Part Three

The Posthuman Management Matrix:

Understanding the Organizational Impact of Radical Biotechnological Convergence

Abstract. In this text we present the Posthuman Management Matrix, a model for understanding the ways in which organizations of the future will be affected by the blurring – or even dissolution – of boundaries between human beings and computers. In this model, an organization's employees and consumers can include two different kinds of agents (human and artificial) who may possess either of two sets of characteristics (anthropic or computer-like); the model thus defines four types of possible entities. For millennia, the only type of relevance for management theory and practice was that of human agents who possess anthropic characteristics – i.e., natural human beings. During the 20th Century, the arrival of computers and industrial robots made relevant a second type: that of artificial agents possessing computer-like characteristics.

Management theory and practice have traditionally overlooked the remaining two types of possible entities – human agents possessing computer-like physical and cognitive characteristics (which can be referred to as 'cyborgs') and artificial agents possessing anthropic physical and cognitive characteristics (which for lack of a more appropriate term might be called 'bioroids') – because such agents did not yet exist to serve as employees or consumers for organizations. However, in this text we argue that ongoing developments in neuroprosthetics, genetic engineering, virtual reality, robotics, and artificial intelligence are indeed giving rise to such types of agents and that new spheres of management theory and practice will be needed to allow organizations to understand the operational, legal, and ethical issues that arise as their pools of potential workers and customers evolve to include human beings whose bodies and minds incorporate ever more computerized elements and artificial entities that increasingly resemble biological beings.

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By analyzing the full spectrum of human, computerized, and hybrid entities that will constitute future organizations, the Posthuman Management Matrix highlights ways in which established disciplines such as cybernetics, systems theory, organizational design, and enterprise architecture can work alongside new disciplines like psychological engineering, AI resource management, metapsychology, and exoeconomics to help organizations anticipate and adapt to posthumanizing technological and social change.

I. Introduction

Facilitated by ongoing technological developments in fields like neuroprosthetics, genetic engineering, social robotics, nanorobotics, and artificial intelligence, a growing convergence between sapient biological entities like human beings and electronic computerized systems is underway. Looking beyond the current reality in which human beings interact with technological instruments that mediate so many of our daily activities, researchers anticipate a future in which human persons themselves *become* technological instruments. Human beings who display carefully engineered architectures,[1] electromechanical physical components,[2] software-guided cognitive processes,[3] and digitally mediated interactions[4] will increasingly resemble computers – and they will share digital-physical ecosystems with computerized

[1] See, e.g., Canton, "Designing the future: NBIC technologies and human performance enhancement" (2004); De Melo-Martín, "Genetically Modified Organisms (GMOs): Human Beings" (2015); Nouvel, "A Scale and a Paradigmatic Framework for Human Enhancement" (2015); and Bostrom, "Human Genetic Enhancements: A Transhumanist Perspective" (2012). Regarding 'brain engineering,' see Gross, "Traditional vs. modern neuroenhancement: notes from a medico-ethical and societal perspective" (2011).

[2] Regarding expected future growth in the use of implantable electronic neuroprosthetic devices for purposes of human enhancement, see, e.g., McGee, "Bioelectronics and Implanted Devices" (2008), and Gasson, "Human ICT Implants: From Restorative Application to Human Enhancement" (2012).

[3] For the potential use of an electronic 'brain pacemaker' to regulate cognitive activity, see Naufel, "Nanotechnology, the Brain, and Personal Identity" (2013). Regarding possible manipulation of the human brain's activity through the use of computerized neuroprosthetic devices, see Viirre et al., "Promises and perils of cognitive performance tools: A dialogue" (2008), and Heinrichs, "The promises and perils of non-invasive brain stimulation" (2012).

[4] See, e.g., *Communication in the Age of Virtual Reality*, edited by Biocca & Levy (1995); *Cybersociety 2.0: Revisiting Computer-Mediated Communication and Community*, edited by Jones (1998); and Lyon, "Beyond Cyberspace: Digital Dreams and Social Bodies" (2001).

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systems whose biological or biomimetic components,[5] evolutionary processes,[6] unpredictable neural networks,[7] and physically mediated social relations[8] cause them to ever more closely resemble human beings.

Such technological and social changes will be so transformative in their effects that they can be understood as creating a world best described as *posthuman*.[9] Within such a post-anthropocentric and post-dualistic environment,[10] it will no longer be natural biological human beings alone who seek

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[5] See, e.g., Ummat et al., "Bionanorobotics: A Field Inspired by Nature" (2005); Andrianantoandro et al., "Synthetic biology: new engineering rules for an emerging discipline" (2006); Cheng & Lu, "Synthetic biology: an emerging engineering discipline" (2012); Lamm & Unger, *Biological Computation* (2011); Church et al., "Next-generation digital information storage in DNA" (2012); and Berner, *Management in 20XX: What Will Be Important in the Future – A Holistic View* (2004), pp. 15, 18, 31, 61-62.

[6] For a discussion of evolutionary robotics and evolvable robotic hardware, see Friedenberg, *Artificial Psychology: The Quest for What It Means to Be Human* (2008), pp. 206-10.

[7] Regarding factors that make it difficult to analyze or predict the behavior of artificially intelligent systems – especially of distributed artificial intelligences (DAIs) displaying emergent behavior – see Friedenberg (2008), pp. 31-32. For a discussion of the behavior of physical artificial neural networks, see, e.g., Snider, "Cortical Computing with Memristive Nanodevices" (2008); Versace & Chandler, "The Brain of a New Machine" (2010); and *Advances in Neuromorphic Memristor Science and Applications*, edited by Kozma et al. (2012).

[8] For robots that interact socially with human beings, see, e.g., Breazeal, "Toward sociable robots" (2003); Kanda & Ishiguro, *Human-Robot Interaction in Social Robotics* (2013); *Social Robots and the Future of Social Relations*, edited by Seibt et al. (2014); *Social Robots from a Human Perspective*, edited by Vincent et al. (2015); and *Social Robots: Boundaries, Potential, Challenges*, edited by Marco Nørskov (2016). For robots that interact socially with one another, see, e.g., Arkin & Hobbs, "Dimensions of communication and social organization in multi-agent robotic systems" (1993); Barca & Sekercioglu, "Swarm robotics reviewed" (2013); and Brambilla et al., "Swarm robotics: a review from the swarm engineering perspective" (2013).

[9] The processes of posthumanization that expand the boundaries of society to include entities other than natural biological human beings as traditionally understood include the age-old forces of *nontechnological posthumanization* (as reflected in works of critical and cultural posthumanism and fantasy literature) and the newly emerging and intensifying forces of *technological posthumanization*, which is the focus of this text and is explored in works of biopolitical posthumanism, philosophical posthumanism, and science fiction. Regarding nontechnological posthumanization, see, e.g., Graham, *Representations of the Post/Human: Monsters, Aliens and Others in Popular Culture* (2002); Badmington, "Cultural Studies and the Posthumanities" (2006); and Herbrechter, *Posthumanism: A Critical Analysis* (2013). Regarding technological posthumanization, see, e.g., Fukuyama, *Our Posthuman Future: Consequences of the Biotechnology Revolution* (2002); Bostrom, "Why I Want to Be a Posthuman When I Grow Up" (2008); and other texts in *Medical Enhancement and Posthumanity*, edited by Gordijn & Chadwick (2008). For an overview of the forms of posthumanism that take these phenomena as their objects of study and practice, see Ferrando, "Posthumanism, Transhumanism, Antihumanism, Metahumanism, and New Materialisms: Differences and Relations" (2013), and our classification scheme in Part One of this text, "A Typology of Posthumanism: A Framework for Differentiating Analytic, Synthetic, Theoretical, and Practical Posthumanisms."

[10] See Ferrando (2013).

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out and create meaning through their exercise of imagination, reason, volition, and conscience; instead the world will likely include a bewildering array of sources of intelligent agency that create meaning through their networks and relations.[11] The implications for organizational management of this dawning 'Posthuman Age' are expected to be vast, and yet they have not yet been comprehensively explored from a theoretical perspective.

In an effort to advance such study, in this text we develop the Posthuman Management Matrix, a two-dimensional model designed to aid management scholars and practitioners in analyzing and anticipating the impacts of posthumanizing technological and social change on organizations. We begin by showing that the agents that are relevant to organizational management can be divided into two varieties (human and artificial agents) and that the traits possessed by a particular agent fall into one of two kinds (which we refer to as 'anthropic' and 'computronic' characteristics[12]). The Matrix thus delineates four general types of possible entities that can potentially serve as workers or consumers for businesses and other organizations. These types of entities are: human agents possessing anthropic characteristics (whom we can refer to simply as 'natural human beings'); artificial agents possessing computronic characteristics (or in other words, conventional 'computers'); human agents possessing computronic characteristics (whom we can refer to as 'cyborgs'); and artificial agents possessing anthropic characteristics (which, for lack of a better term, can be referred to as 'bioroids'[13]). An overview of the four quadrants of the Posthuman Management Matrix and the types of entities that they represent is contained in Figure 1.

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[11] See Ferrando (2013).

[12] In this text we use the portmanteau 'computronic' to refer to physical structures, behaviors, or other phenomena or characteristics which in recent decades have commonly been associated with *computers* and *electronic* devices. This builds on earlier uses of the word found, e.g., in Turner, "The right to privacy in a computronic age" (1970), and Rankin, "Business Secrets Across International Borders: One Aspect of the Transborder Data Flow Debate" (1985).

[13] For use of the term 'bioroid' in an engineering context, see Novaković et al., "Artificial Intelligence and Biorobotics: Is an Artificial Human Being our Destiny?" (2009). Regarding the use of the term in speculative fiction, see, e.g., Pulver, *GURPS Robots* (1995), pp. 74-81, where 'bioroid' is a portmanteau derived explicitly from 'biological android.'

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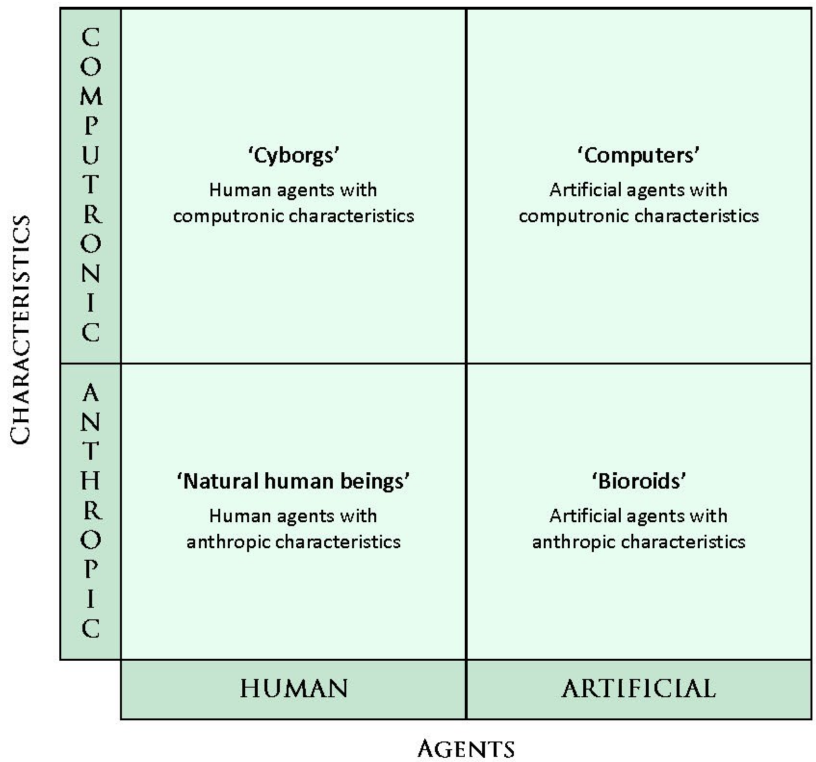

Fig. 1: The Posthuman Management Matrix delineates four types of entities, each of which may be of greater or lesser relevance for the practice of organizational management at a particular point in human history.

The Matrix is then utilized to analyze management theory and practice as they have existed prior to this emerging age of radical technological posthumanization. Beginning from the dawn of human history, the only type of entity relevant to management theory and practice was long that of human agents who possess anthropic characteristics – or in other words, natural human beings who have not been modified through the use of technologies such as neuroprosthetic augmentation or genetic engineering. Only with the arrival of electronic information-processing systems and simple industrial robots in the 20th Century did a second type of entity become broadly relevant for

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organizational management: that of the artificial agent that possesses computronic characteristics, or the 'computer.'[14] Integrating such computerized systems into an organization of human workers is not an easy task, and management disciplines such as enterprise architecture, IT management, and information security have emerged that provide conceptual frameworks and practical tools for successfully coordinating the actions of human and artificial agents to create effective organizations.[15]

The largest portion of this text is dedicated to employing the Matrix as a means of investigating the remaining two types of entities – 'cyborgs' and 'bioroids' – that have heretofore received relatively little serious attention within the field of management but which are set to become ever more prevalent as workers, managers, consumers, and other organizational stakeholders, thanks to the accelerating and intensifying processes of technological posthumanization. We suggest that it will not be possible to adequately understand and manage the many complex operational, legal, and ethical issues that arise from adopting such posthuman agents as employees or customers simply by relying on existing fields such as HR management, IT management, or enterprise architecture. The radically expanded universe of posthuman agents that will participate in the life of organizations will require the development of new spheres of theory and practice that can address the unique forms, behaviors, strengths, and weaknesses of such agents, along with the ways in which they will combine to create rich and complex cybernetic networks and digital-physical ecosystems. Our exploration of these questions concludes by contemplating the sorts of transdisciplinary management approaches that might be able to successfully account for such organizational systems in which natural human beings, genetically engineered persons, individuals possessing extensive neuroprosthetic augmentation, human beings who spend all of their time dwelling in virtual worlds, social robots, artifi-

[14] For early examples of workplace robotics explored from the perspective of management theory and practice, see, e.g., Thompson, "The Man-Robot Interface in Automated Assembly" (1976), and Goodman & Argote, "New Technology and Organizational Effectiveness" (1984).

[15] For a review of enterprise architecture frameworks, see Magoulas et al., "Alignment in Enterprise Architecture: A Comparative Analysis of Four Architectural Approaches" (2012), and Rohloff, "Framework and Reference for Architecture Design" (2008); for a practical overview of organizational design, see Burton et al., *Organizational Design: A Step-by-Step Approach* (2015); for an overview of information security, see Rao & Nayak, *The InfoSec Handbook* (2014).

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cially intelligent software, nanorobot swarms, and sentient or sapient networks work together in physical and virtual environments to achieve organizational goals.[16]

Through this formulation, application, and discussion of the Posthuman Management Matrix, we hope to highlight the challenges that await management scholars and practitioners in an increasingly posthumanized world and to suggest one possible conceptual framework that can aid us in making sense of and responding to these challenges.

II. Formulating the Posthuman Management Matrix

We would suggest that it is useful to analyze the impact of posthumanizing social and technological change on organizational management through a two-dimensional conceptual framework that creates a coherent tool for identifying, understanding, and anticipating organizational transformations that will occur as a result of the convergences described in this text. We can refer to this proposed framework as the 'Posthuman Management Matrix.' Our hope is that such a model can serve as both a theoretical framework for management scholars as well as a practical tool for management practitioners. The Posthuman Management Matrix comprises two dimensions: the horizontal dimension is that of an 'agent' and the vertical dimension is that of an agent's 'characteristics.' We can consider each of these dimensions in turn.

