ISEA2015
Proceedings of the 21st International Symposium on Electronic Art
ISSN: 2451-8611
ISBN: 978-1-910172-00-1

homunculus.agora (*h.a*), an architectonic art installation

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Abstract

This article provides an overview of the development process and motivations behind the creation of *homunculus.agora* (*h.a*) an architectonic installation made of 41 sculptural bodies that were installed in the Main Gallery of the Markham Museum for two exhibitions that spanned from September 2013 to August 2014.

Keywords

architectonic, interactive, biomimetic, emotive, file-to-factory, digital fabrication, design pattern, embryogenesis.

Introduction

homunculus.agora (*h.a*) (*fig. 1*) is a large-scale architectonic installation of 41 sculptural bodies that were organized in a fluid-like cluster. The sculptural bodies are implanted with electronic circuits that give them the ability to express behavioural qualities through light and sound events. A selection of the homunculi are touch sensitive and are positioned on the floor to invite people to touch the work. In doing so, the touch sensitive homunculi react with emotive sound and light responses. *homunculus.agora* derives its name from an alchemically made creature that looks like a miniature of its creator. This is a metaphor for the relation of the technology we create to ourselves, which is deeply connected to our bodies and the way we perceive the world. The term *agora* is a Greek word describing a place for gathering [1]. The Homunculi gather in the museum to facilitate an exchange of emotive expression that contributes to an ecology of form, light, and sound. It becomes a gathering place for people to reflect on the connection we have with the environment and the world around us.

Previous Works

homunculus.agora is a solo work that was developed using knowledge and experience gained from my involvement with several collaborative works that integrate interactive technology in an architectonic installation context:

The emotive *InteractiveWall* (2009) [2], a collaboration between *Hyperbody* [3], *Festo* [4], *Burkhardt Leitner constructiv* [5], was a dynamic wall composed of seven separate wall components that display real-time behaviour. The components bend themselves back and forth, displaying patterns of light on their skins, and projecting localized sound in response to the presence of a participant.

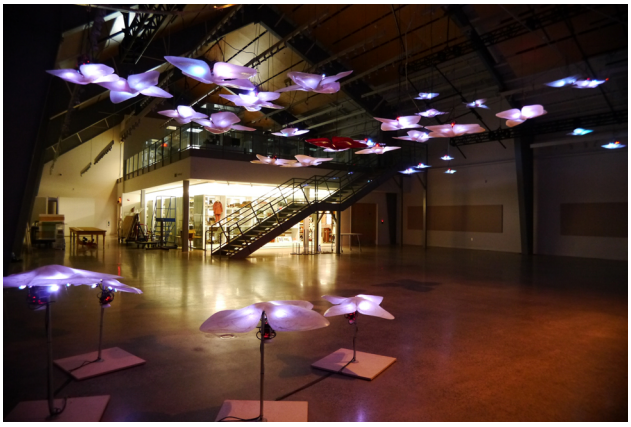

Figure 1. *homunculus.agora* (*h.a*). ©2014 M.D. Hosale.

protoDECK (2009 - 2011) is a project developed by Marco Verde and MarkDavid Hosale for *Hyperbody*, TU Delft, The Netherlands [6]. A key physical subject of the *protoSPACE* 3.0 lab, *protoDECK* is a tool as much as it is an expression of architectural and interaction design. Designed as an open system, *protoDECK* is both physically and behaviourally a modular system developed to embody multi-modal interaction, and to be adaptable to the research and education needs of *protoSPACE* 3.0.

The *Quasar* series (2007-2013)[7], which included *Quasar* (2007)[8], *Quasar 2: Star Incubator* (2012)[9], and *Quasar 3 [danger du zero]* (2013)[10] was an iteration of immersive interactive light and sound installations realized in collaboration with Los Angeles-based architect Jean Michel Crettaz and various other collaborators. The name of the series is derived from a mysterious astronomical occurrence, known as quasars, which are understood to be extremely ancient and highly luminous events that occur in the furthest known reaches in our known Universe. The significance of quasars to the work is that they represent the edge of what can be seen and known, they are a demarcation of our epistemological horizon.

