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Swarm Labour: The Aesthetics of Sentient Machine Collectives at Work

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Advancements in swarm intelligence, biomimetic robotics and related swarm technologies offers an interesting intersection of biological phenomena and machine assemblage. Electrical engineers, entomologists, artists, cultural and media theorists have long observed the labour methods and organisational structure of social insects as a communication system that can be applied to contemporary digital systems and networking. Amongst such swarm technologies of today, this thesis shall focus the development of biomimetic robot swarms in warehouses and sorting centres owned by information technology companies. Situated in a corporate context, swarming machines are in a constant slippery state of reconfiguration as they perform labour tasks that, although effective, appear incomprehensible, chaotic, and alien to the human eye. This thesis will examine the cultural significance of the insect motif in the development of swarm technologies and suggest that figures such as the ant have had their insect-technics appropriated for techno-capitalist use. Through a practise of media-archaeology, a review of insect organisation, socio-cultural symbolism, and their alien figure allows for a discussion on current and future potentials for the integration of swarm intelligence and sentient machines and what this means for the human/animal/machine relations of tomorrow.

Purpose of the research and its importance to the field:

The purpose of this research is to speculate upon human/machine/animal relations that have, through biomimicry, and a practise of media archaeology, manifested as swarm intelligence applications in the field of robotics. This research will theorise about human/machine/animal exchange fuelled by the machine learning revolution as a burgeoning field of mechanical system labour which has resulted in the emergence of sentient swarming machines. The notion of sentience is one fraught with ambiguity. However, in this context, I shall approach the issue of “perceived sentience” as a marker for the ability to demonstrate situational awareness and self-relation (Negarastani, 2018, 20-29). My research will involve: (1) A thorough historical analysis of how prevailing sociocultural and political representations of insects have contributed to the application of insect technics (insect organisation and behaviour) in mechanical tools such as robotics, and later, in machine learning (Parikka, 2010, 1-25). In other words, this project entails a critical review of somewhat forgotten or archaic swarm media to help better understand emerging swarm media of today (Parikka, 2012, 136-139). (2) I will assert that, through applying the behaviour and labour strategies of social insects to machines via swarm intelligence algorithms, artificial assemblages such as robotics, and machine learning tools are awarded a certain *animal spirit*, “creating in the process a series of fantastic hybrids” (Lippert, 2000, 187). (3) This thesis will research swarming technologies employed within corporate warehouses and sorting centres in correlation to underlying shifts brought about by the machine learning revolution: including a transformation of class relations and workplace relations between human, machine, and in the case of swarms, insects. Therefore, as information technology companies integrate swarms into their workforce, it is important to survey the accelerating technological forces that have driven history and that are driving the future of labour today – an issue which calls for a contemporary audit and updating of class struggle for humans and swarming animals (Wark, 2004, 089-125). (4) Finally, a creative component in the form of an art installation comprising of a swarm of small robotic arms, generative sound and visuals shall be created, exhibited and discussed throughout the paper where relevant in relation to the theme and research areas listed above.

Brief survey of background and related works

Swarms were seen as a potential case study for biologists and roboticists in the late 1980’s, due to a growing interest in cellular automata – particularly for their ability to “produce patterns of significant complexity starting from

