vitalist physiology was once again becoming popular.

4.1. Materialism and Vitalism

Our efforts to understand the mysteries of life, animation, and unseen processes may be placed on a continuum between two extreme positions: materialism and vitalism. The former traces its philosophical lineage to Democritus, Epicurus and other Atomists. The material world is a closed system made up of elements that combine to produce all living and non-living things. Consciousness, will, and life itself are the results of chemical or elemental transformations. Materialism suggests there is no immortal soul and no (divine) outside control source.

In contrast, vitalism found expression in Aristotle and other dualists who proposed that there is an “unknown principle” or life force separate from the body that animates the inanimate and governs organs, bodies, and even economies (Packham, 2002). Vitalists, with limited consensus (Wolfe and Terada), tended to focus on vital *forces*, as opposed to *substances*. Vitalism is consistent with spiritual perspectives that believe in the existence of a divine being and an immortal soul. Living matter is fundamentally distinct from non-living substances because it is endowed with “sensation and movement” (Wolfe and Terada, 540).

Early modern scientists wrestled with key questions relating to various unseen physiological functions such as reproduction, digestion, and circulation. In the mid-seventeenth century, advances in fine technology such as microscopes rendered the invisible visible. Materialist-mechanist perspectives drew parallels between divine creation and human invention. “For the mechanists, God became a clockmaker and an engineer constructing and directing the world from outside” (Merchant, 225). The machine metaphor reordered nature and the body. In the mechanistic view, “cosmos, society, and the human being [were] construed as ordered systems of mechanical parts subject to governance by law and to predictability through deductive reasoning” (Merchant, 214). Mechanism and rationality were the means by which both progress and

certainty could be achieved and measured. By the eighteenth century, the mechanistic worldview could be credited with many of the accomplishments of European industry.

Despite its successes, in the early eighteenth century strictly materialist physiology “was being challenged and replaced by a conception of nature as having its own internal forces and animating energies through which it could be understood to be independently self-regulating and self-preserving” (Packham, 470). This argument has historically depended on unanalysable qualitative features such as *pneuma*, sensibility, and the soul to act as a “vital property of matter” (Riskin, 2003, 99). Lifelike simulations such as the lifelike androids described in section 3.2 modelled the proposal that “animal machinery,” being the operating, organic body, “was directly responsible for all vital and mental processes” (ibid.). Today, the question of “presence”, that intangible sense of an individual’s being, is being asked with the assistance of Ishiguro’s Geminoids.

Androids are viewed as important participants in early experiments in artificial intelligence and artificial life by Jessica Riskin. She considers historical androids as prototypes of artificial life and embodied artificial intelligence. Androids and self-moving models were early experiments in created life comprising artificial structure, behaviour and excretions (Riskin, *Origins*). By using life-like materials and producing life-like motions, eighteenth century android designers were making some of the first steps into experiments with artificially animated forms that could simulate living things. For Riskin, the distinction between simulation and imitation is crucial to support a link between the present day artificial life and that of the Enlightenment. Riskin cautions scholars not to assume that the impulse to create life is some sort of “timeless quest”, but rather that the project has “transformed foundationally from each generation to the next” (Wetware, 99).

Heronic automata were designed to excite the admiration of the audience, to bring about wonderment and awe at the remarkable imitation of life. In the eighteenth century, the invention of simulative automata developed, not from a desire to imitate life, but from an effort to use experimentation to test the philosophic limits of life (*Origins*, 604). Automata were used by Vaucanson to define not only the limits of life, but also of humanity itself. Both androids and automatic silk looms were instruments that defined the upper and lower limits of humanity (*Origins*, 624). Far from being trivial toys,

automata were tools with which to “study the relations between the outer and the inner: form and process, bodily movement and physiology, action and thought” (Origins, 627).

Mechanistic explanations of living processes were of particular service to materialist physiology. Vaucanson’s duck waddled into the debate to make a point: living things are machines and their processes are chemical. That the ‘digestion’ performed by the duck was a trick is irrelevant. The duck, like the well-designed promotional presentation it was, appealed to sensibility over sense. Mechanical replications of natural movements had an evocative power over audiences, representing an argument for (or against) a mechanistic explanation (Kang, 2011). The ongoing tension between materialism and vitalism placed physiological concepts around living and nonliving substances under duress. At the same time, fundamental distinctions between living and nonliving beings were placed under duress through the display of mechanical people.

4.2. Android Demonstration - music and the soul

Mechanical models of living things pose a challenge to the “argument that there is a distinction in kind between living and nonliving things” (Berryman 2003, 366). Mechanical models of human beings go a step further, challenging the notion that humans are distinct from machines. By simulating both the interior and exterior of living things, automata in the mid to late eighteenth century reduced the theoretical distance between living and mechanical things (Riskin, 99). As Riskin points out, “If life was material, then matter was alive, and to see living creatures as machines was also to vivify machinery” (99). To demonstrate the philosophical reverberations that occurred as a result, musical androids will now be discussed.

The Turing Test measures if artificial intelligence can pass for human. If an artificial intelligence can sufficiently approximate human interpersonal communications and knowledge architecture in casual conversation, it is said to have succeeded. Other cultural activities have also been battlegrounds for a form of ‘human’ test. Most recently in a testament to the “information age,” knowledge of trivia was tested on the television game show Jeopardy (Watson vs. Jennings, 2011). Until then, chess was the traditional symbol of uniquely human ability. This was the battleground for artificially represented

reason (Turkish Chess Player vs. Benjamin Franklin, 1783) and for computer-generated reason (Deep Blue vs. Kasparov, 1997). These have been special events marketed to a spectator audience.

While knowledge-based games are amusing for the public, they are not the only actions that could be perceived as essentially human. Music has a well-documented ability to affect the emotions and is associated with ineffables such as divine inspiration. Spectators participate in musical performance by being affected by its expression.

Music also has technological qualities equal to its divine and affective ones. Technical skill is required to perform or create compositions. Mastery of an instrument is a curious combination of mechanical skill and emotive expression. A fusion between instrument and operator occurs in truly great performances. The cognitive field of the musician has extended into the instrument itself: the tool and the user have melded (Andy Clark). In music, the motions and passions have always been combined.

During effective musical performance, the synergy of man and machine produces sounds that transcend the boundary between the physical and emotional-spiritual existence. As a result, music has been and continues to be one site of arguments about what makes us uniquely human. Music was one of the first human actions to be fully automated by early programmable devices such as the carillon, wind harp and water organ. It is not surprising, then, that musical performance was one of the most common android activities during the sixteenth through nineteenth centuries. The sense of human automatism apparent in high-speed, virtuosic musical performance was also fodder for materialist arguments such as were presented in Julien Offray de la Mettrie's essay *L'Homme Machine* (1747). Music-playing automata have been the subject of study by musicologists and historians such as Emily Dolan, David Yearsley and Adelheid Voskuhl, among others, for these reasons.

Music formed an integral part of the culture and definition of humanity. In Church, it marked the passage of time and subject of meditation. In court, it highlighted the glory of the ruler. In homes and concert halls, it provided a focus for social activity. And in the development of artificial life, it demonstrated the possibility of art made by machine. The human celebrities of the eighteenth century were the musicians: virtuosic singers,

keyboardists, and violinists. Similarly, the famous androids of the same century were also musicians.

Automation of music has a rich history of its own as inventors have sought ways to eliminate the human component of the performance. Philo of Byzantium designed organs and harps that performed set compositions as a result of water or wind movement. The origins of programming languages stretch further back than Vaucanson and Jacquard's looms to the carillon, an instrument that played bells programmed by pin and barrel. Automated and randomized composition, too, became Baroque parlour games as that period's music had become dominated by programmatic and mathematical chord relations. This field has been explored by Dolan, Leitchentritt and Richards among many others.

In his survey of eighteenth century mechanical instruments, Ord-Hume makes the important point that self-acting instruments were not marginalized novelties. Musical technology was integrated, much as it is today, in the everyday lives of cultural participants. As entertainment media, automated instruments such as barrel organs and flute-clocks existed side by side with other musical instruments (171). The various kinds of mechanical music also served as a democratizing and standardizing cultural force in the eighteenth century.

Many composers in the seventeenth and eighteenth centuries, including Mozart, Handel and Beethoven, produced compositions to be performed by automata enclosed in town-square flute clocks and attached to church organs. The artefacts that have survived are "musical time-machines" that enable us to hear music as it was intended to be played without the imposition of new interpretation (Ord-Hume, 169). In that era of virtuosic performance, composing for machine "afforded the composer a greater degree of control over the interpretation of his music" (168). It also enabled composers to draft music almost unplayable by a human being, as Mozart did in KV 608, expanding virtuosity beyond human limitations.