An interactive sound layer was developed as part of Philip Beesley's sculpture, *Sybil* [11] for the 18th Biennale of Sydney, June 27 - September 16, 2012. *Sybil* fuses textile based sculpture, distributed computing, mechatronics, and living chemistry. *Sybil* is an iteration of Beesley's *Hylozoic Series* [12]. The installation is articulated with a variety of intricately designed and fabricated biomimetic sculptural objects that are kinetic and respond to the presence of overseers in the exhibition space. These responses trigger change reactions of behaviour that propagated throughout the installation. The interactive sound layer involved a 12-channel, peripheral speaker system that monitored the sculpture's internal communication network and triggered global audio events that generate higher order emotional responses within the work.

Motivation

The motivation behind creating *homunculus.agora* was to explore the emotive connections we form with the technological objects we make. I believe we form these connections because the technology we make is part of our ideas, our culture, and our bodies and therefore is part of ourselves.

In legend a homunculus is an alchemically made creature that looks like a miniature of its creator. There are several recipes for making a homunculus, but they all commonly call for the use of the creator's ejaculate as part of a potion in which the homunculus is grown. After the creature is a fully formed homunculus, "…he comes out and puts himself at your service. And they never die. Imagine: they'll even put flowers on your grave after you're dead!" [13]

Conceptually, we form similar connections with our own technological creations as the alchemist did with the homunculus. A product of our culture, technology, in turn, shapes our culture, our minds, and our bodies, having a lasting impact on the organization and manipulation of our World. As we pass on the technology remains, it holds our thoughts and extends our impact beyond the grave to future generations.

The plan of *homunculus.agora* is a reflection of the *Ontario Green Belt* [14], which is a protected horseshoe shaped zone that surrounds the Greater Toronto Area (*fig. 2*). *homunculus.agora* responds to this non-urban territory recognizing it as techno-symptomatic of the urban condition. The *Green Belt* is in part designated as a "wild" (i.e. non-human) zone, in part agricultural, motivated by the desire to strike a balance between nature and human development. The *Green Belt* can be understood as a homunculus in itself, as it is a territory that has been constructed through human intervention, taking its shape based on existing (and anticipated future) urban population growth and development. Although the establishment of the *Green Belt* is motivated by the desire to strike a balance between nature and human development, this territorialisation takes its shape based on existing human development and is constrained by the future needs and ambitions population growth and development. This is not intended to be a criticism of the motivations behind the *Green Belt* per se, rather it is an observation that the formation of these zones is an extension of innovation and technology, and in turn an extension of ourselves. In this manner, human territorialisation/extension covers the entire planet. No stone is left unturned, nothing is unaccounted for.