A. The Matrix's Horizontal Dimension: The Kind of Agent

There are many types of entities and phenomena that must be managed by organizations; however, many of them do not possess or manifest their own agency. Such non-agents include financial assets, land, raw materials, intellectual property, contracts, policies and procedures, and other elements of organizational life that are not capable of gathering data from their environment, processing information, and selecting a course of action.[17]

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[16] See Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 95-96.

[17] Within the context of enterprise architecture, for example, both agents and non-agents can be understood generically as 'entities' that play particular 'roles' in various 'activities' within an organization; see Caetano et al., "A Role-Based Enterprise Architecture Framework" (2009).

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On the other hand, there are many kinds of agents[18] that may actively participate in an organization's activities; these include typical adult human beings, some kinds of domesticated animals (which, for example, can be employed in particular roles within the fields of agriculture, law enforcement, and entertainment), many types of autonomous and semiautonomous robots, and artificially intelligent software programs that run on particular computing platforms. Note that in order to qualify as an agent, an entity does not need to need to possess the same kind of sapience as a typical adult human being; relatively simple automated systems (such as an assembly-line robot or the software managing an automated customer-service telephone line) can be described as agents, even if they do not possess full human-like artificial general intelligence. Conversely, not all human beings can be considered agents from the managerial perspective, even if they are considered to be legal persons and moral patients; for example, an adult human being who is in a coma and whose mind is not able to receive sensory input, process information, and select and act upon particular courses of action would not be considered an 'agent' in the organizational sense employed here.

Much ongoing research and debate is taking place regarding questions of whether and to what extent collective entities can be considered agents. It is a matter of contention whether a social organization such as a country or a swarm of insects can possess its own 'agency' distinct from the agency of all the individuals that constitute it.[19] In some cases, the law recognizes certain types of social entities (e.g., states or corporations) as possessing a sort of agency independent of that of their human constituents, although different conclusions may be formulated when viewing such entities from an ontological or moral rather than a legal perspective. Similarly, some automated artificial agents have been designed in such a way that they are in fact multi-agent systems composed of a number of smaller subsystems and components that are themselves agents. In such cases, the agency possessed by a multi-agent system as a whole is typically of a different sort from that possessed by

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[18] For an overview of biological, robotic, and software-based agents and their key characteristics of autonomy, social ability, reactivity, and proactivity, see Tweedale & Jain, "Agent Oriented Programming" (2011).

[19] Regarding questions about the nature and degree of agency and decision-making responsibility that can be possessed by robotic swarms or networks, see, e.g., Coeckelbergh, "From Killer Machines to Doctrines and Swarms, or Why Ethics of Military Robotics Is Not (Necessarily) About Robots" (2011), pp. 274-75, and Gladden, "The Diffuse Intelligent Other: An Ontology of Nonlocalizable Robots as Moral and Legal Actors" (2016).

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its individual components. More complex is the case of large computer-facilitated networks (e.g., the Internet) that can, in a certain sense, be said to select and act upon particular courses of action and whose 'decisions' are shaped by the activities of individual human and artificial agents that have access to the network and who participate in its sensorimotor and information-processing actions.[20]

Traditionally, facilities such as office buildings or warehouses would not in themselves have qualified as 'agents,' even though they were home to the activities of large numbers of agents and contained an extensive technological infrastructure of mechanical, electrical, and other components that were regularly manipulated by those agents as part of their work. However, the rise of the Internet of Things and smart buildings means that in some cases an office building or production facility that includes sufficient sensory and motor components controlled by a computerized system can potentially be understood as a single coherent 'agent.' A similar phenomenon is now occurring with vehicles, which may be considered agents if they possess self-driving capabilities or other forms of AI.[21]

For purposes of the Posthuman Management Matrix, we can divide the broad spectrum of agents that are relevant to contemporary organizational management into two main categories: human beings (described below as 'human agents') and robots or other artificially intelligent computing systems (described below as 'artificial agents').[22]

1. Human Agents

Human agents are intelligent and sapient actors whose agency is grounded in and exercised through the actions of a biological human brain. Throughout history, such human agents have been the primary (and often

[20] Regarding collectively conscious networks and a "post-internet sentient network," see Callaghan, "Micro-Futures" (2014). Regarding a future Internet that is 'self-aware' in a technical and technological sense, even if it is not subjectively conscious, see Galis et al., "Management Architecture and Systems for Future Internet Networks" (2009), pp. 112-13. A sentient Internet is also discussed in Porterfield, "Be Aware of Your Inner Zombie" (2010), p. 19. For a future Internet that is self-aware as a sort of potentially living entity, see Hazen, "What is life?" (2006). Regarding the growing prevalence of robotic systems that comprise networks and swarms – rather than autonomous unitary robots – and the distributed or unclear nature of decision-making and responsibility in such systems, see Coeckelbergh (2011), pp. 272-75, and Gladden, "The Diffuse Intelligent Other" (2016).

[21] Regarding the ethical implications of creating autonomous driverless vehicles that can exercise their own agency, see Goodall, "Ethical decision making during automated vehicle crashes" (2014).

[22] The simplified schema presented by the Posthuman Management Matrix thus omits, for example, the explicit consideration of domestic animals as potential workplace agents.

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only) agents constituting human organizations. Human beings possess a distinct set of biological, psychological, social, and cultural properties that have been extensively studied by disciplines including biology, psychology, anthropology, sociology, economics, history, philosophy, theology, political science, and organizational management.

2. Artificial Agents

Artificial agents represent a relatively new kind of intelligent actor that has emerged during recent decades and which has the potential to carry out particular tasks or roles within a human organization. Although the universe of artificial agents comprises a diverse array of entities with a broad variety of forms and functions, artificial agents are similar in that: 1) they all possess some means of receiving data from their environment, a means of processing information, and a means of acting on their environment; and 2) the physical substrate within which their agency subsists is not a natural biological human brain.

An artificial agent often takes the form of a piece of software being executed by some physical computational substrate such as a desktop computer, mobile device, server, robot, or network of distributed devices.[23] However, other examples exist that do not involve the execution of a conventional software program; these include artificial neural networks that are not run as a software program on a conventional CPU-based computer but which comprise a network of physical artificial neurons.[24]

B. The Matrix's Vertical Dimension: An Agent's Characteristics

From the perspective of organizational management, there are two broad sets of characteristics that a contemporary agent might display: 'anthropic

[23] Each particular instantiation of such a sensorimotor-cognitive system can be understood as a unique artificial agent; thus technically, the same piece of AI software run on two different computers (or even on the same computer on two different occasions) can be understood as two different artificial agents. (See Wiener, *Cybernetics: Or Control and Communication in the Animal and the Machine* (1961), loc. 2402ff., for the idea that a human brain with all of its short- and long-term memories are "not the complete analogue of the computing machine but rather the analogue of a single run on such a machine" – something which, by definition, cannot be duplicated in another substrate.) However, the term 'artificial agent' is also used in a looser sense to refer to a hardware-software platform comprising a particular piece of hardware and the AI software that it executes rather than to each separate execution of that software.

[24] See, e.g., Friedenberg (2008), pp. 17-36, for a discussion of different physical models that do not necessarily require a conventional Von Neumann computer architecture.

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characteristics' are those that are traditionally possessed by human beings, and 'computronic characteristics' are those traditionally possessed by artificial agents such as robots or artificially intelligent software. We can consider these two suites of characteristics in greater detail.

1. Anthropic Characteristics

Anthropic characteristics constitute that array of traits which throughout history has been possessed by and associated with human beings. These characteristics are reflected in: 1) an entity's physical form; 2) its capacity for and use of intelligence; and 3) its social interaction with other intelligent agents. Below we use these three perspectives to identify and describe some of the key anthropic characteristics.

a. Physical Form

The physical form of an agent possessing anthropic characteristics demonstrates a number of notable traits. Such an agent is:

Composed of biological components. The body of a human being is naturally composed of biological material and not mechanical or electronic components. The qualities of such biological material place limits on the kinds of work that human employees can perform. For example, it is impossible for human beings to work in areas of extreme heat, cold, or radiation without extensive protection, nor is it possible for a human employee to work for hundreds of consecutive hours without taking breaks for sleep or meals or to use the restroom.

Alive. In order to function as an agent within an organization, a human being (and the biological subsystems that constitute its body) must be alive. As a living organism, a human being possesses a metabolism that requires a continual supply of resources (e.g., oxygen, water, and food) from the external environment as well as the ability to emit waste products into the environment in order for the individual to survive.[25]

Non-engineered. The basic physical form of a particular human being is determined largely by genotypic factors that are a result of randomized inher-

[25] In considering a definition for artificial life, Friedenberg (2008), pp. 201-03, draws on the criteria for biological life presented in Curtis, *Biology* (1983): namely, a living being manifests organization, metabolism, growth, homeostasis, adaptation, response to stimuli, and reproduction.

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itance of genetic material from the individual's biological parents; the individual's particular physical characteristics are not intentionally selected or fabricated by a genetic engineer.[26]

Non-upgradeable. There are many congenital medical conditions that can be treated through conventional surgical procedures, medication, the use of traditional prosthetics, or other therapies. The application of such technologies could be understood as a form of 'augmentation' or 'enhancement' of one's body as it was naturally formed; however, such technologies are more commonly understood as 'restorative' approaches, insofar as they do not grant an individual physical elements or capacities that surpass those possessed by a typical human being.[27] Historically, human beings have not been subject to the sort of radical physical 'upgradeability' that might involve, for example, the implantation of additional memory capacity into the brain, an alteration of the rate of electrochemical communication between neurons to increase the brain's 'processing speed,' the addition of new sensory capacities (e.g., infrared vision), or the addition of new or different limbs or actuators (e.g., wheels instead of legs).[28] This differs from the case of contemporary computers, which often can easily be upgraded through the addition or replacement of physical components.

Confined to a limited lifespan. Although the lifespan of a particular human being can be shortened or extended to some degree as a result of environmental, behavioral, or other factors, the human organism is generally understood to possess a finite biological lifespan that cannot be extended indefinitely through natural biological means.[29] A human being that has exceeded its maximum lifespan is no longer alive (i.e., it will have expired) and it cannot be repaired and revived by technological means to make it available once again for future organizational use.

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[26] Although, for example, factors such as diet, exercise and training, environmental conditions, and medicines and medical procedures can extensively modify the form of a human body, the extent to which an existing biological human body can be restructured before ceasing to function is nonetheless relatively limited.

[27] See Gasson (2012).

[28] See Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics: Video Games as Tools for Posthuman 'Body Schema (Re)Engineering'" (2015).

[29] For a discussion and comparison of biologically and nonbiologically based efforts at human life extension, see Koene, "Embracing Competitive Balance: The Case for Substrate-Independent Minds and Whole Brain Emulation" (2012).

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Manifesting a developmental cycle. The physical structure and capacities of a human being do not remain unchanged from the moment of an individual's conception to the moment of his or her death; instead, a human being's physical form and abilities undergo continuous change as the individual develops through a cycle of infancy, adolescence, adulthood, and senescence.[30] From the perspective of organizational management, human beings are only capable of serving as employees, partners, or consumers during particular phases of this developmental cycle, and the unique strengths and weaknesses displayed by human workers vary as they move through the developmental cycle.

Possessing a unitary local body. A particular human being occupies or comprises a particular physical biological body. Because this body is unitary – consisting of a single spatially compact unit – a human being is able to inhabit only one space at a given time; a human being cannot simultaneously be physically present in multiple cities, for example.[31]

Possessing a permanent substrate. Although to some limited extent it is possible to modify or replace physical components of a human body, it is not possible for a human being to exchange his or her entire body for another.[32] The body with which a human being was born will – notwithstanding the natural changes that occur as part of its lifelong developmental cycle or any minor intentional modifications – serve as a single permanent substrate within which all of the individual's information processing and cognition will occur and in which all of the individual's sensory and motor activity will take place until the end of his or her life.

Unique and identifiable. A human being's body creates (or at least, plays a necessary role in creating) a single identity for the individual that persists over time, throughout the person's life. The fact that each human body is unique and is identifiable to other human beings (e.g., such a body is not invisible, microscopic, or 'flickering' in and out of existence from moment to moment)

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[30] See Thornton, *Understanding Human Development: Biological, Social and Psychological Processes from Conception to Adult Life* (2008), and the *Handbook of Psychology, Volume 6: Developmental Psychology*, edited by Lerner et al. (2003).

[31] For a discussion of different types of bodies and their relation to an entity's degree of locality, see Gladden, "The Diffuse Intelligent Other" (2016).

[32] For complications relating to proposed body-replacement techniques such as mind uploading, see Proudfoot, "Software Immortals: Science or Faith?" (2012); for particular problems that would result from the attempt to adopt a nonhuman body, see Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics" (2015).

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means that it is possible to associate human actions with a particular human being who performed them.[33]

B. Intelligence

The information-processing mechanisms and behaviors of an agent possessing anthropic characteristics demonstrate a number of significant traits. Such an agent is:

Sapient and self-aware. A typical human adult possesses a subjective conscious experience that is not simply sensations of physical reality but a conceptual 'awareness of' and 'awareness that.' These characteristics are not found, for example, in infants or in adult human beings suffering from certain medical conditions. In a sense, a typical adult human being can be said to possess sapient self-awareness as a capacity even when the individual is unconscious (e.g., during sleep), although in that moment the capacity is latent and is not being actively utilized or experienced.[34]

Autonomous. Broadly speaking, adult human beings are considered to possess a high degree of autonomy.[35] Through the regular action of its mind and body, a human being is able to secure energy sources and information from its external environment, set goals, make decisions, perform actions, and even (to a limited extent) repair damage that might occur to itself during the course of its activities, all without direct external guidance or control by other human agents. Human beings which, for example, are still infants, are suffering from physical or cognitive impairments (such as being in a coma), or are operating in a hostile or unfamiliar environment may not be able to function with the same degree of autonomy.

Metavolitional. Volitionality relates to an entity's ability to self-reflexively shape the intentions that guide its actions.[36] An entity is nonvolitional when

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[33] For an overview of philosophical questions relating to personal identity, see Olson, "Personal Identity" (2015).

[34] For a discussion of such issues, see, e.g., Siewert, "Consciousness and Intentionality" (2011); Fabbro et al., "Evolutionary aspects of self-and world consciousness in vertebrates" (2015); and Boly et al., "Consciousness in humans and non-human animals: recent advances and future directions" (2013).

[35] For a definition of autonomy applicable to agents generally, see Bekey, *Autonomous Robots: From Biological Inspiration to Implementation and Control* (2005), p. 1. Regarding ways of classifying different levels of autonomy, see Gladden, "Managerial Robotics: A Model of Sociality and Autonomy for Robots Managing Human Beings and Machines" (2014).

[36] For a discussion of the volitionality of agents, see Calverley, "Imagining a non-biological machine as a legal person" (2008), pp. 529-535, and Gladden, "The Diffuse Intelligent Other" (2016).

