Created Beings

From Commonplace Motifs to Robot Myths and Simulacra

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***Abstract*— A commonplace object becomes the basis for an autonomous robotic artwork called *Floribots*. The work exhibits novel movement patterns that are highly engaging to its audience - leading the author to posit the phenomenon of emergence to explain unanticipated artwork behavior. The limits of this explanation are mapped by creating a series of autonomous artworks of varying levels of complexity. A synthesis around the nature of created beings is extended with reference to anthropomorphism, robot mythology, and simulacra.**

***Keywords*— robot; interaction; emergence; automatous; artwork; anthropomorphism; mythology**

I. Commonplace to Cosmic

This paper traces a speculative journey investigating the nature of "created beings" – machines that we make as reflections of ourselves. I look at some ways that these machines interact with us, and potentially with others. Along the way, I make a series of postulations to explain the processes that allow such beings to come into existence and cause them to act in interesting ways. These postulations become the basis for a body of fully-resolved automatous artworks - each of which is described and analyzed in terms of a developing explanatory synthesis.

II. Robot Flowerpots

An origami "chatterbox" is a commonplace object. The chatterbox, also known as a "fortune teller", is familiar to us as a simple paper-folding project and – with appropriate markings and embellishments – as the basis for a popular children's fortune-telling game. I became interested in the chatterbox because of its universality and the intriguing lateral-shift spatial transformation it performs when operated with two hands and used in fortune-telling mode. By attaching this paper origami element to an electromechanical actuator I accidentally produced an alternate *sudden inversion* spatial transformation that is analogous to the transition of a flower from bud to bloom. Further development from this starting point yielded a fully robotized flowerpot (fig 1). This flowerpot has a mirrored upper plate through which emerges a cloth-covered telescopic stem. When activated, the stem grows one metre vertically before the green origami bud atop it suddenly blooms into a pink and yellow origami bloom – whilst producing a distinct "wap" sound. Soon afterwards, the bloom withers back to its flowerpot and returns to a bud state.

Figure 1. Prototype robotic origami flowerpot

Floribots (fig 2) is an interactive collective organism consisting of 128 of these robot flowerpots with appropriate networking, electronics, sensors, and control software – it is a kind of robot garden bed that combines the familiar and comfortable chatterbox motif with a "spooky" manifestation as a huge (8m x 4m) mechanical floral arrangement that "watches you" and constantly reconfigures itself. Conceptually, *Floribots* was intended to stage a real-world encounter between its audience and a kind of "sci fi" tableau of co-operating mechanical plants - while provoking in the observer hopefully equal measures of disquiet and attraction.

When writing the software for the *Floribots* "hive mind" I drew on aspects of the behavior of my then-toddler-aged

Figure 2. *Floribots* responding to its audience

children. Accordingly, *Floribots* was programmed to exhibit different "moods" including the following:

Reactive: when a motion stimulus is detected from the audience, the *Floribots* matrix dances a wave sequence – the nature of which depends on the position of the stimulus. Repeated stimuli at the same locus tend to produce diminishing reactions - as the hive mind becomes increasingly accustomed to stimuli from that direction.

Excited: when the overall frequency of stimulation reaches a threshold, the system performs a semi-chaotic dance sequence.

Bored: when the level of stimulation drops below a threshold - because there have been few audience interactions for a period - *Floribots* becomes "bored" and performs a demonstrative dance to attract audience attention.

Naughty: when *Floribots* has been Bored for a period, and has not been able to attract audience attention in order to re-commence interaction, it enters a transitional "naughty" state and performs a characteristic movement sequence.

Asleep: once *Floribots* has passed through the Naughty state, it eventually "falls asleep", unless audience interaction recommences. When Asleep, *Floribots* sets its flowers to a sleeping position, and goes into low power-consumption mode. After a short time of complete rest, *Floribots* will again become sensitive to movement, which if detected will cause it to "wake up" instantly.

Waking Up: When awoken by movement or being turned on for the first time, *Floribots* will perform a special "stretching" sequence before entering Reactive mode.

Blip: While waiting for a stimulus, *Floribots* occasionally performs a quick single movement, just to let us know that it is "still awake".