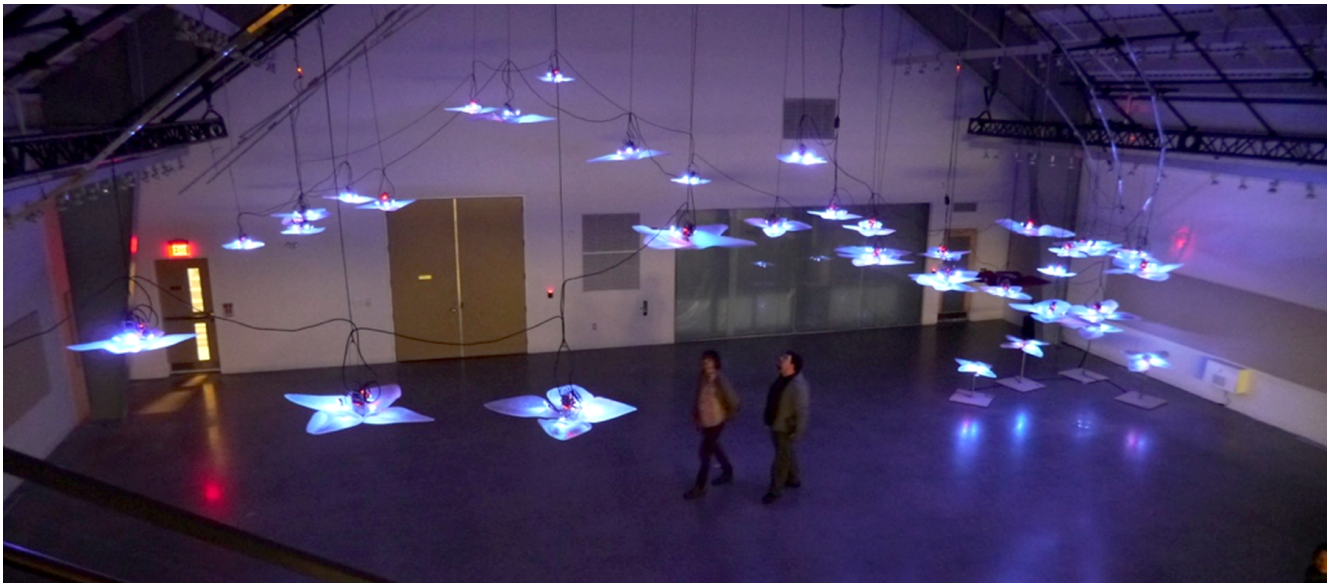

Figure 2. The plan is most observable from the balcony above the work. ©2014 M.D. Hosale

Technical Description

The sculptural bodies of *homunculus.agora* are computationally derived, digital forms built as part of a file-to-factory digital fabrication process that involved generative modelling, CNC milling, and casting of a fibre-composite exoskeleton in the York Digital Sculpture Lab (YDSL) and nD::StudioLab. The fibre-composite endoskeleton is translucent and is embedded with dynamic lights causing it to glow from behind. Loudspeakers are embedded in each of the petals of the homunculi, giving a musical voice to its behaviour. Each homunculus exhibits a continuous flow of ever-changing light patterns and sound events, which is an individual expression of their life cycle based on the generative logic of the work.

Behaviour

Behaviourally, the *homunculus.agora* installation can be understood as a simulated ecology, and is therefore a reflection of the *Green Belt* in behaviour as well as in form. The concept of ecology is present in the social interaction that the work facilitates, as well as in the behaviour of the light and sound events in the sculpture itself. As described above, the term *agora* is a Greek word describing a place for gathering [15]. In this context the *homunculi* gather in the museum to facilitate an exchange of emotive expression in a behavioural ecology of light and sound. It also serves as a gathering place for people to reflect on the reciprocal connection we have with the environment and the world around us. It is a context for a marketplace of ideas.

The life-cycle behaviour of *homunculus.agora* consists of a continuous cycle of high and low energy activity that mimics resting and wake rhythms in living beings. The generative logic and its behaviour are executed by a central computer that interfaces with an *n*D::node, described below.

When unattended, or simply observed, *homunculus.agora* exhibits a continuous flow of ever-changing light patterns and sound events, which are an expression of the life cycles that make-up the generative logic of the work. A subset of the homunculi were mounted on the floor and fitted with sensors to make them responsive to a person's touch. When someone touches the petals of one of the floor pieces it responds with a display of localized light activity near the location of contact and with a corresponding sound. This display is the expression of pleasure that starts as a localized event, but soon dissipates throughout the cluster of the *homunculus.agora,* merging the individual oscillating life cycles of the cluster together. Each petal-like limb is stimulated independently from another allowing for several people to interact with the work simultaneously.

The experience of interacting with a homunculus is like communing with an affectionate creature that expresses itself through a visual-musical language. To deepen this connection a *homunculi* is an interactive sculptural object that is intended to exhibit an affordance of play. This is achieved through the multi-sensory expression of the *homunculi*'s simple animal-like behaviour through the modalities of sound and light; and through responses to the caresses on its shell-like body when being touched.

Fabrication and Form

The sculptural bodies of *homunculus.agora* have an uncanny organic quality consisting of four petal-like limbs that have appearance of being fleshy, plant-like, and artificial in the same instance.