Baroque musical composition also referenced a mechanical worldview. For example, a musical mechanical metaphor can be detected in Bach's *Art of Fugue* (Yearsley). Canonic and contrapuntal writing is by nature formula and rule based, and as

such lent itself well to baroque experiments in automatic or random-number generated compositions based on dice rolls and tables. Baroque music contrasted free, naturalistic melody or virtuosic display against canonic artifice in a sort of musical dramatization of materialism and vitalism. Yearsley suggests that in the longer canons the “mechanistic, self-generating aspects of canonic writing” were exaggerated further to contrast against long episodes of “naturalistic” genres. While at first the canons may mimic the “fluidity of natural thought,” their ever expanding, mathematical cyclical action results in the creation of ever-larger forms. These forms, Yearsley suggests, first “seem to be ‘normal’” but are soon discovered to be “awkwardly, eerily, and profoundly unlike the kind of musical discourse they approximate so well” (190). The result is a musical investigation of the conflict between mechanism and vitalism (ibid.).

Human musicianship, too, was affected by mechanistic worldviews. J.S. Bach’s musical performance has been described as accurate, efficient, expressive but dispassionate (Yearsley, 173). While musical performance in the late eighteenth century was not to be machine-like, the methods for producing appropriate audience response were represented in technical and formulaic terms by eminent musician-pedagogues Joachim Quantz and C.P.E. Bach (Voskuhl, 2007b).

Musical automata invited reflection on the nature of art, the source of human genius, and the possibility of replacement by machine. Music itself was a prominent feature in both materialist and anti-materialist arguments. It was an example that could be used equally for both sides of the debate. In “De machina et anima humana”, Balthasar Ludwig Tralles cited music, mathematics, conversation and religious activity as proof of the immaterial soul (Yearsley, 180). In contrast against La Mettrie, Tralles used musical performance as the perfect example of man’s *mechanical* essence.

In 1754, Leipzig theologian Johann Michael Schmidt invoked J.S. Bach’s music as proof of the irreplaceability of human composers. Only the human soul could interpret the beauties of Bach’s music. He argued that the soul is necessary for appreciation, performance, and judgement of music (Yearsley, 181). Indeed, Schmidt went so far as to say that Bach’s music alone was enough to topple all of materialism’s apparent achievements (Richards, 383).

Bach's music was designed with precision according to complex rules of harmony and form, and in many ways is as encoded as the pins controlling the movements of the Flutor. The structure and rule associated with Bach's music connects it strongly to mechanism/materialism. But the expression of myriad passions amongst contrapuntal harmony, hidden Lutheran hymns, and his coded symbolic-harmonic semaphore is fundamentally human. Bach's compositions articulate the soul's relationship with God.

The implications of a musical machine for performance and enjoyment were not lost on German musicians. Bach's performance style had a powerful analogue with Vaucanson's Flute Player; mechanical music was already effectively present in Europe by the time the android was exhibited. Was it necessary to have a human soul to enjoy music? What about to perform it? The assumption was that only one who both understood and responded to music was able to perform it. Could it be that a "human soul might not be a requirement for the enjoyment and understanding of music" (Yearsley, 179)? Musical android automata tested late eighteenth century questions regarding the constitution of rational and autonomous selfhood (Voskuhl, 2007b, 311).

In these ways, baroque musical culture reflected and reinterpreted mechanistic perspectives. Automated musical performance was not unfamiliar to audiences in church and in town. Performance style and composition methods were based in rationality, harmony, and mathematics. Sentiment and mechanics were in constant interplay in baroque and early classical musical performance. At the core, however, musical performance was considered "a form of communication between the soul of the player and that of the listener": a "soulless machine could never achieve human profundity" (Yearsley, 179).

Some argue for the supremacy of flesh and blood in art. In response to the Flutor, Quantz said "Indeed it would excite astonishment, but it would never move you" (Gaines, 202). In the March 25, 2007, New York Times article, "The Theatre is Alive with the Sound of Laptops", composer Michael John La Chiusa criticizes electronic music, saying, "Do the machines provide the human touch of a live musician? Not to my ear.... It's a question of aesthetics." Annette Richards, opening her article on Mozart's

automated music, cites this aesthetic issue as a primary reason Mozart's Fantasias for mechanical clock are largely ignored by musicologists (366).

It is significant that Vaucanson did not make a defecating man. What an animal does is modeled in analogue by an animal automaton, but the lifelike androids make a multi-layered statement about human achievements: writing, drawing, and above all, music. This is the demonstration of labour mankind commits to raise himself above the state of animal. That music would be one of the activities chosen to reproduce in this context shows how central this field was to notions of human-ness during the eighteenth century.

5. The Uneasy Relationship

An ordinary fellow stands on a stage. His skin glistens from the heat of the spotlights. He mumbles, warms up his voice, and performs a short, passionate song in Spanish and English. It is 2008, at the Museo Nacional Centro de Arte Reina Sofia in Madrid. This is Julio, a collaboration by roboticist and sculptor David Hanson and musician David Byrne. He can mimic emotions. His eyes will fix on you and follow you as you move. He himself is always slightly moving, just like us. And he sings a song about how nothing will ever be the same again. The audience, drawn by an exhibit blending art and science, came to see something extraordinary. Julio does not just open and close his mouth. There is a

“host of emotions that play across the muscles and tissues of the face and neck” (Byrne, http://www.davidbyrne.com/art/art_projects/robot/index.php.) The performance sends chills through the audience.

The Machines and Souls exhibit was curated, like Vaucanson’s Flutor, to demonstrate technical sophistication and to invite audiences to confront the relationship between life and machine. And like the Flutor, Julio contributes to a discussion about what it means to be human. David Byrne suggests that “to see machines mimic these [unique] aspects of human life, is to watch some part of our imagined souls being appropriated” (<http://journal.davidbyrne.com/2008/06/06202008-machin.html>). Yet Julio is also intended to be uncanny, creepy, best described by David Byrne:

fits in mainly with the creepy uncanny side of the show. Julio is old-school creepy — he resembles a person, uses lifelike motions, and — yikes! — smiles and looks around, mumbles to himself, and then bursts into song. He recalls a Frankenstein monster, although, instead of being outwardly and obviously scary, he’s quasi-friendly looking and bursting with emotion. I hope the sense of realism together with the singing make him doubly creepy. How can a machine be feeling what’s expressed in the songs?

One would expect an object contributing to such an art show to be affective, to use all available tools to produce a response in its audience. Julio does just that in a powerful combination of verisimilitude of design and movement, expressive human singing (the song is a recording by Byrne), and provocative content (the poem alone would be enough, as a robot he has no need to warm up his voice).

Julio is an example of an uncanny automaton. We know from Byrne's account that the performance was designed to be that way: it is, after all, art. But we do not know about whether the same peculiar unease elicited by Julio was the intended outcome for the mechanical monk or the Flutor. We can say it is unlikely that *La Joueuse de Tympanon* was intended to frighten Marie Antoinette. It seems equally unlikely that the host of pretty writing, drawing or music-playing automata of the seventeenth to nineteenth centuries, or even today's artificially intelligent speaking and acting androids, have been designed specifically to elicit an unpleasant nervousness in the audience.

Automata stimulate the passions on a visceral level that goes far beyond intellectual exploration. There is a moment, looking at images or videos of androids, when a chill goes up your spine. It's a strange sensation, a pervasive feeling of unease. It does defy reason: there is no place in this for logic. In my classroom showings of android videos, the feeling was described in terms of 'as ifs'. With a confused combination of wonder and discomfort, some audience members felt 'as if' the android had presence or selfhood. Unfortunately, few academics choose to describe their personal reactions to automata. The exception, Elizabeth King, found the mechanical monk "impossible to regard with objective remove" as a result of the combination of "the character of the image" and its "head-on motion" (275). Individuals exposed to the monk in motion found its action "intimidating" and responded with "animal flight" (274). This uncanniness is an uncomfortable emotion that contradicts intellectual knowledge. It is a distant cousin of fear, when what should be safe and familiar "retreats and becomes alien" (Kohak, 147).

This discomfort has become a generally-accepted given with respect to human response to artificial life. Research into the uncanniness of realistic androids is ongoing as scientists and psychologists attempt to figure out what makes them frightening. Books with a decidedly negative bent, such as Gaby Wood's *Dolls* and Minsoo Kang's *Sublime*

Dreams, and popular articles such as *The Economist* “Mapping the Uncanny Valley”, reinforce the perspective that androids are creepy and always have been. Yet, historical androids often depicted civilization, magic and beauty. The suggestion of consciousness in their eyes was advertised, not as titillation, but as a wonder in itself. Given the intense amusement audiences have had from historical androids, and the continuing interest even today, one must ask the question: on what is such “creepiness” based? Even if scholars do not agree that these objects are uncanny, they suggest that artificial life presents (or has presented) significant – and potentially damaging – challenges to philosophical or ethical foundations of culture (Jessica Riskin, Sherry Turkle). A few lone voices from the automata-building industry, such as Hiroshi Ishiguro and David Hanson, have suggested that the uncanny responses may not exist or may be avoidable through design.