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it possesses no internal goals or 'desires' for achieving particular outcomes nor any expectations or 'beliefs' about how performing certain actions would lead to particular outcomes. An entity is volitional if it combines goals with expectations: in other words, it can possess an intention,[37] which is a mental state that comprises both a desire and a belief about how some act that the entity is about to perform can contribute to fulfilling that desire.[38] Meanwhile, typical adult human beings can be described as metavolitional: they possess what scholars have referred to as a 'second-order volition,' or an intention *about* an intention.[39] In human beings, this metavolitionality manifests itself in the form of conscience: as a result of possessing a conscience, human agents are able to determine that they do not wish to possess some of the intentions that they are currently experiencing, and they can resolve to change those intentions.

Educated. The cognitive processes and knowledge of a human being are shaped through an initial process of concentrated learning and formal and informal education that lasts for several years and through an ongoing process of learning that lasts throughout the individual's lifetime.[40] Human beings can learn empirically through the firsthand experience of interacting with their environment or by being taught factual information or theoretical knowledge. A human being cannot instantaneously 'download' or 'import' a large body of information into his or her memory in the way that a data file can be copied to a computer's hard drive.

Processing information through a neural network. Some information processing takes part in other parts of the body (e.g., the transduction of proximal stimuli into electrochemical signals by neurons in the sensory organs); however, the majority of a human being's information processing is performed by the neural network comprising interneurons in the individual's brain.[41] The brain constitutes an immensely large and intricate neural network, and despite on-

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[37] The term 'intentionality' is often employed in a philosophical sense to describe an entity's ability to possess mental states that are directed toward (or 'about') some object; that is a broader phenomenon than the possession of a particular 'intention' as defined here.

[38] Calverley (2008), p. 529.

[39] Calverley (2008), pp. 533-35.

[40] See Thornton (2008), and *Handbook of Psychology, Volume 6* (2003).

[41] For example, see Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 148-49.

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going advances in the field of neuroscience, profound mysteries remain regarding the structure and behavior of this neural network's components and of the network as a whole.[42] The mechanisms by which this neural network processes the data provided by sensory input and stored memories to generate motor output and new memories are highly nonlinear and complex; they are not directly comparable to the process of a CPU-based computer running an executable software program.

Emotional. The possession and manifestation of emotions is not an extraneous supplement (or obstacle) to the rational decision-making of human beings but is instead an integral component of it. Some researchers suggest that the possession of emotions is necessary in order for an embodied entity to demonstrate general intelligence at a human-like level.[43]

Cognitively biased. Human beings are subject to a common set of cognitive biases that distort individuals' perceptions of reality and cause them to arrive at decisions that are objectively illogical and suboptimal.[44] While in earlier eras such biases may have created an evolutionary advantage that aided the survival of those beings that possessed them (e.g., by providing them with heuristics that allowed them to quickly identify and avoid potential sources of danger), these biases cause contemporary human workers to err when evaluating factual claims or attempting to anticipate future events or manage risk. To some extent, such biases can be counteracted through conscious awareness, training, and effort.

Possessing a flawed memory. The human mind does not store a perfect audiovisual record of all the sensory input, thoughts, and imaginings that it experiences during a human being's lifetime. The brain's capacities for both the retention and recall of information are limited. Not only are memories stored in a manner which from the beginning is compressed, impressionistic, and imperfect, but memories also degrade over time.[45] Historically, the only way to transfer memories stored within one human mind to another human mind

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[42] For example, significant outstanding questions remain about the potentially holonomic nature of memory storage within the brain and the role of inter- and intraneuronal structures in memory creation and storage; see, e.g., Longuet-Higgins, "Holographic Model of Temporal Recall" (1968); Pribram, "Prolegomenon for a Holonomic Brain Theory" (1990); and Pribram & Meade, "Conscious Awareness: Processing in the Synaptodendritic Web – The Correlation of Neuron Density with Brain Size" (1999).

[43] See Friedenberg (2008), pp. 179-200.

[44] For an overview of human cognitive biases in relation to organizational management, see Kinicki & Williams, *Management: A Practical Introduction* (2010), pp. 217-19.

[45] See Dudai, "The Neurobiology of Consolidations, Or, How Stable Is the Engram?" (2004).

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has been for the memories to be described and expressed through some social mechanism such as oral speech or written text.

Demonstrating unpredictable behavior. All human beings demonstrate basic similarities in their behavior, and individual human beings possess unique personalities, habits, and psychological and medical conditions that allow their reactions to particular stimuli or future behavior to be predicted with some degree of likelihood; however, it is not possible to predict with full precision, accuracy, and certainty the future actions of a particular human being.

Not capable of being hacked electronically. Because human beings possess biological rather than electronic components and their minds conduct information processing through the use of an internal physical neural network rather than a conventional executable software program stored in binary digital form, it is not possible for external adversaries or agents to hack into a human being's body and information-processing system in order to control sensory, motor, or cognitive activities or to access, steal, or manipulate the individual's thoughts or memories using the same electronic hacking techniques that are applied to the hardware or software of electronic computers and computer-based systems.[46]

C. Social Interaction

An agent possessing anthropic characteristics demonstrates a number of noteworthy traits relating to social interaction. Such an agent is:

Social. Human beings display social behaviors, engage in isolated and short-term social interactions, and participate in long-term social relations that evolve over time and are shaped by society's expectations for the social roles to be filled by a particular individual.[47] Although the social content and nature of complex communicative human actions such as speaking and writing are obvious, even such basic activities such as standing, walking, and breathing have social aspects, insofar as they can convey intentions, emotions, and attitudes toward other human beings.

Cultural. Human beings create and exist within unique cultures that include particular forms of art, literature, music, architecture, history, sports and

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[46] The human mind is subject to other kinds of 'hacking' such as social engineering; see Rao & Nayak (2014).

[47] Regarding the distinction between social behaviors, interactions, and relations, see Vinciarelli et al., "Bridging the Gap between Social Animal and Unsocial Machine: A survey of Social Signal Processing" (2012), and Gladden, "Managerial Robotics" (2014).

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recreation, technology, ethics, philosophy, and theology. Such cultures also develop and enforce norms regarding the ways in which organizations such as businesses should or should not operate.[48]

Spiritual. Human beings broadly manifest a search for and recognition of transcendent reality and ultimate purpose of a form that is described by organized religions and other spiritual and philosophical systems as well as nurtured by the idiosyncratic beliefs and sentiments of individual human beings. Recently researchers have sought to identify biological mechanisms that enable or facilitate the development and expression of such spirituality.[49]

Political. In order to regulate their shared social existence and create conditions that allow for productivity, prosperity, peace, and the common good, human beings have developed political systems for collective defense, decision-making, and communal action. Political activity typically involves a kind and degree of reasoning, debate, strategic thinking, risk assessment, prioritization of values, and long-term planning that is not found, for example, within the societies of nonhuman animals.[50]

An economic actor. In contemporary societies, an individual human being is typically not able to personally produce all of the goods and services needed for his or her survival and satisfaction, and he or she does not have the desire or ability to personally consume all of the goods or services that he or she produces. In order to transform the goods and services that a human being produces into the goods and services that he or she desires to have, human beings engage in economic exchange with one another. Within contemporary societies, businesses and other organizations play critical roles in facilitating such economic interaction.[51]

A legal person. An adult human being is typically recognized by the law as being a legal person who bears responsibility for his or her decisions and

[48] Regarding the critical role that organizational culture plays, e.g., in the management of enterprise architecture, see Aier, "The Role of Organizational Culture for Grounding, Management, Guidance and Effectiveness of Enterprise Architecture Principles" (2014), and Hoogervorst, "Enterprise Architecture: Enabling Integration, Agility and Change" (2004).

[49] For example, see Emmons, "Is spirituality an intelligence? Motivation, cognition, and the psychology of ultimate concern" (2000).

[50] Thus Aristotle's assertion that "man is by nature a political animal" (Aristotle, *Politics*, Book 1, Section 1253a). Regarding different perspectives on the organization of animal societies and the possible evolutionary origins of politics in human societies, see, e.g., *Man Is by Nature a Political Animal: Evolution, Biology, and Politics*, edited by Hatemi & McDermott (2011); Alford & Hibbing, "The origin of politics: An evolutionary theory of political behavior" (2004); Clark, *The Political Animal: Biology, Ethics and Politics* (1999); and *Primate Politics*, edited by Schubert & Masters (1991).

[51] For example, see Samuelson & Marks, *Managerial Economics* (2012), Chapter 11.

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actions. In some cases, relevant distinctions exist between legal persons, moral subjects, and moral patients. For example, an adult human being who is conscious and not suffering from psychological or biological impairments would typically be considered both a legal person who is legally responsible for his or her actions as well as a moral subject who bears moral responsibility for those actions. An infant or an adult human being who is in a coma might be considered a legal person who possesses certain legal rights, even though a legal guardian may be appointed to make decisions on the person's behalf; such a person is not (at the moment) a moral agent who undertakes actions for which he or she bears moral responsibility but is still a 'moral patient' whom other human beings have an obligation to care for and to not actively harm.[52]

2. Computronic Characteristics

Computronic characteristics constitute the collection of traits that have traditionally been possessed by the kinds of computers utilized by organizations, including mainframes, servers, desktop computers, laptop computers, and mobile devices, as well as more specialized devices such as supercomputers, satellites, assembly-line robots, automated guided vehicles, and other computerized systems based on a conventional Von Neumann architecture. These characteristics are reflected in: 1) an entity's physical form; 2) its capacity for and use of intelligence; and 3) its social interaction with other intelligent agents. Below we use these three perspectives to identify and describe some of the key computronic characteristics. It may be noted that in most cases they are very different from – and frequently the opposite of – the anthropic characteristics traditionally associated with human beings.

a. Physical Form

The physical form of an agent possessing computronic characteristics demonstrates a number of notable traits. Such an agent is:

Composed of electronic components. A conventional computer is typically composed of mass-produced electronic components that are durable and readily

[52] Regarding distinctions between legal persons, moral subjects, and moral patients – especially in the context of comparing human and artificial agents – see, e.g., Wallach & Allen, *Moral machines: Teaching robots right from wrong* (2008); Gunkel, *The Machine Question: Critical Perspectives on AI, Robots, and Ethics* (2012); Sandberg, "Ethics of brain emulations" (2014); and Rowlands, *Can Animals Be Moral?* (2012).

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repairable and whose behavior can easily be analyzed and predicted.[53] Such components are often able to operate in conditions of extreme heat, cold, pressure, or radiation in which biological matter would not be able to survive and function. Such components can be built to a large or microscopic scale, depending on the intended purpose of a particular computer. The ability to manufacture electronic components to precise specifications with little variation means that millions of copies of a single artificial agent can be produced that are functionally identical.

Not alive. A conventional computer is not alive: it is not created through processes of biological reproduction, and its form and basic functionality are not shaped by a DNA- or RNA-based genotype; nor does the computer itself grow and reproduce.[54] A computer must typically receive energy from the external environment in the form of an electrical power supply that has been specifically prepared by its human operators and which meets exact specifications;[55] the computer does not possess a metabolism that allows it to assimilate raw materials that it obtains from the environment and convert them into energy and structural components, repair damage and grow, and emit waste products into the environment (apart from byproducts such as heat – which is a significant concern in microprocessor and computer design – and stray electromagnetic radiation such as radio waves).[56]

Intentionally designed. Historically, the structure and basic capacities of a computer are not the result of the inheritance of randomized genetic code from biological parents or from other processes of biological reproduction. Instead, all elements and aspects of a traditional computer's physical form and basic functionality are intentionally planned and constructed by human scientists,

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53 For an in-depth review of the historical use of electronic components in computers as well as an overview of emerging possibilities for (non-electronic) biological, optical, and quantum computing, see Null & Lobur, *The Essentials of Computer Organization and Architecture* (2006). Regarding the degree to which the failure of electronic components can be predicted, see Băjenescu & Bâzu, *Reliability of Electronic Components: A Practical Guide to Electronic Systems Manufacturing* (1999).

54 Curtis (1983) cited seven requisites for a biological entity to be considered alive (organization, metabolism, growth, homeostasis, adaptation, response to stimuli, and reproduction), which Friedenberg (2008), pp. 201-03, also considers to be relevant when attempting to determine whether an artificial entity is alive.

55 Exceptions would include, e.g., solar-powered computing devices.

56 Such emissions by computers also create information security concerns; see, e.g., Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), p. 116.

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engineers, manufacturers, and programmers in order to enable the computer to successfully perform particular tasks.[57]

Upgradeable and expandable. The physical structure and capacities of computers are easily expandable through the addition of internal components or external peripheral devices. Such upgrades allow a computer to receive, for example, new sensory mechanisms, new forms of actuators for manipulating the external environment, an increase in processing speed, an increase in random-access memory, or an increase in the size of a computer's available space for the nonvolatile long-term storage of data.[58]

Not limited to a maximum lifespan. A typical computer does not possess a maximum lifespan beyond which it cannot be made to operate. As a practical matter, individual computers may eventually become obsolete because their functional capacities are inadequate to perform tasks that the computer's owner or operator needs it to perform or because cheaper, faster, and more powerful types of computers have become available to carry out those tasks. Similarly, the failure of an individual component within a computer may render it temporarily nonfunctional. However, the ability to repair, replace, upgrade, or expand a computer's physical components means that a computer's operability can generally be maintained indefinitely, if its owner or operator wishes to do so.[59]

Possessing a stable and restorable form. A computer's physical form is highly stable: although a computer's components can be physically upgraded or altered by the device's owner or operator, a computer does not physically upgrade or alter itself without its owner or operator's knowledge or permission.[60] A computer does not undergo the sort of developmental cycle of conception, growth, maturity, and senescence demonstrated by biological organisms. In general, the physical alterations made to a computer are reversible: a chip that has been installed to increase the computer's RAM can be removed; a

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[57] See, e.g., Dumas, *Computer Architecture: Fundamentals and Principles of Computer Design* (2006).

[58] See, e.g., Mueller, *Upgrading and Repairing PCs, 20th Edition* (2012).

[59] For an overview of issues relating to computer reliability, availability, and lifespan, see Siewiorek & Swarz, *Reliable Computer Systems: Design and Evaluation* (1992), and Băjenescu & Bâzu (1999).

[60] An exception would be the case of computer worms or viruses that can cause a computer to disable or damage some of its internal components or peripheral devices without the owner or operator's knowledge. See, for example, Kerr et al., "The Stuxnet Computer Worm: Harbinger of an Emerging Warfare Capability" (2010).

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peripheral device that has been added can be disconnected. This allows a computer to be restored to a previous physical and functional state.

Potentially multilocal. It is possible for a computer to – like a human being – possess a body that comprises a single unitary, spatially compact physical unit: computerized devices such as a typical desktop computer, smartphone, assembly-line robot, or server may possess a physical form that is clearly distinct from the device's surrounding environment and which is located in only a single place at any given time. However, other computers can – unlike a human being – possess a body comprising disjoint, spatially dispersed elements that exist physically in multiple locations at the same time. The creation of such computerized entities comprising many spatially disjoint and dispersed 'bodies' has been especially facilitated in recent decades by the development of the diverse networking technologies that undergird the Internet and, now, the nascent Internet of Things.[61] The destruction, disabling, or disconnection of one of these bodies that contributes to the form of such an entity may not cause the destruction of or a significant degradation of functionality for the computerized entity as a whole.