Floribots was first exhibited at the National Gallery of Australia in 2005 where it interacted with an audience of some 100,000 visitors over a four month period. In practice, the behavior exhibited by *Floribots* seemed to me much more complex than its predefined moods and the transitions between them that I had programmed. Sometimes mood behaviors effectively partially overlay each other, creating new choreographic modes, whist the sound compositions played by an orchestra of 128 "wapping" paper flowers were entirely novel. The interaction between the work and its audience proved to be intense. I observed people lingering near the work for long periods and found that they would refer to the actions of *Floribots* as though it was a "being", rather than a mechanical arrangement of components. *Floribots* was voted "Peoples' Choice" of the National Sculpture Prize in 2005. It was the first time that I had made a "popular" artwork - seemingly almost by accident.

I understood the role of the commonplace object, the origami chatterbox, in making *Floribots* accessible to its audience - this was an intentional device. However, I felt the engagement that the work engendered with its audience via its novel behavior-patterns required more explanation. I wondered if these behaviors could be understood in terms of "Complexity Theory"[1]. Complexity Theory investigates how relationships between parts of a system give rise to the collective behavior of that system. A sufficiently complex system can sometime self-generate novel behaviors through a process called "emergence". Along these lines, it seemed that the overall "phase space"[1] defined by *Floribots'* mechanical, electrical, and software freedoms had given rise to emergent patterns and expressions - effectively allowing a *created being* to come into existence.

Perhaps, I thought, any sufficiently complex automaton has the capacity to become a *being* and exhibit novel behavior…

To analyze *Floribots* in Complexity Theory terms, I assessed it logically - that is, as a state machine. A state machine is a device with a calculable number of discreet possible conditions. *Floribots* has 128 flowerpots, which can be independently switched between bloom and bud modes. Thus *Floribots* can be regarded as having 2^{128} (circa 10^{38}) potentially different states. Given its order of complexity of 10^{38} - corresponding to many trillion trillion trillion trillion states, I postulated that the shear extent of this complexity was the root cause of its novel (emergent) "being-like" behaviors and resultant intense levels of audience engagement.

III. COUNTING

After my experience with *Floribots*, I decided to create a new autonomous artwork with much less inherent complexity - to see if emergent behavior still manifested. The work I developed was called simply "Counter" (fig 3).

Counter is an interactive installation in the form of a large yellow pedestrian portal that literally counts each person that walks through it. *Counter* has nine magnetically-actuated digits on its front and back faces and is capable of counting to one less than a billion, after which it clocks-over and returns to zero. Each time *Counter's* number changes; a distinct "thwack" sound is made as its magnetic display segments flip over.

Figure 3. *Counter* installed in Aarhus, Denmark

[1] A phase space is a space in which all possible states of a system are represented, with each state corresponding to a unique point in the coordinate geometry of the space.

Figure 4. *Counter* with a "pedestrian vortex"

Apart from its role in mapping the possibilities of created beings, the concept for *Counter* arises from the imperative to "be counted" or "make sure you count" that is part of liberal democratic cultural heritage. In addition, the work carries more unsettling overtones of surveillance and scientific measurement. *Counter* also employs a commonplace, highly accessible, motif in terms of being, at core, a simple "doorway".

Counter has 10^9 potential states, making it hugely less complex than *Floribots* as a state machine. In addition, unlike *Floribots* - which can transition between states in multivalent and open-ended ways - *Counter* has only one transition available: "to increment". Despite being crippled in terms of its relative complexity, *Counter* has proved surprisingly capable of engaging its audience. The work has been installed four times in temporary outdoor exhibitions, three times in Australia and once in Denmark. Each time the work has counted around 2 to 300,000 pedestrians, with its final installation at Bondi in Sydney taking it over one million aggregate interactions.

Two arguably emergent behaviors have manifested repeatedly in all four of *Counter's* installations; phenomena which I term the "pedestrian vortex" (fig 4) and the "decimal effect". A pedestrian vortex forms when a group of people form a circular queue to continuously file through *Counter's* archway and keep it "clocking over" as it counts each individual over and over again. It turns out that being counted repeatedly is sufficiently attractive for this formation to spontaneously occur every time that *Counter* has been exhibited. The decimal effect is a heightened level of crowd engagement and excitement as *Counter* approaches a large power-of-ten clock-over point, such as 10,000 or 100,000. At such moments some jostling to "be the one" occurs and a loud spontaneous cheer will typically arise from the audience.