Despite theories that suggest android design is the primary trigger for response, I consider the beholder’s participation to be crucial to the encounter. In the following sections, I review factors that contribute to an uncanny response. These factors suggest that the beholder experiences a stimulating interplay of beliefs, such as the notion that lifelike images have supernatural power, psycho-neurological events, such as empathy and mirroring, and uncertainty about the status of the object. Uncanny fear belongs to a class of responses so ingrained as to be almost indistinguishable from instinct. The response is unpredictable and unstable – it may not occur in all cases, nor may the response persist in the beholder. I find that the uncanny is a subjective, psychological, aesthetic response that is only beginning to be clarified by evidence-based studies.

5.1. Uncertainty

German psychiatrist Ernst Jentsch is known for making the first attempt to analyze uncanny fear. His article, “On the Psychology of the Uncanny” (1906) makes key associations between this low-level fear, automata and other artificial humans, and uncertainty. In this article, too, the term *unheimliche*, or, ‘uncanny’, is coined. Throughout the past 100 years, this word has been helpful in describing the uneasy sensations some experience when the known and familiar seem unpleasantly transformed. In the struggle for existence, Jentsch states, “intellectual certainty provides psychical shelter” (16). But

when a shift in perspective takes place about something formerly known and self-evident, this psychical shelter evaporates and the result is disorientation and confusion. Jentsch likens this lack of shelter to the exposure of an undefended community in the face of hostile forces (16). Any new or suspicious object could produce such an experience. However, Jentsch highlights above all else, one impression that can produce such uncomfortable confusion:

doubt as to whether an apparently living being really is animate and, conversely, doubt as to whether a lifeless object may not in fact be animate – and more precisely, when this doubt only makes itself felt obscurely in one’s consciousness. The mood lasts until these doubts are resolved and then usually makes way for another kind of feeling (Jentsch, 8).

Lifelike objects may be perceived as dangerous from a conceptual point of view, adds Minsoo Kang (34). For Kang, the danger is that confusion may result as to which object is the “real being,” and that the object may seem to be “on the verge of coming alive” (34). In his view, enjoyment of not-lifelike objects comes from an affirmation of the “normal schema of reality.” Such a schema is predicated on the binary opposition of living/non-living, which is threatened by lifelike images. “The finer the mechanism and the truer to nature the formal reproduction, the more strongly will the special effect also make its appearance” (Jentsch, 10). The intensity of audience responses to lifelike automata is consistent with Jentsch’s prediction: realistic motion and exterior makes for a powerful reaction. Perhaps, these are “inherently unstable objects of ambiguous status that can seem to threaten one’s entire sense of reality” (Kang, 38).

For all beings, a primary characteristic of knowledge about the world is whether something is alive or not. While non-living kinds such as weather and geological events provide the framework for life, our survival hinges on identifying the presence or absence of living kinds. Only flora and fauna can become food or make food out of us. As identification of these kinds is essential for creatures to thrive, it is unsurprising that codifying the features of this kind has been a key interest of yesterday’s natural philosophy and today’s cognitive psychology.

Some theories suggest that knowledge is organized through a hierarchy in which objects are sorted in domains and categories based on form, function, and associative

information. This hierarchical perspective bears some similarity to formal European knowledge structures such as Linnaean biological taxonomy and Aristotelian classification of living things. It is also possible, however, that knowledge is organized in a decentralized model wherein information stored according to knowledge types may form a network of associations (Cree and McRae, 479). When an adult approaches an object, he may correlate the associations and infer the identity of the thing. Some of these associations may be emotional or social in nature, determining the response and uses of the object.

Identification of the biological properties of living and non-living things is relatively straightforward from both natural philosophy and cognitive psychology perspectives. To Aristotle, an object is alive if it must consume something to stay alive, can reproduce itself, and grows or decays. Such a living thing may be a plant, or, if it satisfies additional criteria of self-motion and perception, may be an animal. Further, should the living thing also have intellect, it may be a person. Within this hierarchy of living things, we may then use additional characteristics to identify the type of plant, animal or person.

Perhaps because it is linked to our survival as animals, the distinction between living things and nonliving things is neurologically fundamental. For example, from studies of brain impairment, we have learned that some brain-injured individuals are impacted for only one class of objects: they are able to correctly identify artefacts (such as an airplane or a chair) but challenged to correctly identify living things (such as a cat or a horse). This may be because different types of information are used to identify living and non-living kinds. Visual complexity, detail and variation of shape are more important in identification of living things than for non-living things (Humphreys and Ford, 454). It is also possible that living kinds are identified based on hereditary traits, such as forward-facing eyes, four legs or feathers. Taxonomic membership may also be as important as detail in correct identification of living things (Barret, 477). In contrast, it appears that man-made artefacts may more often be identified based on form-function correlates. Thus one identifies a waste-paper basket on the basis of its usage context, rather than its design (Barret, Humphreys and Ford). The identification of a man-made object is more based on cultural information while that of living things is more based on biological information.

Humans have evolved specialized representations for certain kinds of objects such as living kinds, tools, and food (Barrett, 477). These representations are learned, not innate. Infants do not privilege living over non-living in the first two years of life (Arterberry, 476). The distinctions between living and nonliving kinds begin with learning about self-propelled motion and lines of trajectory, culminating with notions about purpose and intent (Arterberry, 477). In this stage, the living/nonliving specialization is built as a fundamental of knowledge development. Puppets and other apparent self-movers are used to amuse infants and assist in distinguishing between living and non-living things, such as insects and toy cars. By three years of age, a “firm ontological distinction” has been set with the commensurate ability to reason about living and non-living kinds regarding their biological properties (Jipson and Gelman, 1685). It is this distinction that Jentsch suggests is disturbed by lifelike androids.

By three years old, most people are able to identify artefacts as non-living. There is no uncertainty. We might then wonder why anyone would be frightened by a pretty automaton that plays the organ, or feel threatened by the sight of a sixteen-inch mechanical monk. It goes against reason to react in such a way.

Although the android has many visual similarities with organic humans, cultural information advises us that this is a man-made thing. Despite our knowledge to the contrary, the uncanny “makes its appearance even more clearly when imitations of the human form not only reach one’s perception, but when on top of everything they appear to be united with certain bodily or mental functions. This is where the impression easily produced by the automatic figures belongs that is so awkward for many people” (Jentsch, 10).

The waters are muddied when lifelike androids represent properties considered by their contemporaries to be unique to living beings. While in the eighteenth century breathing, speaking and musical performance, were indicative of human-ness, today’s projects involve extreme detail, sight, and basic social skills. Androids produce associations contradictory to their taxonomic placement (non-living, artefact) and network associations (computer, machine). The categories can “mingle” when subjects are asked to reason about other properties such as psychological ones (Jipson and Gelman, 1687).

This mingling plants the seed of doubt that is the source, for Jentsch, of the uncanny response. Perhaps on some level, the audience asks whether an object that appears to be living (or not) actually is. Intellectual ambivalence can be translated into uneasiness by some, only to be relieved by an assertion of the object's actual status. By suggesting that "the mood lasts until these doubts are resolved" (8), Jentsch is in agreement with Seneca and Hero that intellectual mastery of the topic will dissipate wonderment and its associated emotions.

Jentsch also acknowledges that for some, a negative association persists even after certainty has been reached. But it is hard to believe that uncertainty is the whole root of the problem. The associations that inform the uncanny moment are complex, based both in subjective experience and the subject's cultural framework. In addition, despite being clear about the status of an artefact as non-living, adults and children may persist in imposing linguistic, social, or emotive characteristics of life and even sentience on mechanical representations (Turkle). As anyone who has believed their computer has a will of its own can attest, non-living things can seem quite convincingly alive. We engage with these objects even though we acknowledge their status.

5.2. From the Freudian Uncanny to the Uncanny Valley

Although much of Jentsch's theory rests on the notion of uncertainty and liminal objects, his best example of the uncanny comes from nineteenth century literature. Masterful gothic storyteller E.T.A. Hoffmann's "The Sandman" (1816) weaves several potent themes together: mysterious scientific activities, the invasion of a home by a sinister character, threat to children, murder, love, suicide, the removal of eyes, and an android.