Inspiration for the shape of the pieces came from the illustrations of Theodor Kerckring (1671). Kerckring who was among a group of thinkers in historical medical practice, known as *ovists*, that believed embryogenesis of humans begins exclusively in the egg, and that humans are fully formed from the beginning of conception (*fig. 3*) [16].

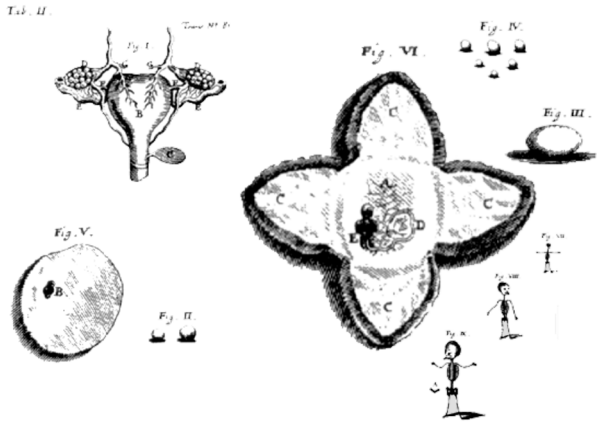

Figure 3. Theodor Kerckring's drawings of the "little man inside the egg." Images taken from Kerckring, Theodor. *Anthropogeniae ichnographia*. Frisius, 1717. *Images are public domain*.

When designing the sculptural bodies it was important to consider how the forms physically related to the human body so that they would be relatable to the human experience. Five forms were generated as polymorphic mutants of the same species in *Rhinoceros 3D* modelling software (*fig. 4*) [17]. Then negative moulds were milled using a large CNC-mill located in the YDSL. What followed was a painstaking manual process whereby the pieces were cast in a low VOC bio-based resin called *Super Sap* by Entropy Resins [18], using a sustainable fibre composite substitute for fibre glass called *Aqua-Veil* by Aqua-Resin [19], and assembled by hand over the course of several weeks with a team of six people. It was purposefully not a factory precision process. The manual assemblage of the pieces gave rise to further mutations in the pieces, so much so that no two are exactly alike, lending to the organic look of the work (*fig. 5*).

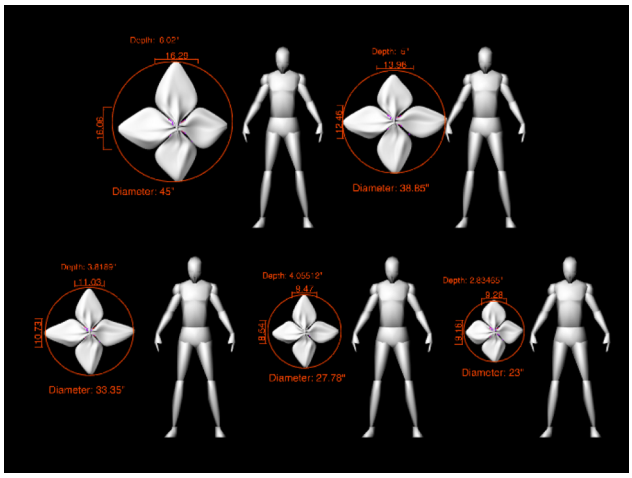

Figure 4. A screen shot from *Rhinoceros 3D* showing how the five base forms used in the work in scale to a 5'10" human body. ©2014 M.D. Hosale

homunculus.agora exists as a cluster of 41 sculptural bodies suspended in the gallery space at the Markham Museum in an area of 18 x 9 meters. Each individual of the cluster varied in size and shape, but are approximately 75 - 175 square centimeters in diameter. While the sculptural bodies were statically suspended in the gallery, the shape of the cluster has directionality and undulates like a wave or fluid system, which is intended to give the feeling of movement and energy. As described above, the plan of *homunculus.agora* is a reflection of the *Ontario Green Belt*, which surrounds the Greater Toronto Area (*fig.2*).