simple rules” (Beni, 2004, 1). Research in the field of biomimetic assemblages that could self-organise and navigate their surroundings based on a process of exploration and exploitation (the gathering of resources and information to inform behaviour), pointed to the idea of an insect swarm as an accessible point of reference to such traits (Majid al-Rifaie, and Bishop, 2013, 85-85). The term “swarm” seemed appropriate to electrical engineering researchers Gerardo Beni and Jing Wang, as, in addition to being a great buzz-word, it encapsulated the interchangeable, disposable, and elementary nature of the individual units that successfully evoked their vision for decentralised robotic systems (Beni, 2004, 1-2). In 1989 Beni and Wang proposed the swarm as the ideal figure for which to base future developments and research in the realm of decentralised robotics systems with their paper, *Swarm Intelligence in Cellular Robotic Systems* (Beni., and Wang, 1993, 704). Prior to this, the study of social insects’ swarming labour systems was developed by biologist E.O Wilson (Wilson, 1962, Abstract). However, it was not until decades later that decentralised labour systems from nature were considered as a case study for the artificial simulation of swarming organisation through system algorithms such as *Boids* (Roy., Biswas., and Chaudhuri, 2014, 57). In more recent years, swarm intelligence has been researched in fields beyond natural science and electrical engineering. Cultural media theorists Jussi Parikka and Eugene Thacker have approached the organisational behaviour of social insects as having revealing correlation to the contemporary networks and intelligent agents. Such theoretical speculation ties philosophical discourse of non-human communication with a re-contextualisation of biological processes and information to the realm of networks, systems and machines. Publications like *Insect Media: An Archaeology of Animals and Technology* (Parikka, 2010), *Biomedial* (Thacker, 2004), and *The Parasite* (Serres, 2007) offer a techno-theoretical account of the scientific application of superorganism organisation found in ant colonies. The result is a transformative examination of how, through biomimetic artificial systems, decentralised networks of the natural world can shape how we think of media technologies. This thesis’ notion of swarm intelligence as a labour force extends these ideas of insect organisation as a form of media to the socio-political realm, citing concerns for prominent workers in the age of machine learning; humans, insects, and machines. Regarding issues of displacement of the human, and insect worker due to the employment of mechanical system assemblages, the writings of McKenzie Wark’s *Hacker Manifesto* becomes relevant. Wark proposes a modernisation of class conflict, one that denotes a possessive “vectoralist” class that monopolises the content of the “Hacker” class (Wark, 2004, 024-045). Hackers consist of musicians, writers, artist, philosophers, biologists and researchers that “hack” through creating new abstractions of

information that contain the possibility for new worlds (Wark, 2004, 014-015). My paper will suggest that, with a little adjustment to Wark's definition of Hacker class, micro-world building insects can perhaps be integrated into this list of hackers, since she states:

All abstractions are abstractions of nature. Abstractions release the potential of the material world. And yet abstraction relies on the material world's most curious quality – information. (Wark, 2004, 014)

Moreover, we can also connect Wark's concept of the creative "hacker" worker role to the potential for creative AI and how the artistic process of the artificial artist might compare to that of the human artist (Mazzone, and Elgammal. 2019, 1-4). – and again, to the creative labour process of the insect superorganism. The theory of Ant colonies as hackers takes Wark's contemporary notions of class conflict and applies them to biomimetic machine learning developments that have arisen from a corporate practise of media archaeology.

Contemporary digital, new media, robotic, generative, and sound art serves as a practical tool to assist in relaying such themes of machine learning, swarming insect behaviours, animal spirits, post human assemblages, and displacement of the worker amongst a techno-capitalist landscape. Media art venues such as Ars Electronica (Linz Austria), ZKM Centre for Art and Media (Karlsruhe, Germany) and Bildmuseet (Umea, Sweden) allow for a dissemination of ideas and discussion regarding machines, digital systems and intelligent agents. The recent collaboration between the Ars Electronica Futurelab and NNT (Japanese Telecommunications Company) *Swarm Arena* (2018), (see Fig. 1), presents a physical demonstration of a robot swarm that capitalises on their entertainment value by depicting how unmanned aerial and ground vehicles (UAVs and UGVs) would be utilised to display big data of spectator sports in a stadium environment. In-line with themes of swarm intelligence, but placing a greater focus on insect-media and the world-building potential of superorganisms, is Nicolas Mangan's *Termite Economies – Phase 1* (2018), (see Fig. 2). The display of 3D printed termite mounds, visuals and sound navigates the issue of exploitation of insectoid activity for economic gain. Carsten Nicolai and Marko Peljhan's *polar^m [mirrored]* (2010) installation reiterates similar aesthetics of nonhuman assemblages surveying natural resources (see Fig. 3). Here, the artists employ robots that use computer vision and electromagnetic radiation detection to gather radioactive data of granite boulders, gathering invisible information to be generated into visuals and sound that is perceivable to a human audience. Additionally, the recent work of Michael Candy has proved to be influential to

this project. Candy, as his website states, “works with the vocabulary of robots... to mediate the liminal realm that technology oppresses on the physical world.” His autonomous robotic *Cryptid* (2019), (see Fig. 4), depicts an insectoid robot with six glowing legs constructed by LED lights that gradually traverses a space with animalistic movements “... in contrast to contemporary automata” (Candy, 2019).