Hoffmann was inspired by folk tales and by the contemporary craze for mechanical wonders, much in the way a horror writer of today may set a gruesome tale of demonic possession in the textual world of social networking. The brooding tale of mistaken and duplicate identities revolves around a young man, Nathaniel, who is haunted by appearances of Coppélius, a mechanic who specialized in making eyes for automata. As an adult, our hero falls in love with a charming young woman, Olympia.

In a horrendous revelation, Nathaniel discovers that Olimpia is nothing but a machine built by Coppelius. Her human-like walking, dancing, and sighing were only the actions of a machine. Nathaniel is consumed by a fit of suicidal despair and throws himself off a building.

To Jentsch, it appeared that the uncertainty about Olimpia's human-ness was responsible for the unsettling emotions transmitted in "The Sandman". But thirteen years after Jentsch's proposition, Sigmund Freud disagreed that uncertainty alone will result in fear. Freud proposes that uncertainty about an android's status is inadequate to explain deep unease that one experiences when reading Hoffmann. He saw something more, and beginning with etymology, further explored the uncanny.

The uncanny's original German, *unheimliche*, refers to the 'un-home-like'. It connotes a reversal of *home*, familiarity and comfort. The once-familiar, once-safe, once-recognizable is rendered un-familiar and worrying. Yet Freud also finds the *unheimliche* in those situations where an unfamiliar thing gains unwanted familiarity: "the uncanny is that class of the frightening which leads back to what is known of old and long familiar" (219). Rather than being the lack of knowledge about a thing, the *unheimliche* is the addition of "something" to the novel and the unfamiliar, a return or a reversal. The familiar hallway in the dark of night becomes a frightening tunnel. The dead are alive, the field at dusk seems strange and enchanted, and the mirror shows someone else's face.

What is most important about the *unheimliche* experience for Freud appears not to be an issue of identification and knowledge. Indeed, he states "knowledge does not dissipate the uncanniness in the least degree" (229). Rather, an *unheimliche* sensation occurs in spite of what is known. A transformation has occurred. The object ought not have become its opposite, the individual ought not be afraid. What Jentsch identified as defencelessness and disorientation at the heart of the uncanny, Freud identifies as an unwelcome loss of agency. One may feel uncanny by viewing someone else uncontrolled (as in epilepsy), by imagining mystic forces are at work (as in repeated coincidences), or if one senses one's actions are being governed by an unseen power disconnected from one's intent.

Freud locates the uncanniness of 'The Sandman' and other horror stories in a "frightening element that can be shown to be something repressed which *recurs*" (Freud, 240). He suggests that one may experience the *unheimliche* in repeated coincidental instances. One might interpret these repetitions as the work of unseen forces with some nefarious intent. Freud observes that the uncanny has its roots in primitive, animistic conceptions of the universe that support narcissistic, magical beliefs. The uncanny can be felt in the "idea of something fateful and inescapable," produced by a variety of experiences of "involuntary repetition" such as acts of madness, epileptic fits, or coincidental recurrences of numbers or people (Freud, 236). Something recurs, is revealed, repeats, against logic and against the protagonist's wishes. The protagonist acts against his own will. He cannot stop the events from unfolding.

Freud's *unheimliche* then becomes the experience of a rift between the conscious self and the body's actions. The conscious self has a sense of mechanical repetition of events leading, always, to an unwanted conclusion. It has been rendered a powerless passenger in an automated body, subject to a prescribed and repetitive series of events. The Freudian uncanny, therefore, is the eerie sense of self-as-automaton, viewed from a self that was certain that it was once autonomous. The uncanny is a disturbance in our sense of self brought about by a machine or automated experience.

For Freud, artificial life alone would not result in the *unheimliche* response. He suggests the repetitive eye-stealing in "The Sandman" – and not Olympia – accounts for the eeriness of the tale. In this story, the confluences of ancient beliefs with mechanical duplication of personhood are largely responsible for its disturbing effect. Although Freud largely discounted the notion that an artificial human can have an aesthetic 'uncanny' effect, others have not been so quick to dismiss the idea.

5.2.1. *Taboos and rituals*

Scholars such as Landes, Altick, Freedberg and Kang have found automata to arouse various associated superstitions and beliefs that Freud would consider to have been largely repressed by modern individuals, especially with respect to life and death. Freedberg suggests that waxen representations of the dead were a fourteenth century corollary of mummification (216). Replicas of newly deceased individuals supported

rituals to mitigate fear associated with death. Kang associates the fear with cognitive uncertainty: if something that was living is now a corpse, it has crossed over a fundamental knowledge category. The potential distress resulting from categorical transition is managed culturally through a programme of rituals that may include three-dimensional representation (32).

It happens that the most common opportunity to view very lifelike representations is in a funerary context as effigies, death masks or even waxwork memorializations. One could even consider the displayed embalmed corpses of Lenin and Ho Chih Minh as representations of living in the same manner a museum of natural history might display a sleeping fawn. The dead are represented as if alive. The technical ability and artistry in such representations has historically resulted in crossover between death ritual and lifelike display. The historical makers of death masks also found employ as modellers of waxwork anatomizations (Landes, Altick, Freedberg).

The creators of lifelike replicas not only made physical objects for education and entertainment. The association with loss and the production of an artificial replacement is also seen in prosthetics. Heinrich Schalch, seventeenth century waxworker, also made glass eyes (Altick, 52). Henri and Pierre Jaquet-Droz made automaton hands but also made prosthetic hands (Riskin). John Merlin, designer of small automaton dancers, invented a variety of medical assistance devices (Altick, 74). While these are humanitarian applications, the imperfect artificial serves as a reminder of loss.

In human hands sits a power that historically had been divine, and replacing something that by poor luck or divine providence has been rendered unavailable may be to break an ancient taboo. There could be some emotional disturbance if one considers life to be a mystery that cannot – and should not – be duplicated through mechanic or organic means.

Mythology and superstition inform these beliefs. They are, in short, a belief that visual representation is fundamentally dangerous (Kang, 35), that creation of artificial life is the result of illicit access to a realm of “infinite chaos and power” (Kang, 43), that there are mysterious, supernatural forces at work which may unpredictably animate the inanimate (Kang, 197), and that to create life is to transgress a sacred order (Wood, 17).

By giving fire and technology to his clay beings, Prometheus' violation of the Olympian taboo led to his punishment and ultimately the release –via Pandora- of the vices upon his creations. The 'new Prometheus' title conferred on Vaucanson, Frankenstein, and others, heralded both miracle and the warning of punishment. Gaby Wood suggests that Vaucanson was haunted by his ever-closer approximations of life to the point where he begged forgiveness for his own trespasses and abandoned his more ambitious projects (64).

That a taboo or association is held with regard to artificial humans is inadequate to explain the uncanny response. There are many instances in which audiences seek out the line between light and darkness. When there are controlled parameters around the frightening object, such as at a zoo or at a horror movie, the frightening becomes "cathartically thrilling" (Kang, 41). Since the eighteenth century, audiences have been happily unnerved by Madame Tussaud's creepy wax tableaux and autopsies. While some automata, such as those in haunted houses, are designed to sate the taste for macabre, bloody, and unnerving subject matter, most historical automata were attractive objects of beauty and refinement.

5.2.2. *Images have power*

That android automata may transgress ancient taboos could account for some of the negative associations that accompany these objects. As Freud suggests, they may uncannily call to mind deathly images, or inspire one to believe in dark magic. But we should not stop at the surface. Androids are not only representative machines produced for pleasure and interest: they are images, lexical components of a culture's communication. A culture has multiple macro-level ways to communicate with itself: sound, images, written words, and the suite of interpersonal verbal and non-verbal cues. How to approach the written word or other human beings is learned through participation in the culture. Similarly, we learn from our culture how to interpret and interact with certain sounds and images. Androids designed for spectators such as those of the eighteenth century would have been approached with the same methods audiences used to approach other images at that time.

Belief in the power of images has a long history in Europe. By the time lifelike android automata were possible in the mid-eighteenth century, a tradition of affective images associated with verisimilitude had been well established in Europe. The production of specific emotions and responses through contemplation of images was a part of medieval spiritual and intellectual disciplines. Empathy was a spiritual practice for medieval Christians assisted by affective images of martyrdoms or biblical moments (Freedberg, 5). Images had talismanic power for the superstitious, but were also a practical choice to convey messages. Powerful images could communicate to an illiterate populace more effectively than the Latin liturgy. We have already seen how objects were used to produce a wonder response that engaged reason and passion in scientific inquiry. Similarly, images were considered able to transform their beholders both physically and spiritually by inspiring empathy (Freedberg, 1-6).