I think that the most interesting, possibly emergent, behaviors of the *Counter* installation are not its mechanical state changes in isolation, but the combination of these transitions with audience behaviors. Thus the true complexity of the created being system includes not only the 10^9 states inherent in *Counter's* electronics but the much larger phase space of its 300,000-per-exhibition human audience. The ultimate complexity of such an automatous artwork becomes difficult to fix, given the demonstrated capacity of *Counter* to "grow" its phase space by absorbing state-potential from its human audience.

Based on my experiment with *Counter*, I conjected that even simple automata have the propensity to "borrow" additional state-potential from their audience, so that they too can achieve emergence.

IV. BINARY AUTOMATA

If an automatous artwork as simple as *Counter* can develop emergence, how simple can the system get, while maintaining this propensity? To investigate, I decided to address the logical limit of state machines. Accordingly, the next work in this series, titled "Clockwork Jayne" (fig 5) has just two states.

Clockwork Jayne consists of a life-size fiberglass ballerina figure mounted on a faceted mirror base enclosing a clockwork mechanism that can rotate her. *Clockwork Jayne* was modelled on prima ballerina Jayne Smeulders of the West Australian Ballet, who heroically posed for over three hours standing "en pointe" while a full body-cast was made. When this work's clockwork mechanism is wound up, the ballerina pivots slowly and a tune plays quietly until the spring winds down. The work draws on another commonplace motif; children's clockwork music boxes with ballerinas that pop up and spin in front of a mirror when you open the lid. As a simple rotating clockwork, this automaton has just two logical conditions: wound-up, and unwound.

When *Clockwork Jayne* was exhibited, despite her extreme simplicity as a state machine, yet another self-generating audience behavior was apparent. *Clockwork Jayne* tends to prompt her gallery audience to form into an orderly queue - patiently waiting for the experience of winding her up and watching her gradually unwind. I have since made another variant on this concept, called "Solar Jayne". *Solar Jayne* (fig 6) is again based on the body-mold of the same ballerina and is also a binary (two state) automaton. She differs in being solar rather than clockwork powered, having six buttons rather than a single winder as interface, and incorporating an extra mechanism to allow her head to "spot" while she pirouettes. Audience members need to press *Solar Jayne's* buttons to make her "go". If they press the "right" button she goes 'round and 'round, if they press the "wrong" button she just shakes her head. When exhibited on Cottesloe Beach in Western Australia, *Solar Jayne* drew a crowd, particularly of children, who would scramble over her base, frantically pressing her buttons many hundreds of

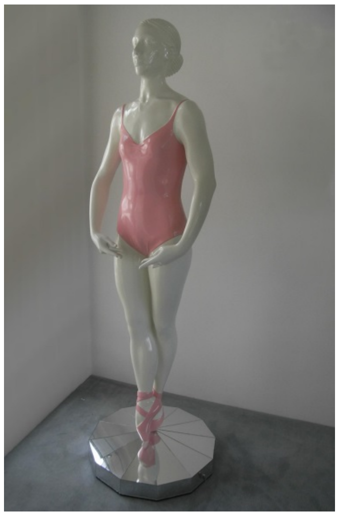

Figure 5. *Clockwork Jayne*

Figure 6. ***Solar Jayne***

times – tirelessly seeking the delight of her pirouette response.

In observing these binary automata, with a level of inherent complexity surely too low to permit emergence from within, I still noted artwork/audience interactions that were intense, at times novel, and arguably emergent. My interpretation, consistent with my earlier conjecture, is that these artworks are able to grow behaviorally by acquiring state-potential from their human audience.

The motivation for humans making their state-potential available to an automaton, however, requires further explanation. In the case of *Counter* the act of enumeration itself is sufficient to prompt deep audience engagement with an abstract, conceptual work. I see a parallel with the use of a commonplace motif in *Floribots;* just as flowerpots are familiar and attractive, so is the very act of counting. It seems that humans are generally attracted to automata based on commonplace motifs and motivated to share state-potential with them. In the case of the ballerina automata *Clockwork Jayne* and *Solar Jayne* however, my view is that it's principally the device of *anthropomorphism* that binds the audience so closely to these human-shaped artworks. Humans are universally attracted to representations of themselves, and the intensity of this reaction is magnified exponentially when the representation *moves*, and even more importantly *reacts to them*. With the boost provided by anthropomorphism, it seems that even binary automata can achieve emergence.

V. Variable Relief

Having explored the limit of low-complexity automata, an alternate wing of investigation suggested itself – that of automata even more complex than the 2^{128} states of *Floribots*. Accordingly, I created a "spatial robot"[2] called "Headspace" (fig 7).