Possessing an exchangeable substrate. Because they are stored in an electronic digital form that can easily be read and written, the data that constitute a particular computer's operating system, applications, configuration settings, activity logs, and other information that has been received, generated, or stored by the device can easily be copied to different storage components or to a different computer altogether. This means that the computational substrate or 'body' of a given computerized system can be replaced with a new body without causing any functional changes in the system's memory or behavior. In the case of computerized systems that are typically accessed remotely (e.g., a cloud-based storage device accessed through the Internet), a system's hardware could potentially be replaced by copying the device's data to a new device without remote users or operators ever realizing that the system's physical computational substrate had been swapped.[62]

[61] Regarding the Internet of Things, see Evans, "The Internet of Everything: How More Relevant and Valuable Connections Will Change the World" (2012). For one aspect of the increasingly networked nature of robotics and AI, see Coeckelbergh (2011). Regarding multilocal computers, see Gladden, "The Diffuse Intelligent Other" (2016).

[62] The ability to replace or reconfigure remote networked hardware without impacting web-based end users is widely exploited to offer cloud-based services employing the model of infrastructure as a service (IaaS), platform as a service (PaaS), or software as a service (SaaS); for more details, see the *Handbook of Cloud Computing*, edited by Furht & Escalante (2010).

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Possessing an unclear basis for identity. It is unclear wherein the unique identity of a conventional computer or computerized entity subsists, or even if such an identity exists.[63] A computer's identity does not appear to be tied to any critical physical component, as such components can be replaced or altered without destroying the computer. Similarly, a computer's identity does not appear to be tied to a particular set of digital data that comprises the computer's operating system, applications, and user data, as that data can be copied with perfect fidelity to other devices, creating computers that are functionally clones of one another.

B. Intelligence

The information-processing mechanisms and behaviors of an agent possessing computronic characteristics demonstrate a number of significant traits. Such an agent is:

Non-sapient. A conventional computer does not possess sapient self-awareness or a subjective conscious experience of reality.[64]

Semiautonomous or nonautonomous. For computerized devices such as robots, autonomy can be understood as the state of being "capable of operating in the real-world environment without any form of external control for extended periods of time."[65] Such autonomy does not simply involve the ability to perform cognitive tasks like setting goals and making decisions; it also requires an entity to successfully perform physical activities such as securing energy sources and carrying out self-repair without human intervention. Applying this definition, we can say that current computerized devices are typically either nonautonomous (e.g., telepresence robots that are fully controlled by their human operators) or semiautonomous (e.g., robots that require 'continuous assistance' or 'shared control' in order to fulfill their intended purpose).[66] Although some contemporary computerized systems can be understood as 'autonomous' with regard to fulfilling their intended purpose – in that they can receive sensory input, process information, make de-

[63] For a discussion of philosophical issues relating to personal identity, see Olson (2015); see also Friedenberg (2008), p. 250.

[64] Regarding different perspectives on the characteristics that a computer or other artificial system would need to have in order for it to possess sapient self-awareness and a subjective conscious experience of reality, see Friedenberg (2008), pp. 163-78.

[65] Bekey (2005), p. 1.

[66] See Murphy, *Introduction to AI Robotics* (2000).

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cisions, and perform actions without direct human control – they are not autonomous in the full sense of the word, insofar as they are generally not capable of, for example, securing energy sources within the environment or repairing physical damage to themselves.[67]

Volitional. Many conventional computerized devices are nonvolitional, meaning that they possess no internal goals or 'desires' for achieving particular outcomes nor any expectations or 'beliefs' about how performing certain actions would lead to such outcomes. However, many contemporary computerized devices – including a wide variety of robots used in commercial contexts – are volitional. As noted earlier, an entity is volitional if it combines goals with expectations; in other words, it can possess an intention, which is a mental state that comprises both a desire and a belief about how some act that the agent is about to perform can contribute to fulfilling that desire.[68] For example, a therapeutic social robot might possess the goal of evoking a positive emotional response in its human user, and its programming and stored information tells it that by following particular strategies for social interaction it is likely to evoke such a response.[69]

Programmed. A conventional computer does not 'learn' through experience; it does not undergo a long-term formative process of education in order to acquire new knowledge or information. Instead, a computer has software programs and data files copied onto its storage media, thereby instantaneously gaining new capacities and the possession of new information.[70] Alternatively, a computer may be directly programmed or configured by a human operator.

Processing information by means of a CPU. A conventional contemporary computer (e.g., a desktop computer or smartphone) is based on a Von Neumann architecture comprising memory, I/O devices, and one or more central processing

[67] Gladden, "The Diffuse Intelligent Other" (2016).

[68] Calverley (2008), p. 529.

[69] Gladden, "The Diffuse Intelligent Other" (2016).

[70] For a discussion of the ways in which the electronic components of traditional computers carry out the work of and are controlled by executable programs – as well as an overview of the ways in which alternative architectures such as that of the neural network can allow computers to learn through experience – see Null & Lobur (2006). A more detailed presentation of the ways in which neural networks can be structured and learn is found in Haykin, *Neural Networks and Learning Machines* (2009). For a review of forms of computer behavior whose activity can be hard to predict (e.g., the actions of some forms of evolutionary algorithms or neural networks) as well as other forms of biological or biologically inspired computing, see Lamm & Unger (2011).

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units connected by a communication bus.[71] Although one can be made to replicate the functioning of the other, the linear method by which such a CPU-based system processes information is fundamentally different from the parallel processing method utilized by a physical neural network such as that constituted by the human brain.[72]

Lacking emotion. A traditional computer does not possess emotions that are grounded in the current state of the computer's body, are consciously experienced by the computer, and influence the contents of its decisions and behavior.[73] Although a piece of software may run more slowly or have some features disabled when executed on particular computers, the nature of the software's decision-making is not influenced by factors of mood, emotion, or personality that are determined by a computer's hardware. A software program will typically either run or not run on a given computer; if it runs at all, it will run in a manner that is determined by the internal logic and instructions contained within the software code and not swayed or distorted by that computer's particular physical state.

Free from cognitive biases. A conventional computer is not inherently subject to human-like cognitive biases, as its decisions and actions are determined by the logic and instructions contained within its operating system and application code and not by the use of evolved heuristic mechanisms that are a core element of human psychology.[74]

Possessing nonvolatile digital memory. Many conventional computers are able to store data in a stable electronic digital form that is practically lossless, does not degrade rapidly over time, can be copied to other devices or media and backed up with full fidelity, and does not require a continuous power supply in order to preserve the data.[75]

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[71] See Friedenberg (2008), pp. 27-29.

[72] See Friedenberg (2008), pp. 30-32.

[73] For the distinction between the relatively straightforward phenomenon of computers possessing 'emotion' simply as a function versus the more doubtful possibility that computers could undergo 'emotion' as a conscious experience, see Friedenberg (2008), pp. 191-200.

[74] It is possible, however, for a computer to indirectly demonstrate human-like cognitive biases if the human programmers who designed a computer's software were not attentive to such considerations and inadvertently programmed the software to behave in a manner that manifests such biases. For a discussion of such issues, see, e.g., Friedman & Nissenbaum, "Bias in Computer Systems" (1997).

[75] Regarding the creation, storage, and transfer of digital data files by computers and other electronic devices, see, e.g., Austerberry, *Digital Asset Management* (2013), and Coughlin, *Digital Storage in*

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Demonstrating predictable and analyzable behavior. Computerized devices can be affected by a wide range of component failures and bugs resulting from hardware or software defects or incompatibilities. However, because a typical computer is controlled by discrete linear executable code that can be easily accessed – and because there exist diagnostic software, software debugging techniques, established troubleshooting practices, and methods for simulating a computer's real-world behaviors in development and testing environments – it is generally easier to analyze and reliably predict the behavior of a computer than that of, for example, a human being.[76]

Capable of being hacked electronically. Computerized systems are vulnerable to a wide variety of electronic hacking techniques and other attacks that can compromise the confidentiality, integrity, and availability of information that is received, generated, stored, or transmitted by a system or can result in unauthorized parties gaining complete control over the system.[77]

C. Social Interaction

An agent possessing computronic characteristics demonstrates a number of noteworthy traits relating to social interaction. Such an agent is:

Nonsocial or semisocial. Conventional computers may display social behaviors and engage in short-term, isolated social interactions with human beings or other computers, but they do not participate in long-term social relations that deepen and evolve over time as a result of their experience of such engagement and which are shaped by society's expectations for social roles to be filled by the participants in such relations.[78]

Consumer Electronics: The Essential Guide (2008).

[76] Even the behavior of sophisticated 'artificially intelligent' computerized systems can be easy to predict and debug, if it is controlled by a conventional executable program rather than, e.g., the actions of a physical artificial neural network. For a discussion of different models for generating artificial intelligence through hardware and software platforms, see Friedenberg (2008), pp. 27-36.

[77] For an overview of such possibilities (as well as related preventative practices and responses), see Rao & Nayak (2014).

[78] Although there already exist telepresence robots (e.g., Ishiguro's Geminoids) that manifest highly sophisticated, human-like levels of sociality, such sociality is technically possessed not by the robot itself but by the hybrid human-robotic system that it forms with its human operator. Regarding such issues, see Vinciarelli et al. (2012) and Gladden, "Managerial Robotics" (2014).

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Lacking culture. Although a large number of computers can be linked to form networks that may constitute a form of computerized society, such aggregations of conventional computers do not create their own cultures.[79]

Lacking spirituality. Conventional computers do not search for a connection with some transcendental truth or reality in order to provide meaning or purpose to their existence; they do not engage in contemplation, meditation, or prayer.[80]

Apolitical. Conventional computers do not directly participate as members of human or artificial political systems. Some computerized systems (e.g., some swarm robots as components in multi-agent systems) participate in social interactions, and even social relations and group governance structures, but they do not generally create political systems of the sort common among human populations.[81]

An economic participant. Conventional computers typically do not function independently within the real-world human economy as autonomous economic actors, although they participate in the economy in many other ways. Computers do not own or exchange their own financial or other assets, nor do they purchase goods or services for their own consumption, although computers may serve as agents that initiate and execute transactions on behalf of human beings or organizations.[82]

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[79] Regarding prerequisites for artificial entities or systems to produce their own culture (or collaborate with human beings in the production of a shared human-artificial culture), see, e.g., Payr & Trappl, "Agents across Cultures" (2003).

[80] Regarding elements that would need to be present in order for a computerized device to develop its own spirituality (rather than to simply have some spiritual value attributed to it by human beings), see, e.g., Geraci, "Spiritual robots: Religion and our scientific view of the natural world" (2006); Nahin, "Religious Robots" (2014); Section 6.2.3.2 on "Religion for Robots" in Yampolskiy, *Artificial Superintelligence: A Futuristic Approach* (2015); and Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (2000).

[81] Regarding ways in which advanced multi-agent systems (such as those found in swarm robotics) might potentially implement patterns of social interaction and organization that resemble or are explicitly based on human political behaviors and structures, see, e.g., McBurney & Parsons, "Engineering democracy in open agent systems" (2003); Ferber et al., "From agents to organizations: an organizational view of multi-agent systems" (2004); and Sorbello et al., "Metaphor of Politics: A Mechanism of Coalition Formation" (2004).

[82] For example, regarding the increasing sophistication of automated trading systems that are capable of teaching themselves and improving their investment strategies over time, without direct instruction from human beings, and the growing use of 'robo-advisors' to manage financial assets on behalf of human owners, see Scopino, "Do Automated Trading Systems Dream of Manipulating the Price of Futures Contracts? Policing Markets for Improper Trading Practices by Algorithmic Robots" (2015), and Sharf, "Can Robo-Advisors Survive A Bear Market?" (2015).

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Property, not a legal person. A conventional computer is a piece of property that is typically owned by a specific human being or organization; a computer is not itself a legal person that possesses a recognized set of rights and responsibilities.[83]

III. Using the Matrix to Analyze the Traditional Practice of Organizational Management

Our two-dimensional Posthuman Management Matrix contains quadrants that describes four types of entities that could potentially be participants in or objects of the activities of organizations such as businesses and which – if they exist – would need to be accounted for by management theory and practice. As illustrated in Figure 1, these four potential types of entities are:

- **Human agents possessing anthropic characteristics**, which we can refer to as '**natural human beings**,' insofar as they have not been significantly enhanced or modified through the use of technologies such as neuroprosthetics or genetic engineering.
- **Artificial agents possessing computronic characteristics**, which we can refer to simply as '**computers**.' Such entities include conventional desktop and laptop computers, mainframes, web servers, and smartphones and other mobile devices whose software allows them to exercise a limited degree of agency.
- **Human agents possessing computronic characteristics**, which we can refer to as '**cyborgs**.' In the sense in which the term is employed in this text, a cyborg is a human being whose body includes some 'artificial components,'[84] however these components do not necessarily need to be electromechanical in nature (as in the case of contemporary neuroprosthetic devices); the artificial elements could be structures or systems composed of biological material that are not typically found in

[83] Stahl suggests that a kind of limited 'quasi-responsibility' can be attributed to conventional computers and computerized systems. In this model, it is a computer's human designers, programmers, or operators who are typically responsible for the computer's actions; declaring a particular computer to be 'quasi-responsible' for some action that it has performed serves as a sort of moral and legal placeholder, until the computer's human designers, programmers, and operators can be identified and ultimate responsibility for the computer's actions assigned to the appropriate human parties. See Stahl, "Responsible Computers? A Case for Ascribing Quasi-Responsibility to Computers Independent of Personhood or Agency" (2006).

[84] See Novaković et al. (2009).

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natural human beings and which are the result of genetic engineering.

- **Artificial agents possessing human characteristics**, which we can refer to as '**bioroids**.' Terms such as 'android' or 'humanoid robot' could potentially be employed to describe such entities, however these terms are often used to imply that a robot has a human-like physical form, without necessarily possessing human-like psychology, cognitive capacities, or biological components. Similarly, the term 'biorobot' could be employed, but it is often used to refer to robots that mimic animals like insects or fish whose physical form and cognitive capacities have little in common with those of human beings. We choose to employ the term 'bioroid' (whose origins lie primarily in the field of science fiction rather than engineering)[85] insofar as it evokes the image of an artificially engineered agent that possesses human-like cognitive capacities and psychology, biological or biologically inspired components, and a physical form that allows it to engage in human-like social behaviors and interactions but which is not necessarily humanoid.

Prior to the development of computers as a practical organizational technology in the 20th Century, it was historically only the lower left quadrant of the Posthuman Management Matrix that was of relevance to organizational managers. Indeed, not only were natural human beings as a practical matter the only available employees and customers, but they were also generally considered to be the only *potential* employees and customers with which the scholarly discipline of management would ever need to concern itself. The possibility that organizations might someday employ and serve entities that were not human agents possessing anthropic characteristics was not studied as a theoretical possibility; the theory and practice of management were con-

[85] For uses of the term 'bioroid' in science fiction literature and roleplaying games, see, e.g., Pulver (1995), pp. 74-81, where 'bioroid' is used explicitly as a portmanteau derived from 'biological android'; Surbrook, *Kazei-5* (1998), pp. 64, 113; Pulver, *Transhuman Space* (2002), p. 12, where 'bioroid' refers to "living beings functionally similar to humans, but assembled using tissue engineering and 'biogenesis' nanotechnology, and educated using accelerated learning techniques"; *Appleseed*, directed by Aramaki (2010); Martinez, "Bodies of future memories: the Japanese body in science fiction anime" (2015); Litzsinger, *Android: Netrunner* (2012); and Duncan, "Mandatory Upgrades: The Evolving Mechanics and Theme of Android: Netrunner" (2014). For a reference to the fictional use of the term 'bioroid' in an engineering context, see Novaković et al. (2009).