In the religious context, medieval and pre-reformation Christian image production was specifically designed to combine the “splendor of impression” with the “ordinary physicality of human forms” (Freedberg, 239). Polychrome limewood sculpture was painted to transmit a “perceived continuity between liveliness and the quality of being lifelike” (Freedberg, 239). Statues were commissioned with jointed limbs and real garments, merging living qualities with inert substance until the beholder would feel as if the statue’s eyes could see (Freedberg, 242-245). For Freedberg, the verisimilitude aesthetic renders audiences unable to suspend their emotional involvement “in favor of differentiated aesthetic assessment” (237). In other words, lifelike design bypasses critical thought and affects beholders on a visceral level.

Through exposure to powerfully evocative representations, audiences are schooled to engage with affective images. They “reconstitute” the material object as living. The beholder is actively and emotionally engaged in the image. The imagination bridges the gap between the inertia of the image and the empathetic emotions of the beholder (Freedberg, 245). One may note in this model that due to the passionate nature of engagement, the imagination may be acting on an instinctual level.

For Freedberg, as for Kang, there is a component of fear when confronting a lifelike image because of a sense that it may come to life (Freedberg, 231). While the initial beholding of lifelike images, especially moving ones like automata, is accompanied

with wonder and admiration, Freedberg argues, we are arrested by the images out of the fear that “they might just come alive, just open their mouths, just begin to move” (231).

Freedberg considers motion as one factor that prevents the imagination from bridging the image and the beholder. He asserts that automata do not produce the same depth and complexity of response as non-moving images produced in traditional fine arts of painting and sculpture (224). Freedberg implies that the medium must be a non-technological one to produce a powerful effect.

A review of any of our subject automata reveals that they are all the products of collaborations between skilled craftsmen and artists. The traditional division between the mechanical and the liberal arts is wholly dissolved in the creation of automata. To apply Freedberg’s theory of response to an analysis of automata, we should remember that these objects are intended to produce a response beyond one of admiration for technological skill. As described previously, the aesthetic appeal of the androids subsumes the technology. The audience may experience delight, admiration, hope for progress, and question the human’s place in a natural (or Godly) hierarchy. The preserved and famous automata are works of art, created with intention for response, and as such it would appear that Freedberg’s theory of response does apply to the fine android automata of the mid eighteenth century.

Lifelike android automata represented emotions, breathing and artistic expression. When viewing these images in motion, we have the opportunity to accept the image as reality and enter its affective world. In this event we meet the image, imagine its congruence to ourselves, and assume that it possesses similar qualities to us.

Thus far, I have shown that lifelike images have been associated with death rituals, a tradition of associating power with images exists, and that lifelike images have been used to stimulate an empathic response. The associations of the images with certain cultural traditions and enculturated responses may inspire an uncanny reaction, but do not indicate inherent creepiness to lifelike images. Perhaps, then, the imagination may play a powerful role in our interactions with nonliving objects.

The uncanny effect is dependent on a shifting of boundaries between familiar and unfamiliar. The beholder quivers between knowledge and instinct when observing the mechanical other. His brain is stimulated as the lifelike image is considered (Ishiguro, 2007). New thinking is provoked as he attempts to categorize and understand this object that exists betwixt-and-between (Turkle, 348). The more lifelike – yet not lifelike – this object is, the more sublime awe may be experienced at its mimetic effectiveness (Kang, 45). While the “uncanny” evokes images of dolls without eyes and other mildly frightening things, we may begin to reconsider the reaction to automata as a stimulation of the mind when encountering a new class of object.

5.2.3. *Empathy Rejection*

Beholders are active participants in a one-sided relationship, projecting their assumptions onto objects. The imagination is actively involved in many aspects of everyday interpersonal relationships and reactions (Bloom). Individuals use their perceptual imagination to produce empathy with objects based on shared characteristics with known living beings (Misselhorn). The object may have many or few similarities with its empathic referent, but the imagination fills in the gaps to create a relationship. A critical disenchantment occurs when the object has so many similarities with its referent that the imagination is no longer required to bridge the gap (Misselhorn, 357). The beholder vacillates between the “image as reflection and the image as reality” (Freedberg, 221). At this point, a philosophical break occurs where the object is proven to no longer qualify for empathy. The uncanny valley is produced as the imagination once again intervenes and the beholder oscillates between what was at first “alive and soulful” and becomes “cold and dead” (Misselhorn, 356-7).

When we encounter any realistic depictions, not just androids, we are prepared to use our imaginations to bridge the gap between image as representation and image as reality. Misselhorn, Kang, and Freedberg agree that in instances where the object is so lifelike that the imagination’s services are not required, uncertainty about how to approach the object results in a lack of empathetic connectivity, expressed as repulsion and dislike. By being lifelike but not alive, the android may repel the audience’s empathic efforts. The object’s capacity to receive or inspire empathy is in question – is it something to be awed by, or is it something to relate to?

In the act of empathy, a parallel is drawn between oneself and another. It assumes there is no difference between the subject and object. They are as one. But when empathy is aroused by a lifelike machine, the conflation of subject and object leads to confusion and anxiety. The machine cannot really reciprocate, and what does this parallel mean for the beholder? Is this the source of Freud's *unheimliche*, the self-come-automaton?

For modern android makers, anxiety could interfere with the commercial success of their product. As a result, lifelike machines of the twenty-first century mirror their audience's emotional displays and demonstrate emotions interactively. By convincingly simulating reciprocity of emotion, they inspire the imagination to bridge the gap and make an empathic connection. The machine seduces by seeming to understand, and any fear that may have existed may simply melt away.

5.2.4. *Integration of the new object-type*

Freud acknowledges that the "uncanny effect is often and easily produced when the distinction between imagination and reality is effaced" (243). If the uncanny response is the result of ancient, uneradicated beliefs, then it is relieved when those beliefs are finally eradicated – he terms this 'reality-testing' and considers this easier to resolve than uncanny sensations resulting from infantile complexes such as the castration complex.

Bresnick adds that the uncanny aesthetic, like the sublime, is experienced most powerfully on the first confrontation. Cathartic thrills are not sustained, and fade in intensity upon repeat experiences. While the sublime aesthetic fades into beauty, the uncanny aesthetic fades into humour and irony (Bresnick, 130). It may be that something that was once unnerving becomes stripped of its power as it becomes less novel, less wonder-full. As it is normalized it loses its status as "otherworldly." It may continue to amuse but no longer transports the beholder into another realm. As the uncanny is a subjective response, I can only speak with certainty for my own experience. As someone who has viewed countless images of uncanny objects and artificial life, I have noted a gradual reduction in the eerie chill.

Stephanie Lay, a psychology PhD candidate who keeps a research blog on the uncanny, identifies the relationship of novelty and the uncanny. She has collected many images of intentionally – and unintentionally – creepy trans- and post-human artefacts. Her collection includes non-mechanized hyper-real human doubles such as Real Dolls and Reborns. It also includes a variety of organic and mechanic boundary-crossing objects such as mismatched doll- and machine parts incorporated into a single body, dolls collected by adults for alternative purposes, and images of children or adults without eyes. She alludes to the dulling impact of exposure when she introduces a truncated Ishiguro android with “Honestly, this was the first time in months that a so-called uncanny picture gave me a jolt on loading the page” (August 3, 2010).

Ms. Lay goes on to describe her reaction to the android: “I’m trying to dissect for myself why it did that, and for once I don’t think it’s actually the face, or at least, not the face alone. No, it’s the limbs - the arms terminating in those smooth stumps, and the legs tapering off into that odd joined point like a half-human, half-grub mermaid.” Her description bears remarkable similarity to phenomenologist Alexander Kozin’s experience of a woman affected by Thalidomide. He describes the woman as “a collage made of odd objects; her arm stub and her twisted legs looked as if they came off from a non-human creature” (472). His response oscillates between recognition and inaccessibility, finding “no outlet in an empathetic connection” (466). For Kozin, wonder itself created an anti-empathetic boundary between the beholder and the object, entrenching the object in otherness in contrast to the normalized observer. His experience of wonder was one of novelty, strangeness “so odd that no available pre-formed measure is capable of giving the encounter any sensible explanation” (466).

In 1970, roboticist Masahiro Mori described the *Bukimi no Tani Genshoo*, or “uncanny valley” response to the developing realism in artificial human design. At that time, there were no sufficiently realistic robots to prove his hypothesis. Mori described realistic androids as being creepy on a continuum somewhere between zombies and artificial limbs. The minute differences between a very realistic and a *bona fide* human being, if detected, would result in a fear-repulsion response. The theory suggests that as artificial life forms become less machine-like and more realistic, they are increasingly accepted by humans until their realism is almost perfect. At this stage Mori suggests the uncanny valley is entered, only to be escaped when perfection is reached.