Fig. 1. *Swarm Arena* (2018), Ars Electronica Futurelab and NNT. Installation view, photography credit: Jürgen Grünwald. Source: <https://ars.electronica.art/futurelab/en/projects-swarm-arena/>.

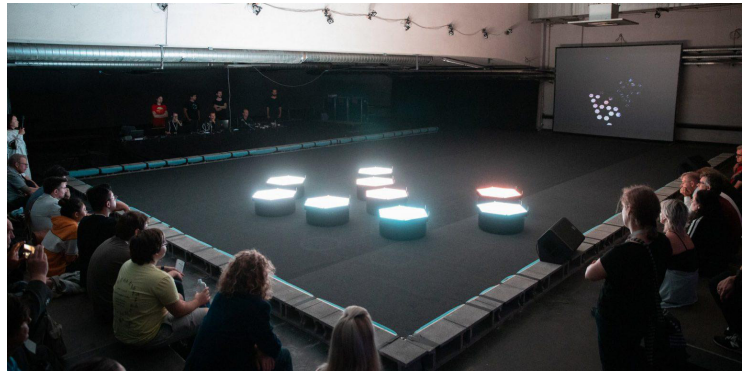


Fig. 2. *Termite Economies - Phase 1* (2018), Nicolas Mangan. Installation View, photography credit unknown. Source: <http://nicholasmangan.com/selected-works/termite-economies-phasel>.

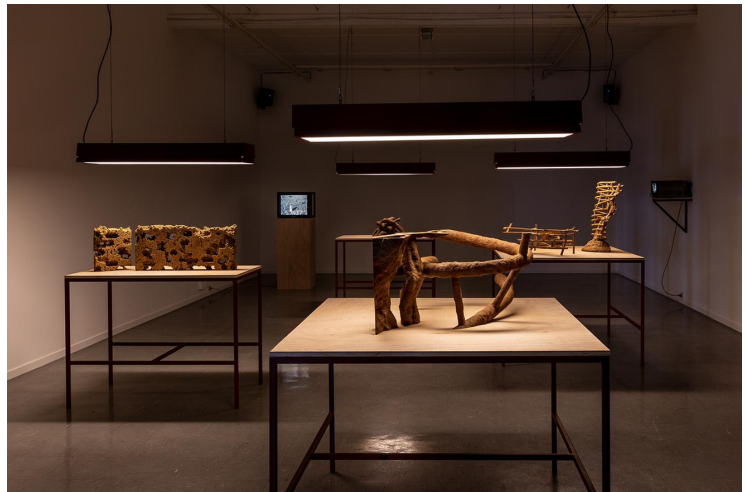


Fig. 3. *Polar*[™] (2010), Carsten Nicolai and Marko Pelijhan. Installation view, photography credit: Ryuichi Maruo. Source: <http://www.shift.jp/en/archives/2010/12/polarm.html>.

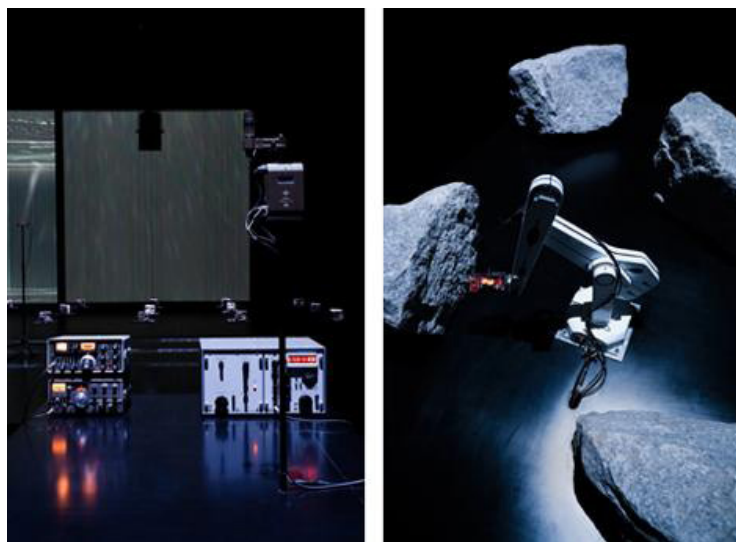
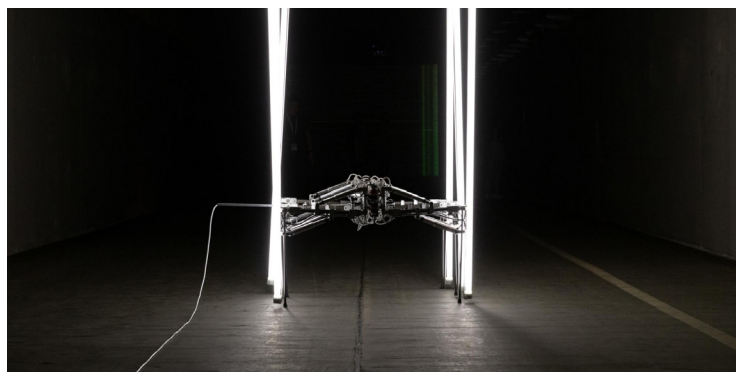