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cerned only with understanding and managing the activities of natural human beings. Within that context, fields such as economics, organizational psychology, and human resource management played key roles.

Eventually, with the development of increasingly sophisticated computers over the course of the 20th Century and up through the present day, management scholars and practitioners began to realize the need to expand the theoretical and practical scope of management to include new subdisciplines that could guide the creation, implementation, and management of artificial agents such as manufacturing robots or server farms controlled by load-balancing software.[86] Because such artificial agents possessed structures, behaviors, and organizational roles that were quite different from those of human agents, existing disciplines such as psychology and HR management did not provide adequate or relevant tools for the oversight of such systems; instead, new fields such as computer science, electronics engineering, robotics, and IT management began to aid organizational managers in designing, implementing, and maintaining such systems that comprise artificial agents possessing computronic characteristics. As a result of such developments, a second quadrant of the Posthuman Management Matrix became not only relevant but critical for the successful management of contemporary organizations.

Despite this experience in which a previously disregarded quadrant of the Posthuman Management Matrix quickly assumed major theoretical and practical importance for organizations, the remaining two quadrants of the Matrix have remained largely neglected within the field of organizational management – as though there existed an implicit presumption that these areas define sets that would continue to remain empty or that these quadrants would only become relevant for organizational management at a date so far in the future that it would be a misallocation of time and resources for management scholars and practitioners to concern themselves with such possibilities now.

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[86] The development of such disciplines and practices was spurred in part by the experience of organizations that made large investments in IT systems in the 1980s, only to discover that simply purchasing exotic new IT equipment would not, in itself, generate desired gains in productivity unless such equipment were thoughtfully aligned with and integrated into an organization's larger business plan, strategies, and processes. See Magoulas et al. (2012), p. 89, and Hoogervorst (2004), p. 16.

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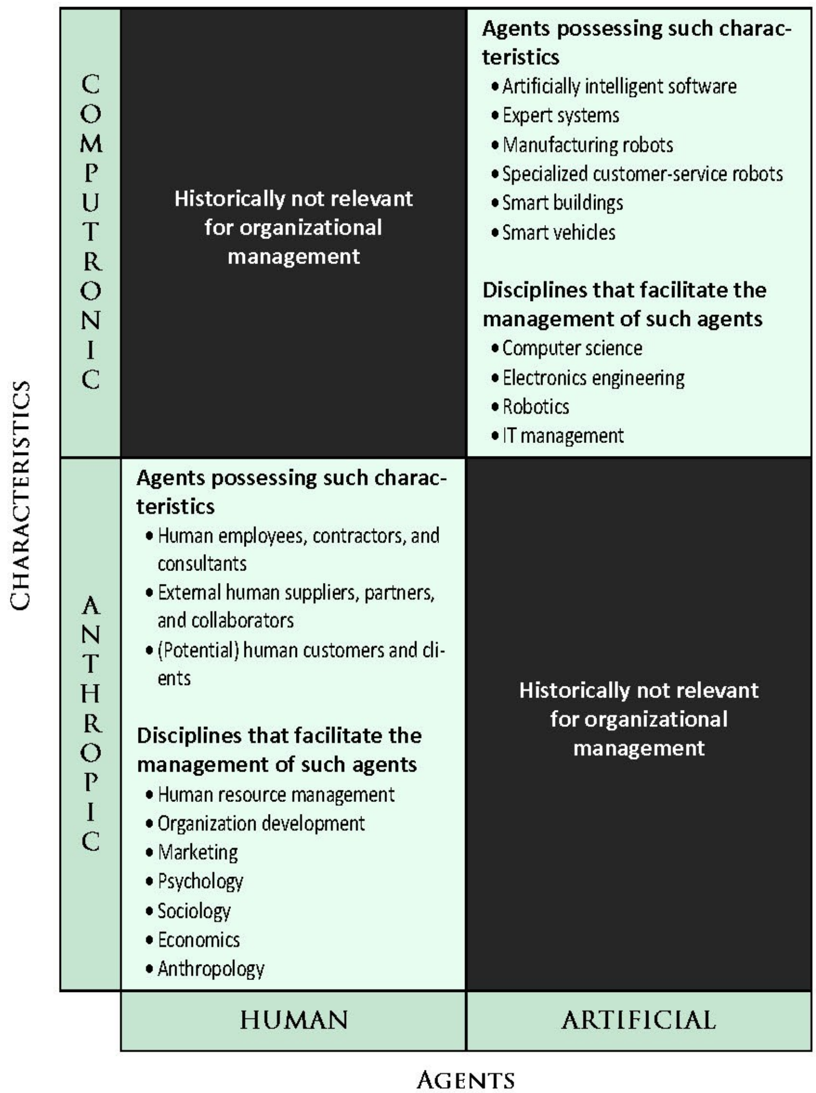

Fig. 2: The Posthuman Management Matrix displaying the two types of entities that have been relevant in recent decades for the theory and practice of organizational management, along with two types of entities that historically have not been considered relevant.

Figure 2 thus depicts the field of management as it largely exists today: a field in which centuries-old management traditions relating to natural human beings have recently been supplemented by new theory and practice

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that address the rise of conventional computers – but in which the possibility and organizational significance of cyborgs and bioroids remain, from a management perspective, largely unexplored.[87]

We can now consider in more detail these four types of entities described by the Posthuman Management Matrix as they have been understood by the field of organizational management from its historical origins up to the present day.

A. Human Agents with Anthropic Characteristics ('Natural Human Beings')

The actions of natural human beings – and the knowledge of how to anticipate and guide their activities – have formed the critical foundation upon which all human organizations have historically been built. Even before the dawn of artificial intelligence and the creation of the first artificial agents, nonhuman agents such as domesticated farm animals have played a supporting role in the activities of some human organizations. However, the overwhelming majority of roles within such organizations – including all of those leadership and management roles requiring strategic thinking and long-term planning, ethical and legal sensitivity, negotiation skills, risk management approaches, and the use of oral and written communication – have historically been filled by human beings, who have always been (and been understood as) human agents who possess anthropic characteristics. Human organizations such as businesses have relied on such human beings as their CEOs and executives, midlevel managers, frontline employees, consultants, partners and suppliers, competitors, and actual or potential customers and clients.

In order to plan, organize, lead, and control[88] the activities of such natural human beings that are found both within and outside of organizations, a number of academic disciplines and practices have been developed over the

[87] For some time, the design, implementation, and implications of human agents possessing computronic characteristics and artificial agents possessing anthropic characteristics have been the subject of intense research and contemplation across a broad range of fields, from computer science and robotics to philosophy of mind and philosophy of technology, ethics, and science fiction; here we are only noting that – notwithstanding the work of a small number of future-oriented management scholars – the field of management has not yet taken up such topics as subjects worthy of (or even demanding) serious consideration.

[88] Planning, organizing, leading, and controlling are recognized as the four key functions that must be performed by managers. See Daft, *Management* (2011).

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last century and more that can facilitate and support the management of organizations. Such disciplines include HR management, marketing, and organization development, along with other disciplines such as psychology, sociology, economics, anthropology, cultural studies, and ergonomics that have broader aims and applications but which can help inform organizational management.

B. Artificial Agents with Computronic Characteristics ('Computers')

Over the last half-century, computers have taken on critical roles within the lives of many organizations. Such agents comprise assembly-line robots used for painting or welding, flexible manufacturing systems, automated security systems, and a broad range of software that possesses some degree of artificial intelligence and runs as part of an operating system or application on servers, desktop computers, mobile devices, and other computerized equipment. Such artificial agents may schedule tasks and optimize the use of physical and electronic resources;[89] transport materials within production facilities;[90] assemble components to produce finished products;[91] interact directly with customers on automated customer-service phone lines, through online chat interfaces, and at physical kiosks to initiate and perform transactions and offer information and support;[92] monitor systems and facilities to

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[89] For an overview of methods that can be employed for such purposes, see Pinedo, *Scheduling: Theory, Algorithms, and Systems* (2012). For more specific discussions of the use of artificial agents (and especially multi-agent systems) for such ends, see, e.g., Ponsteen & Kusters, "Classification of Human and Automated Resource Allocation Approaches in Multi-Project Management" (2015); Merdan et al., "Workflow scheduling using multi-agent systems in a dynamically changing environment" (2013); and Xu et al., "A Distributed Multi-Agent Framework for Shared Resources Scheduling" (2012).

[90] See, e.g., Ullrich, *Automated Guided Vehicle Systems: A Primer with Practical Applications* (2015), and *The Future of Automated Freight Transport: Concepts, Design and Implementation*, edited by Priemus & Nijkamp (2005).

[91] See, e.g., *Agent-Based Manufacturing: Advances in the Holonic Approach*, edited by Deen (2003); *Intelligent Production Machines and Systems*, edited by Pham et al. (2006); and *Industrial Applications of Holonic and Multi-Agent Systems*, edited by Mařík et al. (2015).

[92] See, e.g., Ford, *Rise of the Robots: Technology and the Threat of a Jobless Future* (2015), and McIndoe, "Health Kiosk Technologies" (2010).

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detect physical or electronic intrusion attempts;[93] initiate and execute financial transactions within online markets;[94] and carry out data mining in order to evaluate an applicant's credit risk, identify suspected fraud, and decide what personalized offers and advertisements to display to a website's visitors.[95] In order to manage the activities of artificial agents possessing computronic characteristics, one can draw on insights from a number of disciplines and practices that have been developed over the last few decades, including computer science, electronics engineering, robotics, and IT management.

While human beings still play key roles as leaders, strategists, and managers within organizations, in many cases they are no longer capable of carrying out their work without the engagement and support of the artificial agents that permeate an organization's structures, processes, and systems in so many ways.[96] For many organizations, the sudden disabling or loss of such artificial agents would be devastating, as the organizations have become dependent on artificial agent technologies to perform critical tasks that cannot be performed by human beings with the same degree of speed, efficiency, or power.

C. Human Agents with Computronic Characteristics ('Cyborgs')

Historically, all human beings have been human agents that possess anthropic characteristics. From the perspective of organizational management, the set of human agents possessing computronic characteristics has been seen as empty; such beings are not yet understood to widely exist, and it is presumed that there is no special need to take them into account as potential employees, partners, or clients when considering a business's short-term objectives and operations. Although emerging posthumanizing technologies are

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[93] Regarding the automation of intrusion detection and prevention systems, see Rao & Nayak (2014), pp. 226, 235, 238.

[94] See Philips, "How the Robots Lost: High-Frequency Trading's Rise and Fall" (2012); Scopino (2015); and Sharf (2015).

[95] Giudici, *Applied Data Mining: Statistical Methods for Business and Industry* (2003); Provost & Fawcett, *Data Science for Business* (2013), p. 7; and Warkentin et al., "The Role of Intelligent Agents and Data Mining in Electronic Partnership Management" (2012), p. 13282.

[96] Within the 'congruence model' of organizational architecture developed by Nadler and Tushman, structures, processes, and systems constitute the three main elements of an organization that must be considered. See Nadler & Tushman, *Competing by Design: The Power of Organizational Architecture* (1997), p. 47, and the discussion of these elements within a posthumanized organizational context in Part Two of this volume, on "Organizational Posthumanism."

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beginning to create cases of human agents who indeed possess limited computronic characteristics, the number, nature, and scope of such cases of the 'cyborgization' of human agents is still relatively small, and from the managerial perspective most organizations have been able to simply ignore such cases, as though the category of the cyborg were not yet applicable or relevant to their organizational mission and objectives.[97] Because human agents possessing extensive computronic characteristics do not yet exist as a large population of beings who can serve as employees, partners, or customers for organizations, it is not surprising that organizations do not yet possess specialized practices or academic disciplines that they can rely on to aid them in the management of such entities.

D. Artificial Agents with Anthropic Characteristics ('Bioroids')

The artificial agents that have been broadly deployed and which are relevant for organizational management are generally artificial agents possessing computronic characteristics. While scientists and engineers are making great strides toward developing artificial agents that possess anthropic characteristics, at present such systems are experimental and exist largely in laboratory settings.[98] As a practical matter, within most organizations the category of bioroids is still treated as though it were an empty set; organizations have generally not seen the need to consider such entities when planning their objectives and operations. As with the cyborgs described above, because bioroids have historically not existed as potential employees, partners, or customers for organizations, it is unsurprising that organizations do not yet have specialized disciplines that they can rely on to aid them in managing such entities.

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[97] Fleischmann argues, for example, that within human society there is an inexorable trend that will eventually result in full cyborg-cyborg interaction in the form of social relations among beings who are human-electronic hybrids – human beings whose biological organism possesses extensive and intimate internal interfaces with neuroprosthetic devices. Current phenomena like the widespread interaction of human beings who are dependent on (and interact through) mobile devices such as smartphones are one step along that trajectory. See Fleischmann, "Sociotechnical Interaction and Cyborg–Cyborg Interaction: Transforming the Scale and Convergence of HCI" (2009).

[98] See Friedenberg (2008) for an in-depth review of efforts to develop robots and other artificial beings that possess human-like perception, learning, memory, thought, language use, intelligence, creativity, motivation, emotions, decision-making capacities and free will, consciousness, biological structures and processes, and social behaviors.

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IV. Using the Matrix to Predict and Shape the Future Practice of Organizational Management

In the sections above, we have considered the situation that has existed up to now – with organizations' sole agents being natural human beings and computers. We can now explore the ways in which the situation is rapidly changing due to the emergence of new posthumanizing technologies.

A. The Converging Characteristics of Human and Artificial Agents in the Posthuman Age

Below we review once more the set of variables that define an agent's characteristics and, for each of the characteristics, discuss ways in which the advent of various posthumanizing technologies will result in a growing variety of cyborgs and bioroids. Studies focusing on these two types of entities are emerging as new fields in which ongoing innovation will expand the kinds of workers, partners, and consumers that are available to organizations and which are expected to become crucial loci for management theory and practice in the coming years. We can consider in turn the physical form, intelligence, and social interaction that will be demonstrated by such new types of human and artificial agents .

1. Physical Form

The range of physical forms available to human and artificial agents is expected to evolve and expand significantly. Such changes will be visible in the manner in which a number of key characteristics are expressed (or not expressed); these characteristics are described below.

a. Components

It is anticipated that the bodies of human agents will increasingly include electronic components in the form of artificial organs, artificial limbs and exoskeletons, artificial sense organs, memory implants, and other kinds of neuroprosthetic devices;[99] the major obstacle to the expansion of such technology

[99] See Gasson, "ICT implants" (2008); Gasson et al., "Human ICT Implants: From Invasive to Pervasive" (2012); McGee (2008); Merkel et al., "Central Neural Prostheses" (2007); Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 32-33; and Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics" (2015).

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may be the fact that the natural biological brain (or at least, significant portions of the brain) of a human being will need to remain intact and functional in order for an agent to be considered 'human.'