Headspace draws on the ancient art-form of relief sculpture, but updates the traditional carved stone format to a matrix of 256 motorized polished aluminum rods. Each rod can independently move back and forth by about half a metre,

[2] Spatial Robots are reconfigurable environmental machines that are optimized for altering their shape in response to stimuli. They may be considered to be a sub-branch of interactive architecture.

Figure 7. ***Headspace*** **depicting a facial profile**

allowing the overall grid to assume a wide range of relief topologies. *Headspace* is effectively a "variable relief" sculpture.

Headspace is fully automatous; possessing four motion sensors with which to detect human presence and an on-board software algorithm to regulate its behavior. This *Headspace* "mind" is loaded with three-dimensional scan data from the faces of over 600 schoolchildren, and the rod matrix is able to adjust its relief profile to represent these faces, as well as morph between them and perform various geometric transitions. As a variable portrait system, *Headspace* is capable of human representation - like *Clockwork Jayne* – and thus is also, in a sense, anthropomorphic.

Headspace is vastly more complex than *Floribots*. Each rod in the *Headspace* matrix may be moved between 256 discreet positions, so the overall system has 256^{256} or about 10^{616} states! When *Headspace* was placed on permanent exhibition at Christ Church Grammar School (Perth, Australia), I noticed novel, unanticipated behaviors manifesting in terms of interference between its disparate subsystems, and apparent layering of algorithmically discreet matrix behaviors. So *Headspace* also exhibits emergent behavior - as we may have expected given its very high level of complexity. In addition, *Headpsace* has proven to be exceptional in terms of its audience engagement, although mostly *online*. In fact, more than 150,000 people have viewed the Youtube video of *Headspace* – considerably more than have physically attended any of my gallery exhibitions.

VI. The Pineapple

Although *Headspace* is installed as a permanent art installation, it is located inside a building and its physical audience is restricted to students and staff at one particular school. I wanted to further intensify the relationship between an automatous artwork and its audience by placing a suitable work fully into the public realm where a long-term relationship could develop. In a long term relationship, perhaps even more state-potential can cross over from humans to a created being… The opportunity to try this out arose in the form of a

Figure 8. *Totem* responds to pedestrian movement

public art commission for the pedestrian plaza next to the Perth Arena indoor stadium in Western Australia.

The work I created for the Perth Arena is a spatial robot called “Totem” (fig 8). The design for the reconfigurable elements of *Totem* is based around a triangulated version of the chatterbox geometry of *Floribots*. The original origami of *Floribots* is vastly scaled up for *Totem* - as each “petal” is now some 2m in length, made of aluminum, and mounted on a structural steel frame. *Totem* is 11m tall, weighs almost 20 tonnes, has 108 reconfigurable elements, three laser projectors, and is fully automatous and interactive with its environment. It is believed to be one of the largest automatous robotic artworks globally.

Totem is roughly cylindrical in form, is colored bright yellow, and has a complex faceted surface. Perhaps unsurprisingly, given these characteristics, *Totem* has been given the nickname “The Pineapple” by the people of Perth where it is located. *Totem* has 2^{108} or about 10^{32} states, so it falls somewhere mid-range in terms of the realm of complexity I have explored in this paper. *Totem* has also demonstrated emergence in terms of novel sequences and pattern overlays in the movements of its reconfigurable elements. In addition, *Totem* tends to provoke a characteristic pedestrian “orbiting” behavior, as people repeatedly circle around the work, seeking to stimulate its motion sensors and prompt a movement response.

VII. COSMIC CONNECTIONS

Totem is physically large and its engagement timescales are long. It has been running continuously since late 2012 - during which time it has built an ongoing relationship with its audience. However, it occurred to me that a more expansive yet mode of connection for an automaton could be contemplated. I speculated that there could be other audiences and sources of state-potential available to a suitably optimized robotic artwork. The opportunity to investigate this possibility arose with a commission to create an external artwork for the NEXTDC Data Centre, in Malaga, Western Australia. The resulting work is titled “Readwrite” (fig 9) - which is activated by stimuli of primarily extra-galactic origin.