Fig. 4. *Cryptid* (2019), Michael Candy. Installation view, photography credit: Jürgen Grünwald. Source: <https://ars.electronica.art/outofthebox/en/cryptid/>.



Description of the proposed approach

This research project will be carried out in-line with what media theorists have termed as a practise of media archaeology. This shall involve, as media archaeology stipulates, a combination of cultural, and media theory to enhance arguments regarding current and future applications of new media technologies that reference archaic media forms, challenging the teleological notion of linear technology. As such, this paper is concerned with anthropomorphises of machine/animal spirits and also how swarm technologies have the potential to blur human/animal/machine relations in and beyond a workplace context. Taking a historical approach, this thesis will examine the employment of insect technics in mechanical apparatuses, from as early as the late 19th century, in relation to entomological discourse and prominent social allegory found in literature, folklore and even scripture that glorifies the insect figure as an undisputed expert of self-organisation. Jumping forward, this will be contrasted to the contemporary landscape of industrial systems labour. The result will be a mapping of where insects and human stand within the machine learning revolution of present day, detailing the historical applications of swarm intelligence, the use of ACO (ant colony optimisation) algorithms, and displacement of biological swarming animal labour and human labour. Subsequently, a theoretical framework of animal/machine hybrid spirits existing within an industrial and techno-capitalist context shall be constructed. The creative component of this research will involve an exhibition of an installation comprised of multiple robots displaying swarm-like behaviours in a factory setting. However, in light of the appropriation of ant's insect technics for corporate use, and also workers' rights/struggles, the robots will become agitated, restless, and even angry with their situation: gyrating violently as though they embody the trapped *animal spirits* of an ant colony that has been captured for techno-capitalist employment. Through this creative approach, I wish to amplify the sensory qualities, and atmosphere of corporate biomimetic swarms: their animalistic, jittery sounds, gyrating movements, and overall sentient ambiance.

Expected contributions

This thesis and creative work aim to contribute the budding discourse of theoretical speculation regarding the intersection of insect labour systems and autonomous network technologies. Through an examination of state of the art applications of swarm intelligence, as well as a historical overview of sociocultural representations of insects and how these attitudes towards superorganism organisation strategies inform robotic design, I wish to detail possible repercus-

sions of an emerging swarm intelligence labour force. By investigating the ant colony and their insect-technics (Parikka, 2010), I will review the techno-capitalist condition in relation to the corporate appropriation of animal labourer for economic gain, and suggest that we can add social insects to Wark's list of creative hackers that fall victim to capital production. Hacked into machine assemblages, insect media challenges the way we observe, interact, and think of nature-mimicking sentient machines in the work place. In reference to the displacement of human workers since the industrial revolution, and today's displacement of insect labour systems, the creative component will offer these theories a speculative mood of discontent, anguish, and struggle, as expressed by a robotic swarm display.

Progress towards goal

This research project is being facilitated by the Masters of Fine Arts (Research) course at the University of Western Australia. Starting the degree in February, 2020, the research and development of the creative work has been underway for 12 months, with 12 months remaining (February, 2022). My progress includes a several thesis section drafts, experimentation with 6-degree-of-freedom robotic arms, an installation prototype, and a detailed outline of how to incorporate a machine vision sensor to several of the robotic arms for an artwork planned to be exhibited in Perth in February, 2022.

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