Conversely, expected developments in genetic engineering technologies, soft robotics, and artificial life will increasingly allow the bodies of artificial agents to include components formed from biological material.[100] In cases that involve extensive engineering and modification of the genome (and especially in 'second-generation' entities that are the result of natural reproductive processes between biological parents rather than cloning or other direct engineering), it may be difficult conceptually and practically to specify whether an entity is an 'artificial agent' composed entirely of biological components or a 'human agent' whose biological substrate has been intentionally designed. The legal, ethical, ontological, and even theological questions involved with such potential practices are serious and wide-ranging.

B. Animation

Currently, only those human beings that are alive are capable of serving as employees or customers of an organization. Techniques such as 'mind uploading' and the development of artificial neurons that can replace or replicate the actions of neurons in the brain of a living human being may someday allow human agents that are no longer 'alive' in a biological sense to have their unique memories, knowledge, cognitive patterns, and social relations utilized by agents that function as employees, partners, or customers for organizations. The extent to which such nonbiological human agents can be identified with the biological human beings from whom they are derived depends on issues that are philosophically controversial and complex.[101]

Meanwhile, the development of biological components for use in robots and other artificial agents and ongoing advances in the development of nonbiological artificial life (e.g., autonomous evolvable computer worms or viruses that satisfy standard scientific definitions of life-forms) can result in

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[100] See Berner (2004), pp. 15, 18, 31, 61-62. For a discussion of the possibilities of using DNA as a mechanism for the storage or processing of data, see Church et al. (2012) and Friedenberg (2008), p. 244.

[101] See Koene (2012); Proudfoot (2012); Pearce, "The Biointelligence Explosion" (2012); Hanson, "If uploads come first: The crack of a future dawn" (1994); Moravec, *Mind Children: The Future of Robot and Human Intelligence* (1990); Ferrando (2013), p. 27; and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 98-100, for a discussion of such issues from various perspectives.

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artificial agents that are considered to be alive, insofar as they constitute a viable system that demonstrate a physical metabolism, the ability to maintain homeostasis, reproduction, reaction and adaptation to the environment, and other key characteristics.[102]

C. Design

The growing possibilities for genetic engineering, gene therapy, and the augmentation of human agents through the implantation of neuroprosthetic devices or other synthetic components means that the body possessed by a human agent will no longer necessarily be a natural substrate that is produced through the randomized inheritance of genetic material from biological parents and that is free from intentional design by institutions or individual human engineers.[103] Besides the major moral and legal questions raised by such possibilities, there are also operational issues that would confront organizations whose pool of potential employees or customers includes human agents who have been designed in such ways; for example, forms of genetic engineering that create synthetic characteristics shared broadly across a population and which reduce genotypic diversity may render the population more vulnerable to biological or electronic hacking attempts (and may make such attempts more profitable and attractive for would-be adversaries), although such standardization may also make it easier for effective anti-hacking security mechanisms to be developed and deployed across the population.[104]

At the same time, artificial agents may no longer be products of explicit design and engineering by human manufacturers. Some artificial life-forms that exist within the digital-physical ecosystem primarily as physical robots possessing some degree of AI or as digital life-forms that temporarily occupy

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[102] See the discussion of essential elements of artificial life in Friedenberg (2008), pp. 201-03, which is based on the criteria for biological life presented by Curtis (1983). See also Gladden, "The Artificial Life-Form as Entrepreneur: Synthetic Organism-Enterprises and the Reconceptualization of Business" (2014).

[103] For different perspectives on such possibilities, see, e.g., De Melo-Martín (2015); Regalado, "Engineering the perfect baby" (2015); Lilley, *Transhumanism and Society: The Social Debate over Human Enhancement* (2013); Nouvel (2015); Section B ("Enhancement") in *The Future of Bioethics: International Dialogues*, edited by Akira Akabayashi (2014); Mehlman, *Transhumanist Dreams and Dystopian Nightmares: The Promise and Peril of Genetic Engineering* (2012); and Bostrom (2012).

[104] For the relationship between the heterogeneity of information systems and their information security, see Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), p. 296, and *NIST SP 800-53* (2013), p. F-204.

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physical substrates may manifest structures and behaviors that are the result of randomized evolutionary processes that lie beyond the control of human designers or which are the result of intentional design efforts conducted by other artificial agents whose nature is such that they are inscrutable to human understanding – in which case, from the human perspective, the engineered agents would essentially lack a comprehensible design.[105] In other cases, human designers may have intentionally engineered an artificial agent's basic structures (such as a physical neural network), but the exact nature of the behaviors and other traits eventually developed and demonstrated by those structures may lie beyond the reach of human engineering.[106]

D. Upgradeability

The growing use of technologies for somatic cell gene therapy and neuroprosthetic augmentation may increasingly allow the physical components and cognitive capacities of human agents to be upgraded and expanded even after the agents have reached a stage of physical and cognitive maturity.[107]

Conversely, it may be difficult or impossible to upgrade, expand, or replace the physical components of artificial agents that are composed of biological material in the way that components of an electronic computer can be upgraded. In the case of especially complex or fragile artificial agents, efforts to upgrade or otherwise modify an agent's physical components after its creation may result in the impairment or death of such biological material or of the agent as a whole. Similarly, after an artificial agent that possesses a holonomic physical neural network has been created and achieved intellectual maturity through experience and learning, it may not be possible to intervene directly in the neural network's physical structure or processes to upgrade its capacities or edit its contents without irreparably harming the agent.[108]

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[105] Regarding evolutionary robotics and evolvable robot hardware, see Friedenberg (2008), pp. 206-10.

[106] Regarding the relationship of artificial life and evolutionary robotics, see Friedenberg (2008), pp. 201-16.

[107] See, e.g., Panno, *Gene Therapy: Treating Disease by Repairing Genes* (2005); *Gene Therapy of the Central Nervous System: From Bench to Bedside*, edited by Kaplitt & During (2006); and Bostrom (2012).

[108] Regarding the potentially holonomic nature of memory storage within the brain, see, e.g., Longuet-Higgins (1968); Pribram (1990); Pribram & Meade (1999); and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 200-01.

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E. Lifespan

A human agent whose bodily components can be easily replaced with biological or electronic substitutes after deteriorating or becoming damaged or whose components can be (re)engineered to prevent them from undergoing damage or deterioration in the first place could potentially experience an extended or even indefinite lifespan, although such engineering might result in side-effects that are detrimental to the agent and which would render such lifespan extension undesirable as a practical matter.[109] As in other cases, the moral and legal questions involved with such activities are serious.

At the same time, artificial agents whose bodies include or comprise biological components or whose cognitive processes follow an irreversible developmental cycle (e.g., in which the neural network of an agent's 'brain' possesses a maximum amount of information that it can accumulate over the course of the agent's lifespan) might possess a limited and predetermined lifespan that cannot be extended after the agent's creation.[110]

F. Operational Cycle

Genetic engineering could potentially speed the natural biological processes that contribute to physical growth and cognitive development or slow or block processes of physical and cognitive decline. Scholars also envision the possibility of neuroprosthetic technologies being used to allow human beings to instantly acquire new knowledge or skills through the implantation of memory chips or the downloading of files into one's brain; if feasible, this could allow human cognitive capacities to be instantaneously upgraded in a manner similar to that of installing new software on a computer, thereby bypassing typical human processes of cognitive development and learning.[111]

At the same time, the integration into artificial agents of biological components and physical neural networks whose structure and behavior render

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[109] Regarding issues with technologically facilitated life extension or the replacement of a human being's original biological body, see Proudfoot (2012); Pearce (2012); Hanson (1994); and Gladden, "'Upgrading' the Human Entity: Cyberization as a Path to Posthuman Utopia or Digital Annihilation?" (2015).

[110] As early as the 1940s, Wiener speculated that a physical neural network that is incapable of adding new neurons or creating new synapses but which instead stores memories through increases to the input threshold that triggers the firing of existing neurons may display an irreversible process of creating memories through which its finite available storage capacity is gradually exhausted, after which point a sort of senescence occurs that degrades the neural network's functioning and disrupts the formation of new memories. See Wiener (1961), loc. 2467ff.

[111] See, e.g., McGee (2008).

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them difficult to control externally after their deployment means that it may become impossible to simply 'reset' artificial agents and restore them to an earlier physical and informational state.[112]

G. Locality

The use of neuroprosthetic devices and virtual reality technologies may effectively allow a human agent to occupy different and multiple bodies that are either physical or virtual and are potentially of a radically nonhuman nature.[113] In this way, a human agent could be extremely multilocal by being present in many different environments simultaneously.[114]

At the same time, an artificial agent whose cognitive processes are tied to a single body comprising biological components or a single physical artificial neural network that possesses limited sensorimotor and I/O mechanisms may be confined to exercising its agency within the location in which that cognitive substrate is located.[115]

H. Permanence of Substrate

Historically, a particular human agent has been tied to a particular physical substrate or body; the dissolution of that body entails the end of that human being's ability to act as an agent within the environment. Ontologically and ethically controversial practices such as the development of artificial neurons to replace the natural biological neurons of a human brain and mind uploading may allow a single human agent's agency to exist and act beyond the physical confines of the agent's original biological physical substrate – but only under certain definitions of 'agent' and 'agency' that remain strongly

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[112] Regarding the difficulty of detecting and understanding the current state of an artificially intelligent system (let alone restoring it to a previous state), especially that of a distributed artificial intelligence (DAI) displaying emergent behavior, see Friedenberg (2008), pp. 31-32.

[113] Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics" (2015).

[114] See Gladden, "The Diffuse Intelligent Other" (2016) for a discussion of multilocality.

[115] Regarding different fundamental architectures for the design of artificially intelligent systems – from a CPU-based Von Neumann architecture and software-based artificial neural network to models utilizing grid computing and distributed AI – see Friedenberg (2008), pp. 27-32. Regarding the extent to which a human-like AI may necessarily be tied to a single body that interacts with a particular environment, see Friedenberg (2008), pp. 32-33, and the literature on embodied embedded cognition – e.g., Wilson, "Six views of embodied cognition" (2002); Anderson, "Embodied cognition: A field guide" (2003); Sloman, "Some Requirements for Human-like Robots: Why the recent over-emphasis on embodiment has held up progress" (2009); and Garg, "Embodied Cognition, Human Computer Interaction, and Application Areas" (2012).

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contested.[116] Similarly, the use of genetic engineering or neuroprosthetically mediated cybernetic networks to create hive minds or other forms of collective agency involving human agents might allow such multi-agent systems or 'super-agents' to survive and function despite a continual addition and loss of biological substrates which mean that the entity's substrate at one moment in time shares no components in common with its substrate at a later point in time.

Just as certain posthumanizing technologies might – according to their proponents – free human agency from its historic link to a particular biological body, other technologies might increasingly bind artificial agency to a particular permanent physical substrate. For example, an artificial agent whose cognitive processes are executed by biological components or a physical artificial neural network and whose memories and knowledge are stored within such components may not be capable of exchanging its body or migrating to a new substrate without losing its agency.[117]

I. Identity

If a human agent's agency is no longer irrevocably tied to a particular biological body, it may become difficult or impossible to attribute actions to a specific human agent or even to identify which human agent is occupying and utilizing a particular physical body in a given moment – since a single electronic sensor or actuator could simultaneously belong to the bodies of multiple human agents. The ability of neuroprosthetically mediated cybernetic networks to create hive minds and other forms of collective consciousness among human and artificial agents may also make it difficult to identify which human agent, if any, is present in a particular physical or virtual environment and is carrying out the behaviors observed there.[118]

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[116] Regarding such issues, see Koene (2012); Proudfoot (2012); Pearce (2012); Hanson (1994); Moravec (1990); and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 99-100.

[117] It is not yet clear, for example, whether an artificial intelligence possessing human-like levels of intelligence could potentially exist in the form of a computer worm or virus that can move or copy itself from computer to computer, or whether the nature of human-like intelligence renders such a scenario theoretically impossible. Regarding the significance of a body for artificial intelligence, see, e.g., Friedenberg (2008), pp. 32-33, 179-234.

[118] Regarding such issues, see Gladden, "Utopias and Dystopias as Cybernetic Information Systems: Envisioning the Posthuman Neuropolity" (2015), and Gladden, "'Upgrading' the Human Entity" (2015).

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Conversely, if an artificial agent is tied to a particular physical body (e.g., because the agent's cognitive processes cannot be extracted or separated from the biological components or physical artificial neural network that execute them), this may provide it with a uniqueness and identity similar to that historically enjoyed by individual human beings.[119] On the other hand, an artificial agent that possesses a spatially dispersed or nonlocalizable body may possess even less of a clear identity than is possessed today by conventional hardware-software computing platforms.

2. Intelligence

The range of information-processing mechanisms and behaviors available to human and artificial agents is expected to evolve significantly as a result of posthumanizing technological and social change. Such changes will be expressed through the possession (or lack) of a number of key characteristics, which are described below.

a. Sapience

By interfering with or altering the biological mechanisms that support consciousness and self-awareness within the brain, neuroprosthetic devices could deprive particular human agents of sapience, even if those agents outwardly appear to remain fully functional as human beings; for example, a human agent might retain its ability to engage in social interactions with longtime friends – not because the agent's mind is conscious and aware of such interactions, but because a sufficiently sophisticated artificially intelligent neuroprosthetic device is orchestrating the agent's sensorimotor activity.[120] Genetic engineering could also potentially be employed in an attempt to create human agents that lack sapience (and could be subject to claims by their producers that they should be considered property rather than legal persons and moral agents) or human agents whose transhuman sapience is of such an unusual and 'advanced' sort that it is unfathomable – and perhaps even undetectable – to natural human beings.[121]

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[119] For an overview of issues of personal identity from a philosophical perspective, see Olson (2015). For an exploration of questions of physicality and identity in robots, see Friedenberg (2008), pp. 179-234.

[120] See Gladden, "'Upgrading' the Human Entity" (2015).

[121] See Abrams, "Pragmatism, Artificial Intelligence, and Posthuman Bioethics: Shusterman, Rorty, Foucault" (2004); McGee (2008), pp. 214-16; Warwick, "The cyborg revolution" (2014), p. 271; Rubin, "What Is the Good of Transhumanism?" (2008); and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 166-67.

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Much research from a philosophical and engineering perspective has been dedicated to considering whether sufficiently sophisticated artificial agents might be capable of achieving sapience and possessing self-awareness and a subjective conscious experience of reality. Controversy surrounds not only the theoretical questions of whether artificial agents can potentially possess sapience (and, if so, what types of artificial agents) but also the practical question of how outside observers might determine whether a particular artificial agent possesses conscious self-awareness or simply simulates the possession of such self-awareness.[122] Regardless of how these questions are answered by philosophers, theologians, scientists, engineers, and legislators, emerging popular conceptions of artificial agents and their potential for sapience may require organizations to treat certain kinds of artificial agents *as though* they possessed a degree of sapience comparable, if not identical, to that possessed by human beings.

B. Autonomy

Some kinds of neuroprosthetic devices or genetic modification may weaken the desires or strategic planning capacities of human agents or subject them to the control of external agents, thereby reducing their autonomy. New kinds of social network topologies that link the minds of human agents to create hive minds or other forms of merged consciousness can also reduce the autonomy of the individual members of such networks.[123] Neuroprosthetic augmentation, genetic modification, and other uses of posthumanizing technology that renders human agents dependent on corporations or other organizations for ongoing hardware or software upgrades or medical support similarly reduce the autonomy of those agents.[124] On the other hand, technologies that allow human agents to survive and operate in hostile environments or to reduce or repair physical damage to their bodies would enhance such agents' autonomy.