Readwrite is an automatous robotic artwork some 10m in length, with 24 pneumatically actuated “flipping” elements arranged in a grid, mounted on the front elevation of the data center. Motion sequences on *Readwrite* are triggered by the detection of charged “muon” particles. Muons are terrestrial cosmic rays generated in the upper atmosphere by interactions with high-energy particles originating from distant supernovae and the accretion disks of supermassive black holes in active galactic nuclei. *Readwrite* has four muon detectors – with one mounted at each corner of the artwork. When a “cosmic ray” hits one of the corners of the piece, a propagating wave of flipping elements begins from that point.

The *Readwrite* control algorithm is based on a heavily modified version of the *Floribots* code-base, and retains elements of the emotional modes of that work - which were originally modelled on the behavior of my sons at toddler-age. Given this, although *Readwrite* is lower in complexity at a mere 2^{24} or $\sim 10^{7}$ states, it is not surprising that some of the propensity for emergent behavior first noted in *Floribots* remains evident. Indeed, *Readwrite* has been observed to perform overlapping choreographies and mid-flip reversals which can be interpreted as emergent behavior patterns.

In terms of local audience reaction, *Readwrite’s* location on an arterial road in an industrial precinct means that little local impact is readily apparent - bar the occasional car slowing down to get a better view. Thus it seems that *Readwrite* is unlikely to be able to borrow state-potential from its human audience. However, perhaps its ultimate complexity as an automatous system extends to its network of extra-galactic connections - which could give rise to considerable additional emergent potential. A caveat however, is that the cosmic conversation in which *Readwrite* is involved is fundamentally *re*active rather than *inter*active in character - due to large distances (millions of light years) extending the feedback time from its extra-galactic interlocutors beyond the likely endurance of the artwork.

Figure 9. *Readwrite* performing a wave sequence triggered by a cosmic ray

VIII. ROBOT MYTHOLOGIES

I noted previously that the *Clockwork Jayne, Solar Jayne,* and *Headspace* automatous artworks employ the compositional device of anthropomorphism – that is, they mimic the physical appearance of a person. Extrapolation beyond the notion of anthropomorphism led me to wonder what it might be like for a created being to not just to look, but to *be*, like a person - to delve into the realm of the "anthropo-onlological". I anticipated that even deeper levels of audience engagement should be possible with this approach, with yet greater potential for human phase space to be "shared" with an automaton. I decided that an investigation of this possibility would best be made via an ongoing dialogue between a real person and a made person - somewhat in the tradition of a "Turing test" [2]. I have collected a set of pre-existing frameworks for such conversations that I call "robot mythologies".

My list of candidate robot mythologies includes widely known stories about made beings, such as: Mary Shelly's *Frankenstein* [3] - the creature who becomes jealous of its creator; *Pinocchio* [4] - the wooden boy who wants to be real; Rachel - the replicant who thinks she's a real woman [5]; *Terminator* - the robot from the future that becomes a surrogate father figure [6]; Golem - the clay being from Jewish mythology that is animated by an inscription but cannot itself talk; the Tin Man - who yearns for a heart to fill his empty chest [7]; and the robot doppelganger of Maria who unleashes lust-driven chaos and stirs dissent throughout *Metropolis* [8].

Perhaps the most emotionally-charged robot myth is *Coppelia*, as it deals specifically with romantic love and attraction. *Coppelia* is a story about a clockwork girl, who is mistaken for a real girl by a boy who falls in love with her. The story thickens further when the clockwork girl is in turn impersonated by a real girl, jealous of the boy's affections. *Coppelia* is a ballet, with music by Saint-Léon, Nuitter, and Delibes, based on a story by Hoffmann [8]. It was first performed in Paris in 1870, and since then has become part of the classical ballet repertoire and is staged frequently by ballet companies around the world. Because the *Coppelia* story deals with the issues at the edge of humanity - machines interchangeable with persons, love and attraction in flux at this boundary - I decided it was fertile ground on which to develop an automatous artwork dealing with the crux of the created being issue.

IX. THE COPPELIA PROJECT

The Coppelia Project[3] involves the creation of a troupe of four life-size automatous robot ballerinas who are able to learn and perform dance movements and interact with each other and their audience. *The Coppelia Project* is inspired by the story of a clockwork girl in the ballet *Coppelia*, whilst also drawing on the commonplace metaphor of clockwork music boxes, like the *Clockwork Jayne* artwork.

The Coppelia Project robots are optimized narrowly as ballerina robots or "dolls". They can spin "en pointe", while moving their, arms, head, and waist. However, they cannot walk and their hands do not have grippers to pick things up.