Mori's hypothesis has also been used in literary and popular culture analysis regarding instances where a characterization is unexpectedly creepy. The theory considers that humans may have positive or negative familiarity with objects. Positive familiarity is the usual type of recognition – of living beings, of human eyes, of mechanical-looking robots and elegantly designed tools. Mori believes that human reactions to machines are determined by the design of the object. If the object too closely resembles its living model, a negative –or unnerving- familiarity is experienced. To make a prosthetic eye or hand less unsettling, Mori suggests it should be made less realistic and more beautiful (Mori, 2).

Here an issue arises with notions of the uncanny valley and its application to humans or humanoid androids. All human forms that deviate from the norm are met with mistrust, wonder, or an uncanny fear, unless there is a cultural model that can mitigate these reactions. The identification of a deviation or mutation brings up old prejudices and fears. In human society, conscious efforts are made to increase tolerance of diversity and difference where human beings are concerned. Therefore, should one identify for a moment the amputated limb of another as an imaginary amputation of one's own limb, one may learn to convert the resulting fear to understanding and sympathy.

The question remains as to whether the uncanny valley is a universal response to lifelike androids, and whether it really requires mitigation. There is plenty of anecdotal evidence to suggest modern individuals have a sense of unease when faced with images of lifelike androids. The online media are peppered with discussions of the 'uncanny valley' and its implications for robot design and future integration of artificial beings to society at large. It is certainly a design issue when a commercial product intended for sale produces an unexpectedly negative response. Yet individuals who are exposed to androids on a regular basis may not suffer from an uncanny effect.

The uncanny experience, as described above, is an eerie emotion resulting from ambiguity between culturally embedded norms and knowledge categories. In the case of androids, the uncanny is an aesthetic response to the lifelike case of the machine. Following Edmund Burke and Levi-Strauss, Kang suggests that the encounter with an object of uncertain status commences with a fear response and reduces to a sense of relief. This sense of relief is, in his estimation, the source of the emotion we now call

'amusement' and 'humour'. In other words, we giggle with amusement when the wind-up toy is revealed to not be a threat after all.

Ishiguro takes a more practical approach, suggesting strangeness is experienced as the result of a subtle perceptual imbalance between the appearance and the behaviour of an object (113). Humans have inadequate mental models for recognizing "robots and other toys" that do not behave in a "robot-like way" (113). If the machine were more perfect, there would be no imbalance, regardless of the object's liminal cultural status. Rather than proposing that humans develop cultural models that could account for discrepancies between the appearance and behaviour of androids, Ishiguro seeks to erase the issue by making androids indistinguishable from humans.

Yet the response is involuntary and unpredictable. It defies logic: there is no reason to feel threatened by a thing that lacks both the agency and the ability to harm. There is equally no reason to approach a lifelike object as if it is a person. Haven't we moved beyond the notions of repressed, animistic beliefs that Freud suggests drives uncanny experiences? If we have no conscious intellectual ambiguity about what we are dealing with, why should some of us react as we do?

5.2.5. *Under the surface – Neurology and aliefs*

One possible explanation is neurological. Research by Italian neuroscientist Giacomo Rizzolatti introduced the concept of "mirror neurons". The research team identified brain cells that fired when either the primate picked up, or saw someone else pick up, an object. Further research uncovered even more interesting data: each neuron was associated with an action. These mirror neurons are heralded as the possible neurological source of empathy, and understanding them is relevant to autism and psychology studies. Like the monkeys of the original study, humans are stimulated both by viewing an action and by making it themselves. On a neurological level, we are each other. "It seems we're wired to see other people as similar to us, rather than different," Gallese says. "At the root, as humans we identify the person we're facing as someone like ourselves." (<http://www.apa.org/monitor/oct05/mirror.aspx>)

This concept, that we mirror what we see, has existed in thought prior to these studies. David Freedberg's phenomenological exploration of icons describes some beliefs about the impact of images. Whether it is an ancient belief in inspirited images, or a renaissance belief that gazing upon a painting of a beautiful woman while copulating will produce beautiful children, the effect of images has been imagined to be a physical one that transcends the mind-matter barrier (Freedberg, 3). Marshall McLuhan was fond of the saying "we become what we behold", and even today, arguments about violence on television are predicated on the notion (or superstition) that what we see has a palpable effect. While mirror neurons have not yet been applied to media studies, the theory has proven useful in robot sciences.

Applying the mechanistic perspective inherent in brain sciences, the "activation" of the human mirror system can be achieved by stimulating the human interactant to anthropomorphize robots. This activation "could potentially tap into the powerful social motivation system inherent in human life, which could lead to more enjoyable and longer lasting human-robot interactions" (Oberman et. al, 2195). In other words, it's less about what's happening inside the robot than within the human being.

Oberman seeks to determine which cues stimulate a mirror neuron response in humans. Subjects viewed separate video footage of human hands and robotic hands carrying out activities such as pointing and lifting a ball. A separate experiment attempted to measure whether mirror neurons are differently stimulated when volition is present. This was measured through EEG readings gathered while subjects watched video footage of hands completing actions independently and moved by strings like a puppet. Oberman et. al concluded that mirror neurons may be stimulated by the motions of non-living objects, and may be stimulated regardless of an apparent lack of volition (2198). With this experiment, Oberman et al. have determined that neurological mirroring can result from observing actions of both living and nonliving things.

So the brain, on a level far below consciousness, responds to actions that seem alive as if they are alive. Perhaps this response is cross-referenced against other knowledge, resulting in the stimulation and philosophical oscillation that, for some, is eerie.

Another promising area of inquiry is in Tamar Gendler's proposal of "alief" to indicate

A mental state with associatively linked content that is representational, affective and behavioural, and that is activated – consciously or nonconsciously- by features of the subject's internal or ambient environment. (642)

This may look very similar to beliefs, or even imagination. However, Gendler draws an important distinction between aliefs, beliefs and imaginings. Beliefs are propositions accepted by the subject as true, which may be revised as new information is received. Imaginings are propositions for which the true-ness (and reality) is irrelevant: the subject accepts an imagining even when it is impossible. Aliefs, in contrast, may occur without the subject's acceptance, even at times directly contradicting both beliefs and imaginings. For example, having poured white sugar into a bottle marked "Not Poison", the subject may know (believe) that the contents of the bottle are not poison. The suggestive word "poison" on the label may inspire the subject to imagine briefly that the bottles contents are toxic, but the subject's belief contradicts the imagining. Yet, against will, logic, and consciousness, the subject finds himself unwilling to drink Kool-aid made with the verified not-poisonous white sugar. The subject prefers to use the bottle marked "sugar", filled by the subject from the same source as the other (Gendler, 15-16). An alief may be belief-concordant (as with choosing the bottle marked "sugar"), or belief-discordant (as with refusing to use the other "poison" bottle despite evidence to the contrary).

Aliefs often govern action from a primitive level, depending on "associational patterns that have been laid down in our minds as the result of our experiences and those of our genetic ancestors" (Gendler, 17).

The alief theory has not been applied to the uncanny valley by scholars, but Gendler's proposition of how aliefs may operate unites the disparate explanations of uncanniness in androids. Aliefs may be activated by aesthetic or imagined stimuli. The notion of 'associatively linked content' neatly captures the complex of associations described throughout this paper. Finally, the breakdown of 'representational, affective

and behavioural' features of the mental state seeks to integrate reactions that are usually disparate and in the case of androids, may be context-inappropriate.

Gendler's theory is that the response to representational content – whether real or imagined – has “cognitive-behavioural coherence” “regardless of the attitude that one bears to the content activating the associations” (651). In other words, an aspect of the representational content may result in a cognitive and behavioural response appropriate to that aspect even if the response is inappropriate to one's consciously-held knowledge. There is no pretence that the object is other than a man-made machine, yet some features of its design may trigger a cognitive-behavioural chain reaction that may defy conscious logic. The representational content of the android may be “artificial person”, but it could also be as Kang suggests “non-living person”, “exotic”, “unknown-magical”, “alive” or “dead”. Thus to apply Gendler's schema to Ishiguro's theory of the uncanny valley, perceived representational content of an android might be “diseased”, resulting in affective content of “contagious!” and a behavioural motivation “get away!”. Because we have no confirmation that the responses are universally negative, the alief state could equally be “Toy! Fun! Play!”.