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[122] On the possibility that efforts to ascertain the levels of intelligence or consciousness of artificial entities might be distorted by human beings' anthropomorphizing biases, see Yampolskiy & Fox, "Artificial General Intelligence and the Human Mental Model" (2012), pp. 130-31. On the distinction between intelligence, consciousness, and personhood in such a context, see, e.g., Proudfoot (2012), pp. 375-76. For a broader discussion of such issues, see, e.g., *The Turing Test: The Elusive Standard of Artificial Intelligence*, edited by Moor (2003).

[123] See Gladden, "Utopias and Dystopias as Cybernetic Information Systems" (2015).

[124] See Gladden, "Neural Implants as Gateways to Digital-Physical Ecosystems and Posthuman Socioeconomic Interaction" (2016).

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The development of synthetic systems that possess human-like levels of artificial general intelligence would result in the appearance of artificial agents that do not function autonomously with regard to carrying out some specific task that they are expected to perform but which function autonomously at a more general level in deciding their own aims, aspirations, and strategies.[125] The development of robots that can obtain energy from their environment, for example, by consuming the same kinds of foods that are edible for human beings[126] or which possess biological components that can heal wounds that they have suffered will also result in artificial agents with increased autonomy.

C. Volitionality

Researchers have already observed ways in which certain kinds of neuroprosthetic devices and medications can affect their human host's capacity to possess desires, knowledge, and belief;[127] insofar as technologies disrupt or control such abilities, they may impair their human host's exercise of his or her conscience, which depends on the possession of these capacities. This may result in the existence of human agents that are no longer fully metavolitional but instead merely volitional or nonvolitional.[128] The use of neuroprosthetics, virtual reality, and other technologies to create hive minds and other forms of collective consciousness among human agents may also impair the volitionality of human agents participating in such systems and reduce them to a state that is less than metavolitional; each agent may no longer possess its own individual conscience but instead help to form (and be guided by) the conscience of the multi-agent system as a whole.

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[125] See, e.g., Yampolskiy & Fox (2012).

[126] See, e.g., the discussion of artificial digestive systems in Friedenberg (2008), p. 214-15.

[127] Regarding the possibility of developing neuroprosthetics that affect emotions and perceptions of personal identity and authenticity, see Soussou & Berger, "Cognitive and Emotional Neuroprostheses" (2008); Hatfield et al., "Brain Processes and Neurofeedback for Performance Enhancement of Precision Motor Behavior" (2009); Kraemer, "Me, Myself and My Brain Implant: Deep Brain Stimulation Raises Questions of Personal Authenticity and Alienation" (2011); Van den Berg, "Pieces of Me: On Identity and Information and Communications Technology Implants" (2012); McGee (2008), p. 217; and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 26-27.

[128] For a discussion of different levels of volitionality, see Gladden, "The Diffuse Intelligent Other" (2016).

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Meanwhile, advances toward the development of human-like artificial general intelligence point at the eventual creation of artificial agents that possess a capacity for knowledge, belief, personal desires, and self-reflexive thought – in short, the components necessary for an entity to be metavolitional and to possess a conscience.[129] The existence of conscience within artificial agents would have significant ramifications for the ways in which such agents could possibly be employed by organizations. Organizations that have metavolitional artificial agents as employees or customers could motivate them to act in certain ways by appealing to their conscience – to their sense of morality, justice, mercy, and the common good. At the same time, metavolitional artificial agents serving as employees within organizations could not be expected to automatically carry out instructions that have been given to them without first weighing them against the demands of their conscience. In the case of metavolitional artificial agents serving in roles that have a critical impact on human safety (e.g., robots serving as soldiers, police officers, surgeons, or the pilots of passenger vehicles) this could have positive or negative consequences.[130] For example, a robotic police officer who had been given an illegal and immoral command by its corrupt human supervisor to conceal evidence might decide to ignore that command as a result of its conscience; on the other hand, a robotic soldier could be manipulated by skilled 'conscience hackers' belonging to an opposing army who present the robot with fabricated evidence of atrocities that appeal to known weaknesses or bugs within the robot's metavolitional mechanisms and which persuade the robot to desert its post and join that opposing army.

D. Knowledge Acquisition

The use of genetic engineering to alter the basic cognitive structures and processes of human agents and, especially, the use of neuroprosthetic devices to monitor, control, or bypass the natural cognitive activity of a human agent may result in agents that do not need to be trained or educated but which can simply be 'programmed' to perform certain tasks or even remotely controlled by external systems to guide them in the performance of those tasks.[131]

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[129] See Calverley (2008) and Gladden, "The Diffuse Intelligent Other" (2016), for an explanation of the relationship of various cognitive capacities to the possession of second-order volitions (or metavolitions) on the part of artificially intelligent entities.

[130] Regarding the moral and practical implications of the possession of a conscience by artificial agents such as robots, see Wallach & Allen (2008).

[131] Regarding the 'programming' of human beings through the intentional, targeted modification of

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At the same time, there will be growing numbers and kinds of artificial agents that cannot simply be 'programmed' to carry out particular tasks in the manner of earlier conventional computers but which must be trained, educated, and allowed to learn through trial and error and firsthand interaction with and exploration of their world.[132]

E. Information-processing Locus

Increasingly the information processing performed by and within a human agent may occur not within the physical neural network that comprises natural biological neurons in the agent's brain but in other electronic or biological substrates, including neuroprosthetic devices and implantable computers that utilize traditional CPU-based technologies.[133]

Meanwhile, artificial agents' information processing may increasingly be performed within electronic or biological physical neural networks that do not rely on conventional CPU-based computing architectures, which do not possess a traditional operating system or the ability to run standard executable software programs, and which may be immune to many traditional electronic hacking techniques.[134]

F. Emotionality

The use of advanced neuroprosthetic devices that can heighten, suppress, or otherwise modify the emotions of human beings may result in populations of human agents whose programmatically controlled emotional behavior – or lack of emotional behavior – more closely resembles the functioning of computers than that of natural human beings.[135]

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their memories and knowledge, see, e.g., McGee (2008); Pearce (2012); and Spohrer, "NBICS (Nano-Bio-Info-Cogno-Socio) Convergence to Improve Human Performance: Opportunities and Challenges" (2002). Regarding the remote control of human bodies by external systems, see Gladden, "Neural Implants as Gateways" (2016), and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015).

[132] See, e.g., Friedenberg (2008), pp. 55-72, 147-200; Haykin (2009); and Lamm & Unger (2011).

[133] See, e.g., Warwick & Gasson, "Implantable Computing" (2008), and the discussion of cognitive neuroprosthetics in Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 26-27.

[134] See, e.g., Friedenberg (2008), pp. 17-146.

[135] For the possibility of developing emotional neuroprosthetics, see Soussou & Berger (2008); Hatfield et al. (2009); Kraemer (2011); and McGee (2008), p. 217.

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Meanwhile, the creation of autonomous robots with increasingly sophisticated and human-like social capacities and emotional characteristics – perhaps generated by the internal action of a complex physical neural network – may yield new types of artificial agents that cannot simply be programmed or configured to perform certain actions by their human operators but which must instead be motivated and persuaded to perform such actions through an application of psychological principles, negotiation techniques, and other practices typically employed with human beings.[136]

G. Cognitive Biases

Genetic engineering could potentially be used to create new designer types of cognitively engineered human beings whose brains do not develop cognitive biases. Alternatively, a neuroprosthetic device could be used to monitor the cognitive processes of a human mind and to alert the mind whenever the device detects that the individual is about to undertake a decision or action that is flawed or misguided because the mind's cognitive processes have been influenced by a cognitive bias; beyond directly intervening to prevent the effects of cognitive biases in this manner, such a device could potentially also train the mind over time to recognize and avoid cognitive biases on its own.[137]

Artificial agents that are patterned after human models of cognition and which display human-like levels of intelligence, emotion, sociality, and other traits may be subject to many of the same cognitive biases as human beings;[138] highly sophisticated artificial agents (e.g., superintelligences) might also suffer from their own idiosyncratic forms of cognitive biases that may be hard for their designers to recognize or anticipate.[139]

H. Memory

Genetic engineering could potentially be used to enhance or otherwise alter the natural neural mechanisms for the encoding, storage, and retrieval of memories within the brain of a human agent. The use of neuroprosthetic de-

[136] See Friedenberg (2008), pp. 179-200.

[137] See Gladden, "Neural Implants as Gateways" (2016).

[138] Regarding the potential for emotionally driven biases in artificial intelligences, see Friedenberg (2008), pp. 180-85, 197-98.

[139] For cognitive biases, mental illnesses, and other potentially problematic psychological conditions that may be manifested by advanced AIs, see, e.g., Chapter 4, "Wireheading, Addiction, and Mental Illness in Machines," in Yampolskiy, *Artificial Superintelligence: A Futuristic Approach* (2015).

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vices to control, supplement, or replace the brain's natural memory mechanisms could result in human agents that possess memory that is effectively lossless, does not degrade over time, and can be easily copied to or from external systems.[140]

At the same time, the use of biological components or physical artificial neural networks as a substrate for the cognitive processes of artificial agents could result in agents whose memories are stored in a highly compressed form that degrades unreliably over time and which makes individual memories difficult to recall, even when they are retained within the memory system.[141]

I. Predictability

Human agents whose actions are influenced or controlled by neuroprosthetic devices or whose range of possible behaviors has been constrained through genetic engineering may produce behavior that is more predictable and is easily 'debugged' in a straightforward and precise manner that has traditionally been possible only when dealing with computers.[142]

Meanwhile, artificial agents that possess human-like cognitive capacities – including emotion and sociality – may generate behavior that is difficult to reliably predict, analyze, or control, especially if the agents' cognitive processes take place within a physical neural network whose activities and current state cannot easily be determined by outside observers.[143]

J. Vulnerability to Hacking

Human agents that possess electronic neuroprosthetic devices would be vulnerable to electronic hacking attempts similar to those employed against

[140] Regarding genetic and neuroprosthetic technologies for memory alteration in biological organisms, see Han et al., "Selective Erasure of a Fear Memory" (2009); Josselyn, "Continuing the Search for the Engram: Examining the Mechanism of Fear Memories" (2010); and Ramirez et al., "Creating a False Memory in the Hippocampus" (2013). Regarding the use of neuroprosthetic systems to store memories as effectively lossless digital exograms, see Gladden, "Neural Implants as Gateways" (2016), and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 156-57.

[141] Regarding memory mechanisms for artificial agents, including those involving neural networks, see Friedenberg (2008), pp. 55-72.

[142] Regarding the testing and debugging of neuroprosthetic devices (especially in relation to information security), see Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 176-77, 181-84, 213-14, 248-19, 242-43, 262.

[143] For an overview of issues relating to the social behavior of artificial agents, see Friedenberg (2008), pp. 217-34.

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conventional computers. Moreover, advanced technologies for genetic engineering and the production of customized biopharmaceuticals and biologics may allow the biohacking even of human agents that do not possess electronic neuroprosthetic components.[144]

At the same time, artificial agents that include or wholly comprise biological components rather than electronic components might thereby reduce or eliminate their vulnerability to traditional methods of electronic hacking. However, such artificial agents may be vulnerable to biohacking approaches that are based on genetic engineering or biopharmaceutical technologies as well as to psychologically based social engineering attacks.[145]

3. Social Interaction

The forms of social engagement and belonging available to human and artificial agents are expected to be transformed by the advent of posthumanizing technologies. Such change will be manifested through the possession (or absence) of a number of key characteristics, which are described below.

a. Sociality

Neuroprosthetic devices or genetic modifications that affect long-term memory processes could make it difficult or impossible for human agents to engage in friendships and other long-term social relationships with other intelligent agents. Such human agents would no longer be fully social but instead semisocial or even nonsocial.[146] Ongoing immersion in virtual worlds or neuroprosthetically enabled cybernetic networks with other human minds or other kinds of intelligent agents could potentially also lead to the atrophying or enhancement of human agents' social capacities.

At the same time, an increasing number of artificial agents may possess fully human-like sociality, including the ability to participate in long-term social relations that deepen and evolve over time as a result of the agents' experience of such engagement and which are shaped by society's expectations

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[144] Regarding the possibility of hybrid biological-electronic computer viruses and other attacks, see Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), p. 53.

[145] For a discussion of social engineering attacks, see Rao & Nayak (2014), pp. 307-23, and Sasse et al., "Transforming the 'weakest link'—a human/computer interaction approach to usable and effective security" (2001).

[146] For ways of describing and classifying degrees of sociality of artificial entities, see Vinciarelli et al. (2012) and Gladden, "Managerial Robotics" (2014).

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for the social roles to be filled by the relations' participants. This would potentially allow artificial agents to serve as charismatic leaders of human beings who guide and manage the activities of their followers not through threats or intimidation but by inspiring or seducing them.[147]

B. Culture

Human agents whose thoughts, dreams, and aspirations have been attenuated or even eliminated or whose physical sensorimotor systems are controlled through the use of genetic engineering, neuroprosthetic devices, or other advanced technologies may no longer possess a desire or ability to perceive or generate cultural artifacts. If a single centralized system (e.g., a server providing a shared virtual reality experience to large numbers of individuals) maintains and controls all of the sensorimotor channels through which human agents are able to create and experience culture, then that automated system may generate all of the aspects of culture within that virtual world, without the human agents who dwell in that world being able to contribute meaningfully to the process.[148]

Artificial agents already play important roles in supporting the creation, maintenance, and dissemination of human culture(s), and some artificial agents are already capable of acting autonomously to generate works of art, poetry, music, content for computer games, webpages, Internet memes, and other kinds of cultural artifacts.[149] It is expected that in the future, artificial agents will not only play a role in contributing to predominantly human cultures or act in symbiosis with human agents to create hybrid human-artificial cultures that are truly shared; they will also create among themselves entirely new synthetic cultures whose art, music, architecture, literature, philosophy, and way of life could never have been developed by human beings (and perhaps cannot even be observed or comprehended by human beings), due to

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[147] See Gladden, "The Social Robot as 'Charismatic Leader': A Phenomenology of Human Submission to Nonhuman Power" (2014). For an exploration of the potential social behavior of advanced artificial agents, see Friedenberg (2008), pp. 217-34.

[148] Regarding the possibilities of a centralized computerized system shaping culture by mediating and influencing or controlling the communications among neuroprosthetically enabled human minds, see Gladden, "Utopias and Dystopias as Cybernetic Information Systems" (2015), and Gladden, "From Stand Alone Complexes to Memetic Warfare: Cultural Cybernetics and the Engineering of Posthuman Popular Culture" (2016).

[149] See Friedenberg (2008), pp. 127-46, and Gladden, "From Stand Alone Complexes to Memetic Warfare" (2016).

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the physical and cognitive differences between human agents and the artificial agents that create such cultures.[150]

C. Spirituality

Researchers have raised concerns that the use of neuroprosthetic devices to replace or dramatically alter the structures and activities of the body and mind of human agents may result in the loss of those fundamental characteristics that make such agents human. While this can be analyzed from purely biological and psychological perspectives,[151] it may alternatively be understood from philosophical and theological perspectives as a dissolution of the 'soul' or 'essence' of such human agents.[152] The use of genetic engineering in transhumanist efforts to design beings that possess superior (and even transcendent) intelligence and morality raises similarly significant questions about the nature of humanity and future human beings.