The Coppelia Project dolls are taught ballet movements by having their arms, head, and torso physically moved through a ballet sequence by a ballerina trainer. An on-board computer captures the motion so it can be replayed later in various dance move combinations. Realization of *The Coppelia Project* required custom-developed electronics and software to enable real-time ballet motion capture and replay – a solution for this requirement was developed and integrated with the assistance of roboticist David Veerman.

The mechanical articulation of the *Coppelia* dolls was the result of an extensive research and development exercise undertaken with Jayne Smeulders of the West Australian Ballet. Jayne assisted in establishing the biodynamic requirements for ballerina movement by demonstrating the classical ballet positions (fig 10) and the paths of the limbs in transition between these states. Jayne also acted as the model for the robots, each of whom shares her body shape and facial appearance.

In terms of its complexity, *The Coppelia Project* has quite a large phase space and thus ample potential for emergence. Each of the four dolls has 18 independent axes with 12-bit position resolution on each, allowing $4{,}096^{72}$ distinct conditions of the system - which equates to 2^{864} or about 10^{260} states. This is lot more complex than *Floribots*, but still much less so than *Headspace*.

My goal with *The Coppelia Project* is to create "mythically charged" automata – a group of interactive, self-determined, expressive machines – that once set free, operate independently to explore questions at the edge of humanity. Specifically: are machines interchangeable with persons? What are the patterns of love and attraction at this boundary?

I see *The Coppelia Project* as a kind of staged confrontation between humanity and its technological alter-ego. The dolls are "blanks" that are energized by their programming to mimic the elegant movements of human dancers, but they are imperfect in their attempts at human grace. Another stark difference

Figure 10. Jayne Smeulders demonstrating ballet positions

[3] The Coppelia Project has been assisted by the Australia Council for the Arts, The Western Australian Government through the Department of Culture and the Arts, The West Australian Ballet, and the many generous contributors to its crowd-funding campaign.

between people and robots is that people are unique, while robots are manufactured goods and can be made on a production line. To emphasize this distinction, the *Coppelia* robots will perform as a group of four identical machines.

Currently, just one *Coppelia* doll – believed to be the world's first full-size robot ballerina - has been assembled. This first doll – named "Lilas Juliana Areias" (fig 11) - gave her debut solo performance to an audience of special guests at an exhibition at my studio in 2013. Parts for the other three robots are in various stages of assembly, so the piece overall remains a "work in progress". When fully realized, I hope to use *The Coppelia Project* as the basis for a yet more ambitious work integrating human and robot dance in a new ballet stage production.

My selection of the *Coppelia* theme was made decisive by a fascinating aspect of this ballet when viewed on-stage. In a *Coppelia* production one sees a beautiful and graceful ballerina "hamming it up" to deliberately move like a clunky robot. We know when we see this performance that the clunky robot being imitated is meant to be a real girl who is pretending to be a clockwork girl, who has been mistaken for a real girl. Why not, I thought, add yet another layer of irony to this intrigue by making a robot to imitate the human ballet dancer? In contemplating this stack of one thing pretending to be another thing, which is in turn pretending to be yet another thing, I am reminded of the concept of "simulacra" as articulated by the cultural theorist Jean Baudrillard [9].

Figure 11. *The Coppelia Project* - "Lilas Juliana Areias"

X. Complexity Inflation

Earlier I analyzed the inherent complexity of some of the automatous artworks that I have made by regarding them as state machines. I generalized from this a pattern where the novel behaviors that characterize *created beings* arise spontaneously from highly-complex automatous systems. Often however, the ultimate complexity of these systems seems to be inflated by an injection of state-potential from their audience. I found that audiences are prepared to "lend" phase space to an automaton were that artwork has first offered to "bind" with them in some way. I have noted that this offer to bind can be expressed in the following ways:

- Using a commonplace motif; such as a flowerpot for *Floribots* or enumeration for *Counter*.
- Anthropomorphism; looking like a ballerina for *Clockwork Jayne*, or taking on the facial appearance of a school-student for *Headspace*.
- Occupying the public realm; like *Totem* which is installed next to Perth Arena, in the central business district of Perth.
- Making a mythic connection; like *The Coppelia Project.*

I have also touched on one possibility beyond this anthropocentric structure, where other audiences and sources of state-potential could become available, in terms of the extra-galactic stimuli to which *Readwrite* reacts. However, the primary circumstances that I have found which engender complexity-inflation all seem very much about humanity, or "*us*", in the following ways:

- Commonplace – being familiar to us.
- Anthropomorphic – looking like us.
- Public – being present with us.
- Mythic – being part of our story.