Figure 5. A series of images showing the fabrication process of *homunculus.agora*. *A total of 168 forms were cast and sculpted to make 42 pieces.* ©2013 M.D. Hosale

Hardware System

homunculus.agora uses a custom designed microcontroller platform, called the *n*D::node [20], to control its behaviour. An ongoing research project, the *n*D::node is a low-cost, *Arduino*-based hardware platform [21] developed to facilitate the creation of scalable, component-based media art works at architectonic scale. The *n*D::node forms a networkable system capable of handling hundreds of nodes that can be spread over large distances providing control (via LED's and actuators) while receiving real-time sensor data from the local environment (*fig. 6*). The result is a high-resolution bidirectional feedback system that can be embedded in the material systems of architectonic objects. The inspiration for the development of the *n*D::node stems from the problem that currently there are no low cost, ready-made, off-the-shelf solutions for the deployment of large networks of micro-controllers that can communicate with each other and/or with a central computer system bi-directionally. Systems that do exist are generally high cost, proprietary, and complicated to use, and as such, they are out of the grasp of most media artists and architectural researchers. To this end, the *n*D::node is being developed as a low-cost, readily deployable, open-source solution. *n*D::nodes bridge the divide between the virtual and physical by providing a ready to use platform for sensing and actuation that can be used in conjunction a wide rage of projects that require these technologies. *n*D::nodes could be integrated in every aspect of the Interactive Digital Environments facility, including the walls [22], ceiling, floor [23], and in stand alone objects in the space. Results from this work could be equally applied to large scale installations and related projects that require large arrays of localized sensing and control, such as those found in the fields of architecture, media arts, exhibition development, and related creative industries.

Figure 6. Overview of the *n*D::node system as used in *homunculus.agora*. ©M.D. Hosale 2014.

*n*D::nodes are developed to be a modular with the intention that the modules can be used to adapt to different projects easily. In previous projects modularity happed at the level of design and once manufactured the modules were populated on a single circuit board, such as with the *QYUnode* used in Quasar 2 and 3 (*fig. 7., right)*. However, in *homun-*

culus.agora this approach was not feasible due to the small space constraints of the piece and the larger circuit needed. So, it was decided to move some of the modules (such as sound, light, sensing) off board resulting in the system pictured above. Moving to this multi-board modularity has other advantages as it allows for different *n*D::nodes to have different arrangements of modules in the same system, and it allows for rapid prototyping of future projects due to the reconfiguration of existing modules, and its easy interfacing to new modules and prototype circuits.

The result is a system that is, topologically, very similar to the system developed by Robert Gorbet and Philip Beesley for the *Hylozoic Series* and related projects [24]. However, there are major differences in the communications system and the logic and organization of the boards, which I will not elaborate on here. However, it is noteworthy to acknowledge that 1) the *n*D::node is compatible with the *Hylozoic* system as it was integrated into the *Hylozoic* system for the purposes of a performance given at DEAF 2012 [25]; 2) there has been a sharing of ideas of the design of the boards and the technical details; and 3) while the two projects have developed independently (even before I ever met Beesley) there was clearly an influence of the *Hylozoic Soil* system on the design of *n*D::node having read their publications and analyzed their work.

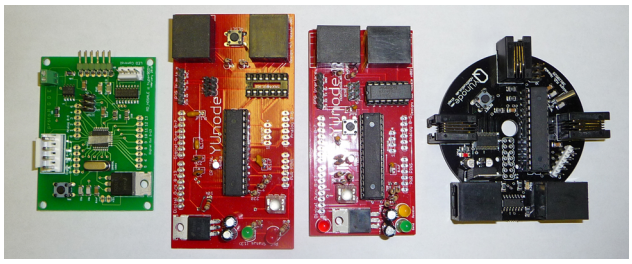

Figure 7. previous versions of *n*D::node used in other projects in chronological order from right to left. ©M.D. Hosale 2014.