While Gendler's influential papers on alief states review research into suggestion and associations with specific objects, they do not explore states triggered by objects that may transform over time. Aliefs are powerfully triggered in some who find themselves too terrified to step on a glass-floored balcony despite 'knowing' that the surface is solid (Gendler, 634). The glass-floor balcony will not change. Androids are representations in motion that may delight one moment, then cause an alternate and unpredictable reaction the next. There might be a momentary jerk of the android's body, a movement of its eye, or another action that produces the alief chain response. Just as easily, the next actions of the android may produce a different response. The idea of “alief” has the potential to bring clarity to uncanny reactions and provide a framework for future analysis. To move forward with this line of inquiry, further research is required to capture the features of the affective moment.

5.3. Evidence-based research into uncanniness in androids

Anecdotal information recorded as asides in academic texts, newspapers, and books, indicates that the uncanny effect is produced by objects that border on lifelike. I have found no definitive study that determines a universally uncanny response to androids amongst modern people. However, recent research is making progress in defining the features of uncanny objects.

The arts and psychological sciences identify the uncanny valley as an individualized aesthetic experience arising from embedded cultural and personal expectations. They suggest that it is a response that is strongest at the outset, reducing in impact with repeated exposures. In contrast, Hiroshi Ishiguro approaches the “uncanny valley” as a neurological given resulting from design. Because the uncanny response is an unexpected inhibitor to integration of androids in society, some empirical research has investigated its features.

While the arts have enquired as to the nature of man and machine, robotics science has worked to understand how man and machine can interact to improve each other. The primary goal of this field is to create marketable, useful humanoid ‘partner’ robots that can provide service, education and companionship. A secondary benefit of research in partner robotics is greater understanding of human emotional and neurological response. Creating a mechanical form that can integrate in human culture is a lofty goal, but according to this research, we are getting closer every day.

The androids of today far surpass those of previous centuries in artificial intelligence, functionality and lifelike action. Historical European androids were not intended for social integration and had no actual interactive qualities. Android sciences and neurology are the only evidence-based disciplines that have studied how the human responds to artificial life. Of the many unknowns about the mind, one that looms for this paper is whether it is possible to apply a study of human response today to an imaginary audience of yesterday. To avoid anachronism, this paper does not assume that seventeenth century individuals responded in the same manner as individuals today. Indeed, it is quite possible that these audiences may not have had a negative reaction to lifelike androids. It may even be possible that they may have experienced the ‘eerie’

sensation characteristic of the uncanny without attaching a negative interpretation to it. Today, however, there appears to be discomfort with eeriness.

Ishiguro (2007) reported on a number of experiments done with humans and lifelike androids. He argues that there is a crucial relationship between behaviour and appearance that requires not only realistic motion but also exterior. Ishiguro's lifelike androids are physical duplicates molded from living humans. He reports on three experiments. In the first, after a two-second exposure to a lifelike android, subjects were asked to identify whether it was human or machine. He found that when the android had micromovements mimicking those of humans, 70% of respondents did not detect that their companion was a machine. However, he notes that the remaining respondents "felt a certain strangeness about the android's movements and appearance" (112). Ishiguro does not attempt to investigate this strangeness further, suggesting instead that subjects expect consistency between behaviour and appearance. This mis-match, he argues, is also the source of fear produced in a study of age-dependent uncanny reactions (113).

Ishiguro used two more experiments to see if subjects responded differently to humans than to androids. When his subjects interacted with a human, their eyes roamed frequently. In contrast, eye movements tended to be fixed on the face of the android based on the human. His conclusion was that roaming eye movements are a way of signaling thought and social behaviour. The lack of social eye motion, then, indicates that human interactants were not socializing with the child android. However, his final experiment required subjects to respond to inquiries by an artificial person, and in this he found that subjects would "deal with it as a social partner even if he/she consciously recognizes it as a robot" (115).

Current studies relating to acceptance of androids as human partners fail to replicate the exhibition context of historical androids. With the exception of Ishiguro and Sherry Turkle's case studies, there have not been studies specific to interaction with androids. Instead, most studies use imagery of androids.

The challenge for android scientists remains the correlations between brain stimulation, perception of mind, and emotional response, which has not been adequately described in their papers. In addition, studies that use video imagery of androids do not

consider that androids have featured prominently in media products that portray such machines as mass-produced, deceptive, sinister, and dangerous. As Paul Bloom describes, learning occurs not only through first-hand experience but also through stories, lessons and demonstrations. It is possible that subjects, influenced by our modern cinematic stories, may react very differently to video imagery of androids than to face-to-face interaction.

For example, although they acknowledge the many popular cultural products of the twentieth century that describe the dangers of automata that feel, Gray and Wegner see these not as an influence on their subjects, but as a sign of androids' implicit dangers. For example, Data's brother Lor in *Star Trek* unlocked the secret of emotion only to become twisted and dangerous; the desperate-to-live androids of *R.U.R*, *Blade Runner*, and *Battlestar Galactica* seek love and wreak havoc on the human worlds; finally, HAL tragically distorted the Asimov laws.

Saygin, Chaminade, and Ishiguro acknowledge the dearth of research in the uncanny valley (2717). They used fMRI imaging of subjects viewing actions by human, machine, and lifelike androids to determine if a neurological uncanny valley exists. FMRI imaging is capable of showing how the brain is stimulated when the subject perceives an object. For Saygin, Chaminade, and Ishiguro, increased neural response correlates with prediction errors and, by extension, a negative, uncanny response. Subjects who viewed actions by lifelike androids did have greater stimulation in the inferior parietal cortex, which is the site of visual perception of biological motion (2718). This stimulation was not experienced when viewing the same action by clearly biological or mechanical (i.e. not liminal) objects.

Karl MacDorman and Hiroshi Ishiguro attempted to prove the existence of the uncanny valley by having subjects rate photographs of people on scales related to eeriness and likeability. The images were slowly morphed from a least-lifelike to most-lifelike appearance. They found that objects in the mid-range, that were not wholly lifelike or not-lifelike, produced the greatest ambivalence in their subjects. Yet these eerie mid-range objects are distorted. Abnormality, such as inconsistency of the scale of eyes, produces a negative response (Seyama and Nagayama, 348). Morphing between pleasant imagery, on the other hand, has not yielded such negative responses (Seyama

and Nagayama, 343). Hanson et al. also found no evidence of negative response to realistic robots or to aesthetically pleasing morphed images (Hanson et al., 30). They suggest that aesthetic design may be socially engaging. Intriguingly, they suggest that people are more sensitive to realistic faces. This sensitivity “may imply that realistic faces transmit a rich, high-bandwidth stream of data” (30). The experience of this transmission, they suggest, may trigger a variety of responses: fear reflexes, surreal feelings, or strangeness.

Recent research by Burleigh et al. (2013) has further defined the parameters of the experienced uncanny by measuring response to morphed and altered images. They found no support for an uncanny response resulting from objects with imperfect human likeness (766). However, they positively confirmed incidence of eeriness where the lifelike object straddles ontological boundaries. It is also more likely to experience eeriness when the lifelike object fails to appropriately demonstrate emotions (Tinwell, et. al).

In another study seeking answers about the uncanny valley, Kurt Gray and Daniel Wegner asked subjects a series of questions regarding how they would feel about boundary-crossing objects. Specifically, people were asked to consider their comfort levels with computers that could plan, as opposed to computers that could feel. Other groups were asked about humans that could plan but not feel. Not surprisingly, when faced with object-type conflicts, people registered discomfort with the concept of sensitive computers and insensitive people.

Gray and Wegner suggest that our expectations regarding the presence (or absence) of mind contribute to the uncanny experience. Their findings suggest that androids are unsettling if they are perceived as machines with motives and emotions, just as human beings are generally unsettling if they are perceived not to have emotions or sensation. This notion is consistent with Gendler’s alief and Freedberg’s empathy oscillation, all of which indicate that the uncanniness individuals experience is directly related to whether our expectations about fundamental characteristics correspond with what we perceive. Uncanniness isn’t as much about androids as it is about what the viewer senses should be, might be, or is.

5.4. Conclusion

This chapter has investigated the uncanny valley from several perspectives. None of these perspectives bring absolute certainty to the resolution of uncanny results. By bringing the disparate perspectives together, we have seen how lifelike mechanical humans occupy a liminal space that may conflict with our cognitive knowledge structure, stimulate conscious or unconscious belief-action chains, violate our philosophical perspectives, or cause beholders to flutter between conflicting states of mind. But we have not seen a universal response that could be extrapolated back to historical audiences. We have also not seen consistent negative reactions. Despite the popularity of the uncanny valley, there is minimal evidence that people feel more than a bit strange about all automata all the time. Some people feel strange when they see an android for two seconds. These strange feelings indicate that something is not quite right: the movement is not lifelike, the eyes pause too long, the hands are the wrong scale, or the fingers too fused.