So, is an investigation of the way that created beings emerge via such exchanges with humanity, ultimately just another way of looking at *ourselves*, by apprehending mere copies or representations of us? To answer this question adequately I refer further to the work of Jean Baudrillard.

XI. Simulacra

To me, Baudrillard is the primary authority on the nature of technological simulations, copies, and representations. He has examined the historical and cultural development of these phenomena and has identified three orders of simulacra:

- First order; where objects are unique and each representation is a clear counterfeit of the real and is recognized as merely a place-marker for the real.
- Second order; where mass production and widespread availability of mechanically produced copies cause distinctions between representation and original to begin to break down.
- Third order, where the distinction between reality and representation vanishes. In the third order of simulacra, which roughly corresponds with the world we now inhabit, Beadrillard says that we experience a precession of simulacra; that is, the representation precedes and determines the real.

How can the *Coppelia Project*, where I aim to make anthropo-onlological automata, be reconciled with this undermining of the ultimate reference – humanity – on which the construct is founded? The apparent model for these automata is of course "us" – human beings. We are unique, natural, imperfect, people; who possess *agency* – that is, we have volition, capability, and motivation. It seems obvious that to the extent that an automaton begins to seem like a *being* it is because it seems like *a human*.

However, Baudrillard explains that, in general, the real, authentic, and original – in this case the true human - has been dissipated by the "precession of simulacra". In making this observation, I think Beaudrillard hints at a yet more interesting interpretation of where "true humanity" might now lie. It seems to me that our collective nature has come to reside in the very layering of the simulacra-stack that we have built up around ourselves. This "stack" is no longer ordered from most authentic to least, but is like a loop, perhaps akin to the "pedestrian vortexes" that spontaneously form to cycle through the aperture of *Counter*. By analogy; the defining photographic portrait of our time has shifted from the stiffly-posed formal tableaus of a century ago, to a digital "snap" of a teenager in the very act of taking a "selfie". In this context, *The Coppelia Project* contributes to the definitional process - by adding further layers of simulation to the simulacra-stack, and possibly even extending the system laterally by acting as a simulacrum of an entire stack of simulacra. Indeed, I think that such referent-less human simulacra systems now constitute the most useful "us" available for artistic examination.

XII. MIRRORBEINGS

In this paper I have described how commonplace motifs such as origami chatterboxes, doorways, and music boxes can become the basis for unexpectedly-behaving and deeply engaging automatous artworks. I have analyzed the emergent behavior exhibited by these automata in terms of the inherent complexity of each artwork, and examined how they can sometimes acquire additional complexity and potential for emergence by effectively borrowing "state-potential" from their human audience. I have noted the role of anthropomorphism in intensifying the engagement between audience and robot, and looked at the potential for robot mythologies to extend this engagement.

I have touched on the notion of simulacra to help understand the cultural context of automatous artworks that seem like beings. We humans naturally tend to see ourselves as the primary originals confronting our secondary simulations in the form of such creations; but Baudrillard reveals that our position as originals is no longer privileged. Any claim that we are the first and special beings – in a milieu characterized by pervasive practices of re-representation, multiple duplication, and perfect copying - has been deeply undermined.

In many of my works I include a reflective element - a mirror. For example, every *Floribot* has a mirrored base-plate, and *The Coppelia Project* dolls have mirror-polished aluminum skeletons (fig 12). These inclusions are deliberate, as I see every created being as a kind of mirror. The implication is that the relationship between creator and created is ultimately reciprocal. Via the precession of simulacra our creations reveal in us aspects of an "inverse Pinocchio" – the boy who wishes he was wooden. In a similar vein - via confrontations with automata - we may also see reflected our various propensities as jealous creatures, speechless golems, and beautiful clockworks.

I have made automatous artworks utilizing a progression of artistic devices from commonplace inclusions to mythic allusions in pursuit of ever-deeper audience engagement and greater opportunities for emergence. It seems that the resultant created beings are imitating us, while we in turn imitate them - and that the greatest potential for emergence arises from the pooled phase space of us *and* our creations. Further, we have seen a hint that even further potential may be tapped from the very phase space of the cosmos.

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