Software System

The challenge of developing nonlinear interactive systems in my work has led me to the ongoing development of a software framework, called *WorldMaker Universe* (WMU). The inspiration for the development of WMU was to provide a strong connection between the hardware, software, and conceptual components of my research in order to maintain a fluid connection between the virtual and physical aspects of my work [26]. The framework facilitates the creation of expressive and emergent behaviour in interactive installation environments by encapsulating common use elements of the software design of interactive environments into a ready to use set of abstractions. The organization of this framework is based on a model of nonlinear narrative that is a composite of operations (data generators), structures (scaffolds for data flow), and personae (the interactive input and output representation of data). Each of these elements can vary independently of each other. Many of the concepts and terminology that help define this framework are taken from design patterns, as used in computer science, such as those found in *Design Patterns: Elements of Reusable Object-Oriented Software* [27]. This system proved beneficial in the development of the behavioural aspects of the work described above.

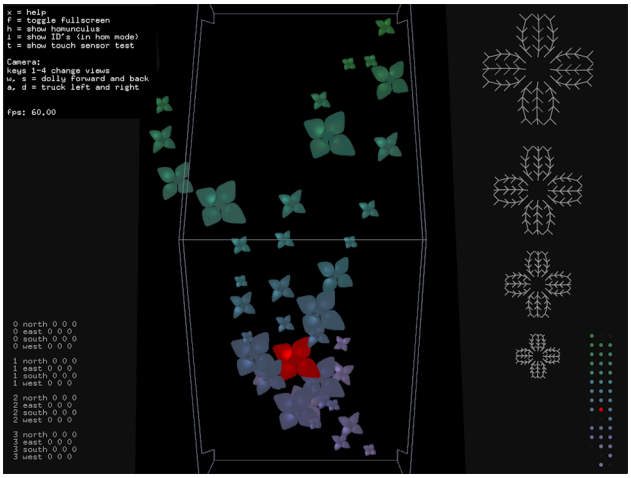

Figure 8. *homunculus.agora* software with the simulation and design for *Apple Mac*. ©M.D. Hosale 2014.

The software was developed using *OpenFrameworks* a C++ framework for the development of computational art [28]. *OpenFrameworks* facilitated the deployment of the software on multiple platforms, which proved beneficial for both prototyping and dissemination. One of the challenges of the work was the duration of the install (collectively for a year from September 2013 - August 2014). This meant that there would need to be a central control system for the installation that was robust but affordable. Another issue during this period was difficulty in travelling to the museum on a regular basis to update and monitor the piece. Therefore a software workflow was developed for the installation that included simulation, behavioural design, and deployment in the same code base. For speed and convenience a simulation and design version was developed for the *Apple Mac*, which allowed for development of the behavioural patterns remotely (*fig. 8*). And despite the vast differences between these the computing platforms, the deployment target platform was a *RaspberryPi Model B* [29] (*fig. 9*), which was low cost and had a small form factor. The software workflow was effective, but didn't entirely alleviate the need to travel to the museum for refinements of the system. Currently efforts are being made to connect the two platforms over the Internet so that updates can be made to the system without being onsite. A significant technical challenge, and assuming it is solved it will allow for newer topologies that will effect the dissemination of this and newer artworks, such as telematic interfacing between users and the work, and the work with other works.

Summary of Exhibitions

Land|Slide Possible Futures

homunculus.agora was commissioned by curator Janine Marchessault for the *Land|Slide Possible Futures* exhibition, which took place at the Markham Museum, Markham, Ontario, Canada, from September 21st to October 14th 2013 [30]. *Land|Slide Possible Futures* featured over 30 artists who were invited to respond to various themes related to urbanism in the context of a heritage museum in the Greater Toronto suburb of Markham.

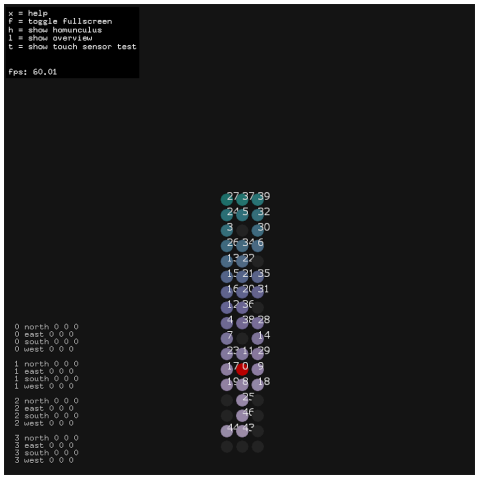

Figure 9. *homunculus.agora* software, deployment version for *RaspberryPi Model B*. ©M.D. Hosale 2014.