What we know for certain is that sometimes some people feel uneasy when they view images of artificial or trans- humans. We know people are uncomfortable with ideas or imagery that puts minds or souls where we think they don't belong. Conversely, people are uncomfortable with a lack of mind or soul, where we think it should be. There is very little evidence that the real objects are as deeply unsettling as the idea of ensouled or mindful androids.

Despite the strangeness of the idea of artificial life, in actual interaction, people appear capable of polite interaction with androids. Historical and modern people even line up to see them in all the (leather or silicon) flesh. Despite Gaby Wood and Minsoo Kang's arguments to the contrary, there is no confusion about the status of the objects. From research by Turkle, Jipson and Gelman, and Arterberry, we have seen that modern individuals are not uncertain about the biological status of self-moving machines. While psychological and possibly even spiritual or paranormal properties may be imposed on an object, there is no uncertainty about whether the machine is alive. Considering the small size, display setting, and low visual complexity of lifelike historical androids, it is unlikely our eighteenth century counterparts were so gullible as to be

unable to identify the biological status of these objects. Perhaps, then, the wind-up toy was never perceived as a threat.

What we have learned, then, is that something happens to individuals when they encounter lifelike androids. That 'something' may not necessarily be fear or repulsion. It may be as simple as stimulation, confusion, a reorganization of response. The lifelike android confounds the emotional, philosophical, and intellectual presuppositions of its audience. It is experienced as a strange and self-contradictory object. The encounter is an unexpected confrontation between the known and the unknown, a surprising –and subjective- jumble of mismatched sensory responses and aesthetic reactions.

The most successful, famous lifelike androids did not frighten their audiences. Even today they gently tease us with a tantalizing mixture of ambiguity and familiarity. They keep the audience in the unknown, questioning: "What is it? How was it made? Why was it made? What does this mean?". The art in this science has been to create something remarkable and affective that remains so, long after the novelty has worn off.

6. Conclusion

We have seen mechanical humans entertain, amuse and demonstrate cultural acts over two thousand years of history. Mechanical humans present vignettes of human existence that, like paintings and films, comment on contemporary life.

Although androids appeared in church spectacle in the late middle ages and were mass-produced in the Victorian period, these devices are distinct from those that were the focus of this paper. In the first instance, they were associated with other affective images intended to communicate aspects of the Christian afterlife. In the second, mechanical novelty in the form of ingenious entertainments had lost its appeal in favour of biological entertainments: personal experiences, moving pictures, and human mutations.

We observed that androids tend to be created in cultures that both actively accumulate and develop knowledge and have the resources to fund spectacles: Ptolemaic Alexandria, Golden Age Islam, Enlightenment Europe, and the late twentieth century global village. The androids in these periods were unique creations of artisans that were associated with other technological developments. As such, they had a dual role as spectacular delights and as demonstrations of ingenuity in expertise. These mechanical people turn the focus on human ability, invention, and achievement.

Despite this appeal, there is a tradition in interpretation of historical androids that associates them with fear and negativity. We explored the apparent negative response to androids, discovering that it may have several sources. Deep-set uncertainty about the status of the lifelike object may result in ambivalence. By exploring concepts of knowledge development from both a philosophical and cognitive perspective, we saw that humans interpret objects by correlating features. Where an object does not fit into an exclusive binary opposition such as living/non-living, uncertainty results and efforts are made for resolution. In some cases, uncertainty can be distressing. We reviewed one example of how mechanical depictions of life could create philosophical uncertainty.

We also found, however, that it is unlikely that audiences were consciously uncertain about the nature and status of lifelike androids. Androids do not necessarily produce fear, and where such an emotion is produced it is neither predictable nor lasting. They do, however, produce a heightened reaction. This may be in part due to the showmanship of their exhibitors, but it may also be an innate response to lifelike design. We react to something that is like us, and seek to integrate it (or not). The more lifelike it appears to be, the greater its potential to be a social partner.

Spectator products exploit the distance between beholder and object, but interactive products collapse the distance to produce a relationship. A psychological approach to the android-human interaction revealed that humans use a number of tools to augment their perception. These tools include imagination, projection, and anthropomorphism, which are used regularly to transcend gaps in relationships with both living and nonliving subjects. Individuals project personhood and emotion onto the artificial human. In other words, if we must deal with an object that adequately resembles a person in affect and appearance, we have personal and cultural processes to guide our interactions.

This project's focus is the spectatorial and wondrous android. For all the attention paid today to the negative associations with historical automata, they remain a standard exhibition that continues to produce excitement and delight. The appeal of spectator androids cannot be understated. As was described, they were displayed in the most spectacular environments in a context of wonder and exploration. As the only mechanically animated media available in their time, the apparent miracle of their movement was extremely attractive. This combined with their depictions of beauty, youth, the exotic and the wealthy for a potent experience. Even today, the opportunities to view or interact with these machines are tinged with wonder.

I have taken a broad approach, covering the history, uses, and responses to artificial humans since the days of Hero of Alexandria. Many of the themes in this project warrant further study, especially from an interdisciplinary approach. Research in cognition, perception, and recognition of faces and objects, may provide key insight into recognition and acceptance of modern androids. This area of study has been underexploited in robot sciences. The conceptual android of literature and philosophy

could bear further exploration, especially in regard to the changing nature of its impact. A contrast exists between mechanical and biological artificial people in literature such as Hoffmann's Olympia and Shelley's monster that would make an intriguing inquiry. Finally, throughout this project we have reviewed artificial people as representations of lived or imagined experience. The role of three-dimensional mechanical animation as a proto-medium used to transmit cultural moments and stories is an enticing question.

When we look at today's androids, we may think of them as part of an ongoing story about humanity's relationship with itself and its creations. The intended role of lifelike androids has changed since Jaquet Droz and Vaucanson created their automata. European historical androids were spectator devices meant to be looked at and reflected upon as objects of beauty and technology. Even Japanese karakuri through the Edo period, which had a modicum of overt interactivity, were intended to be mechanical performers. Today's androids are designed to be partners, teachers and social companions that, like human beings, interactively engage the emotions as well as the rational mind. Unlike any object of the past, the lifelike humanoid machine may also be designed to project enough qualities of 'being' as to be perceived –and treated – as an entity capable of reciprocal interpersonal relationships.

The art of android building is an art of illusion. The lifelike representation suspends the disbelief of its beholder so that the technology fades into the background. Vaucanson intended to educate as well as entertain when he demonstrated chemical digestion with his automaton duck. The mechanical marvel captured the audience, but the real argument was about digestion. Since the twentieth century, Gaumard Scientific Ltd has produced lifelike simulators for medical skill development. For example, the Noelle model cries, moves, bleeds and gives birth. Such a simulator is only effective if its audience buys into the illusion, allowing themselves to behave with Noelle's organs as if they were real. AURORA, KASPAR, and Romo are all semi-humanoid therapeutic androids that model sociable responses for autistic children. Some children respond very well to these machines, and learn better interaction skills with humans as a result of their experiences with the androids.

Android automata may well have a future in modern society. Should they be developed as communicative devices, they will have to demonstrate convincingly human social responsiveness, verbal and nonverbal communication, and domain-specific knowledge (Zhao, 2006). They may also be simply *robots*, human-shaped tools that easily maneuver our human-shaped world on our behalf. As tools or proxies for human labour and caregiving, especially in home and office environments, androids will be successful if their technology becomes *transparent* against their environment and purpose. Transparency can occur when the technology becomes ubiquitous or when its interface is so intuitive as to seem 'second nature'. In contrast to a gadget, the transparent technology becomes "so embedded, so fitting, so natural, that we use it without even thinking" (Weiser, quoted by Pew, 14). We cannot predict if robots will attain the ubiquity and transparency of the personal computer, the light switch, or the automobile.

The latent possibility that androids may become ubiquitous still raises moral and ethical unknowns. They may attain a type of citizenry amongst living things, similar to that of insects and other inscrutably intelligent life forms, with unknown implications for society. They could even cease to stimulate as they join the complement of intentional-self-movers on earth. They may cease to "impress themselves with any felt permanence or effect on the imagination", and be "closer to the level of *curiosa*" (Freedberg, 224). Yet can a gadget be trusted to teach children, care for the elderly and provide companionship to the lonely? Might there be implications to a programmatic relationship? These are questions yet unanswered.

For hundreds of years, android automata have held both a marginal status in academic inquiry and a consistent presence amongst amusements for both intellect and emotion. These spectacles have been a mainstay of entertainment technology as novelties and ambiguous puzzles for an eternally curious public. Where once an android played the dulcimer, today an android sings ever-changing improvisational jazz. In part because they require both aesthetic and technical skill, and in part because we have increased sensitivity to these almost-humans, these machines are a site for the intersection of art and science, philosophy and technology.

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