Farm To Table

homunculus.agora was asked to remain in the Markham Museum in order to be part of the *Farm To Table* exhibition from January 31st to August 17th, 2014 [31]. *Farm To Table* was an interesting exhibition in that it featured three artists along with a variety of historical and educational displays centred on the theme of food production. *homunculus.agora* was asked to contribute to the exhibition because of the work's connection to the Greenbelt and its agricultural activities.

homunculus.alpha (h.α)

homunculus.alpha (h.α) was presented at the *re-new 2013*, *Digital Arts Forum* from October 28 - November 3 at PB43, Copenhagen, Denmark [32].

homunculus.alpha (h.α) is a single sculptural body that served as a prototype to the larger cluster that appeared in the Markham Museum. Although chronologically the alpha was shown after the cluster was mounted, it was in fact the first one created. It served as the basis for the largest pieces in the cluster. I was interested in showing the single object for reasons of transportability and simplicity, but also was a context to see what kind of emotive connections could be derived from the individual. The results were mixed, but the effort proved useful, as there were a number of technical and behavioural problems that had to be solved before the piece was even able to be mounted that ended up influencing the development of the larger cluster as a whole.

Conclusions and Future Work

homunculus.agora is intended to be an adaptive work that can be installed in many kinds of situations. In the future it would be interesting to explore different configurations and topologies for the work such as exhibiting it in smaller, more intimate rooms, or building it up from the floor, rather than suspended, and other shapes entirely. In terms of the behavioural qualities it would be interesting to extend the sensing to be responsive to real-time environmental data as well as the surrounding ecology. Unfortunately, as of the writing of this text there is no current plan to exhibit the work further, but the development of the core technologies that made this work possible, such as the *n*D::node and the *WorldMaker Universe* (WMU) are under continuous development. Because of the advances in the simulation software and the modular hardware, *homunculus.agora* will prove to be a fertile development context for the *n*D::node and the WMU for foreseeable future.

Acknowledgements

I would like to thank the following people who made this project possible: *Fabrication Consultants*: Marco Verde (ALO [architecture | research and fabrication lab | education]) and Brandon Vickerd; *Fabrication Production Team*: Nicole Clouston, Brandon Davis, Qendrim Hoti, Rhianna Paul, Karen Pham, and Erika Roshan; *Augmented Reality Consultant*: Andrew Roth; *Augmented Reality Production Team*: Susana Navarete, Rohan Likhite, Jeff Tuxworth, and Ursula Sarracini; *Electronics Consultant*: Brandon J. DeHart; *Electronics Enclosures Assembly*: Miguel OCampo-Gooding, Radi Hilaneh, Rohan Likhite, Jeff Tuxworth, and Ursula Sarracini; *Installation Consultant and Rigging*: John Sabourin, Snap Hoek Productions Inc.; *Installation Team*: Lisa Hosale, Miguel Ruiz, Amy Stewart, and Jonathan Tyrrell; with Special thanks to James McKernan; Realized in the nD::StudioLab, Augmented Reality Lab, and Digital Sculpture Lab at York University, Toronto, Ontario, Canada.

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Author's Biography

Mark-David Hosale is an artist and composer who use technology as a means of expression. Mark-David has a Ph.D. in *Media Arts and Technology* from the University of California. He is an Assistant Professor in Digital Media in the *School of Arts, Media, Performance, and Design* at York University, Toronto, Ontario, Canada. He has had works exhibited and performed internationally at conferences, universities, and festivals; and has given lectures and taught at institutions in Denmark, The Netherlands, Norway, Canada, and the United States. The connecting tissue of his interdisciplinary interests lies in his exploration of nonlinear narrative as a representation of information, time, and space. His research and work also explores the boundaries between the virtual and the physical world. Whether as part of an installation or performance work, the virtual spaces he creates are technologically transparent, sophisticated and virtuosic, as well as intuitive to experience and use.