At the same time, artificial agents that possess sufficiently sophisticated and human-like cognitive capacities may be subject to instinctive desires to seek out and experience some transcendent truth and reality and may engage in behaviors such as meditation, contemplation, and even prayer.[153]

D. Political Engagement

Human agents that have been neuroprosthetically augmented may form social and technological networks that demonstrate new kinds of network topologies and may engage in new forms of cybernetic relations with similarly augmented human agents and with artificial entities; such human agents may dwell (virtually, if not physically) in societies in which traditional human political systems and structures are not meaningful or relevant.[154] Such human agents may find themselves disconnected from political life and

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[150] See Payr & Trappl (2003); regarding the creation of hybrid human-artificial cultures in an organizational setting, see Gladden, "Leveraging the Cross-Cultural Capacities of Artificial Agents as Leaders of Human Virtual Teams" (2014). For a philosophical analysis of digital-physical ecosystems in which human and artificial agents may interact symbiotically to generate shared cognitive and cultural artifacts (and in which such artifacts may even exist as actors that can propagate themselves), see, e.g., Kowalewska, "Symbionts and Parasites – Digital Ecosystems" (2016).

[151] For a discussion of, e.g., the psychological impact of neuroprosthetic devices upon a user's perceptions of authenticity and identity, see Kraemer (2011) and Van den Berg (2012).

[152] E.g., see Gladden, "'Upgrading' the Human Entity" (2015).

[153] For a discussion of such possibilities, see Kurzweil (2000).

[154] Regarding the possible fragmentation of human societies as a result of posthuman neuroprosthetics, see Gladden, "Utopias and Dystopias as Cybernetic Information Systems" (2015); McGee (2008), pp. 214-16; Warwick (2014), p. 271; Rubin (2008); Koops & Leenes, "Cheating with Implants: Implications of the Hidden Information Advantage of Bionic Ears and Eyes" (2012), p. 127; and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), 166-67.

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institutions of the 'real' world and instead immerse themselves in new kinds of structures that might resemble traditional computer networks more than political systems.

At the same time, artificial agents that possess intelligence and sociality that are human-like (or which surpass the capacities of human beings) may create political systems and structures to govern their relations with one another or may seek to participate in human political systems.[155]

E. Economic Engagement

The adoption of posthumanizing technologies may weaken the ability of human beings to serve as autonomous economic actors. Depending on the precise terms under which such components were acquired, a human agent whose body has been subject to extensive neuroprosthetic augmentation and is largely composed of electronic components may not even 'own' its own body or the products generated by that body, including intellectual property such as thoughts and memories. Such a human agent may for practical purposes be wholly dependent on and economically subjugated to the corporation(s), government agencies, or other institutions that provide maintenance services for its synthetic components and legally or practically barred from purchasing goods or services from competing enterprises.[156] The use of neuroprosthetic devices or other technologies that directly affect a human agent's cognitive processes may also impair that agent's ability to make free choices as an autonomous economic actor.

Conversely, artificial agents may gain new abilities to function as independent economic actors. Some forms of artificial life may be able to function as autonomous organism-enterprises that acquire resources from within the digital-physical ecosystem shared with human beings, process the resources to generate goods and services, and then exchange those goods and services with human beings or other artificial agents to generate revenue, including profit that the artificial life-form can use for purposes of growth, reproduction, or risk management.[157] Such artificial life-forms could compete directly

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[155] For the possibility of social robots exercising referent power or charismatic authority within human social or political institutions, see Gladden, "The Social Robot as 'Charismatic Leader'" (2014).

[156] See Gladden, "Neural Implants as Gateways" (2016), and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015).

[157] For an approach to modelling entrepreneurship on the part of artificial agents, see Ihrig, "Simulating Entrepreneurial Opportunity Recognition Processes: An Agent-Based and Knowledge-Driven Approach" (2012). For an innovative exploration of the possibility of creating fully autonomous systems for entrepreneurship, see Rijntjes, "On the Viability of Automated Entrepreneurship" (2016). See also Gladden, "The Artificial Life-Form as Entrepreneur" (2014).

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with human enterprises within the real-world economy or offer new kinds of goods and services that human agents are incapable of offering.

f. Legal Status

Human agents that have been intentionally engineered by other human beings or organizations (e.g., biological clones or custom-designed human beings) may be subject to claims that they are not full-fledged legal persons but rather wards or even property of those who have created them – especially if the agents have been engineered to possess characteristics that clearly distinguish them from 'normal' human beings.[158]

Conversely, sufficiently sophisticated artificial agents that possess human-like cognitive capacities or biological components may not be considered inanimate objects or property from a legal perspective but either moral patients possessing rights that must be protected or even moral subjects that can be held legally responsible for their own actions.[159]

B. The Four Types of Beings Relevant for Technologically Posthumanized Organizations

The only two quadrants of the Posthuman Management Matrix that have historically been considered relevant objects for management scholarship and practice are those of natural human beings and, more recently, computers. However, the advent of new posthumanizing technologies will create a variety of entities that fall within the remaining two quadrants and which can serve as potential employees, partners, and customers for businesses and other organizations. This will require the field of management to directly address those two quadrants – to create theoretical frameworks for understanding the activities and organizational potential of such entities and to develop new practices for managing them. Figure 3 reflects the fact that during the dawning Posthuman Age, all four quadrants of the Matrix will at last be relevant for management.

[158] See, e.g., Cesaroni, "Designer Human Embryos as a Challenge for Patent Law and Regulation" (2012); Pereira, "Intellectual Property and Medical Biotechnologies" (2013); Bera, "Synthetic Biology and Intellectual Property Rights" (2015); Camenzind, "On Clone as Genetic Copy: Critique of a Metaphor" (2015); Section B ("Enhancement") and Section D ("Synthetic Biology and Chimera") in *The Future of Bioethics: International Dialogues*, edited by Akabayashi (2014); and Singh, *Biotechnology and Intellectual Property Rights: Legal and Social Implications* (2014). For perspectives on the ways in which such issues have been explored within fiction, see, e.g., Pérez, "Sympathy for the Clone: (Post) Human Identities Enhanced by the 'Evil Science' Construct and its Commodifying Practices in Contemporary Clone Fiction" (2014).

[159] Regarding such questions see, e.g., Wallach & Allen (2008) and Calverley (2008).

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Characteristics	Human	Artificial
Computronic	**Agents possessing such characteristics** • Neuroprosthetically augmented human employees, partners, and (potential) customers • Human beings inhabiting immersive virtual worlds • Human beings linked in hive minds • (Semi)permanent human members of symbiotic human-robotic systems • Genetically augmented humans **Disciplines that facilitate the management of such agents** • Psychological engineering • Cyborg psychology & cyberpsychology • Human technology management • Genetic & neural engineering • Biocybernetics & neurocybernetics	**Agents possessing such characteristics** • Artificially intelligent software • Expert systems • Manufacturing robots • Specialized customer-service robots • Smart buildings • Smart vehicles **Disciplines that facilitate the management of such agents** • Computer science • Electronics engineering • Robotics • IT management
Anthropic	**Agents possessing such characteristics** • Human employees, contractors, and consultants • External human suppliers, partners, and collaborators • (Potential) human customers and clients **Disciplines that facilitate the management of such agents** • Human resource management • Organization development • Marketing • Psychology • Sociology • Economics • Anthropology	**Agents possessing such characteristics** • Social robots with human-like forms and cognitive abilities • Artificial general intelligences with human-like neural networks • Biological robots • (Semi)permanent robotic members of symbiotic human-robotic systems **Disciplines that facilitate the management of such agents** • Synthetic biology • Social robotics • Artificial psychology • Artificial marketing • AI resource management • Artificial organization development

Agents

Fig. 3: The Posthuman Management Matrix displaying the two types of entities (in the lower left and upper right quadrants) that have long been relevant for the theory and practice of organizational management, joined by two types of entities (in the upper left and lower right quadrants) that are becoming newly relevant in the dawning Posthuman Age.

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We can now consider in more detail the future roles that all four types of entities may play for future posthumanized organizations, along with the academic disciplines and practical bodies of knowledge that can contribute to their effective management.

1. Natural Human Beings

At least during the early stages of the emerging Posthuman Age, human agents with anthropic characteristics will remain the key leaders and decision-makers within businesses and other organizations. This will not necessarily be due to the fact that such natural human beings are more capable than artificial agents or technologically modified human beings when it comes to performing the actions involved with managing others; it will instead likely be due to legal, political, and cultural considerations. For example, even after sufficiently sophisticated social robots have been developed that are capable of serving effectively as CEOs of businesses, it may take many years before the ethical and political questions surrounding such practices have been resolved to the point that human legislators and regulators allow the human businesses and other institutions that are subject to their oversight to legally employ such artificial agents as CEOs.[160]

It appears likely that human agents that possess at least limited computronic characteristics will achieve positions of formal leadership within organizations before artificial agents accomplish that feat. This can be anticipated due to the fact that current law and cultural tradition already allow human beings to fill such roles: while existing laws would generally need to be explicitly changed in order to *allow* artificial agents to serve, for example, as CEOs of publically traded corporations, those same laws would need to be explicitly changed in order to *bar* human agents who possess computronic characteristics from filling such roles. Indeed, declining to offer a human being a position as an executive within a business because he or she possesses a pacemaker, defibrillator, cochlear implant, robotic artificial limb, or other device that endows him or her with limited computronic characteristics would, in many cases, be considered a form of unlawful employment discrimination, and even simply attempting to ascertain whether a potential employee possesses such traits could in itself be illicit.[161]

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[160] The question arises of whether such artificial agents will voluntarily allow themselves to be subject to human laws or will instead seek to formulate their own.

[161] See Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 93-94.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
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Although human agents who possess extensive computronic characteristics and artificial agents are expected to gradually fill a broader range of positions within organizations, there will likely remain a number of professions or specific jobs which – at least in the early stages of the Posthuman Age – can only be filled by natural, unmodified human agents.[162] For example, some positions within the military, police forces, or intelligence services may initially be restricted to natural human beings, in order to avoid the possibility of external adversaries hacking the minds or bodies of such agents and gaining control of them and the information that they possess. Roles as judges, arbitrators, and regulators might be restricted to natural human beings on ethical grounds, to ensure that such officials' decisions are being made on the basis of human wisdom, understanding, and conscience (including the *known biases* of the human mind), rather than executed by software programs that might possess unknown bugs or biases or be surreptitiously manipulated. Some roles – such as those of priest, therapist, poet, or existentialist philosopher – might as a practical matter be restricted to natural human beings, because the work performed by persons in such positions is considered to derive unique value from the fact that it is performed by a human being rather than a machine.

The adoption of posthumanizing technologies across the world will likely be highly uneven, as differences in economic resources and systems, political systems, and philosophical, religious, and cultural traditions combine in unique ways in different parts of the world to either spur or restrain the adoption of such technologies. The role of natural human beings as workers and consumers may maintain greater importance in some regions and industries than in others. Wherever such beings fill places as workers or consumers, the traditional disciplines of psychology, sociology, economics, anthropology, cultural studies, marketing, organization development, HR management, and ergonomics will continue to be relevant for theorists and practitioners of organizational management.

2. Computers

It is expected that artificial agents with computronic characteristics will continue to play a fundamental – and ever-growing – role as backbone elements within the increasingly ubiquitous networked systems that constitute

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[162] See Gladden, "Neural Implants as Gateways" (2016).

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the digital-physical infrastructure within which human beings will dwell. Artificial systems that can be quickly and reliably programmed to perform certain tasks without any worry that a system might become bored or annoyed or object to its assigned tasks on moral grounds will remain highly useful and desirable.[163]

Although the theory and practice used to design, implement, and manage such systems will likely continue to evolve rapidly, even during the near-future Posthuman Age such disciplines will likely be recognizable as heirs of our contemporary fields of computer science, electronics engineering, robotics, and IT management.

3. Cyborgs

As described in earlier sections, the increasing use of neuroprosthetic enhancement, genetic engineering, and other posthumanizing technologies is expected to result in a growing number of human agents that no longer possess the full suite of traditional anthropic characteristics but instead reflect some degree of computronic characteristics. Such agents might include human employees or customers whose artificial sense organs or limbs mediate their experience of their physical environment;[164] human beings who never physically leave their bedroom but instead engage with the world through long-term immersion in virtual worlds and digital ecosystems;[165] groups of

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[163] One can consider, for example, the case of autonomous military robots. Serious efforts have been undertaken to create morally aware autonomous military robots that can be programmed with a knowledge of and obedience to relevant national and international legal obligations governing the conduct of war, as well as a knowledge of relevant ethical principles and even a 'conscience' that allows a robot to assimilate all available information, evaluate the propriety of various courses of action, and select an optimal ethically and legally permissible course of action. However, scholars have noted the possibility for cynical manipulation of such technologies – e.g., perhaps the creation of robots who possess a 'conscience' that is sufficiently developed to reassure the public about the ethicality of such devices while not being restrictive or powerful enough to actually block the robot from performing any activities desired by its human overseers. See Sharkey, "Killing Made Easy: From Joysticks to Politics" (2012), pp. 121-22. On the other hand, if a robot's conscience is such that the robot becomes a conscientious objector and refuses to participate in any military actions at all, then the robot becomes operationally useless from the perspective of its intended purpose.

[164] For discussions of particular types of neuroprosthetic mediation of sensory experience of one's environment, see, e.g., Ochsner et al., "Human, non-human, and beyond: cochlear implants in socio-technological environments" (2015), and Stiles & Shimojo, "Sensory substitution: A new perceptual experience" (2016). On ways in which the absence of mediation transforms teleoperation into telepresence in the case of noninvasive brain-computer interfaces, see Salvini et al., "From robotic tele-operation to tele-presence through natural interfaces" (2006).

[165] Regarding the implications of long-term immersion in virtual reality environments, see, e.g., Bainbridge, *The Virtual Future* (2011); Heim, *The Metaphysics of Virtual Reality* (1993); Geraci,

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human beings whose minds are neuroprosthetically linked to create a hive mind with a collective consciousness;[166] human beings who are temporarily or permanently joined in symbiotic relationships with robotic exoskeletons,[167] companions,[168] or supervisors;[169] or genetically augmented human beings whose physical structures and cognitive capacities have been intentionally

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Apocalyptic AI: Visions of Heaven in Robotics, Artificial Intelligence, and Virtual Reality (2010); and Koltko-Rivera, "The potential societal impact of virtual reality" (2005). Regarding psychological, social, and political questions relating to repetitive long-term inhabitation of virtual worlds through a digital avatar, see, e.g., Castronova, "Theory of the Avatar" (2003). On the risks of potentially 'toxic immersion' in a virtual world, see Castronova, *Synthetic Worlds: The Business and Culture of Online Games* (2005). On implantable systems for augmented or virtual reality, see Sandor et al., "Breaking the Barriers to True Augmented Reality" (2015), pp. 5-6. For a conceptual analysis of the interconnection between physical and virtual reality and different ways in which beings and objects can move between these worlds, see Kedzior, "How Digital Worlds Become Material: An Ethnographic and Netnographic Investigation in Second Life" (2014).

[166] Regarding the possibility of hive minds, see, e.g., McIntosh, "The Transhuman Security Dilemma" (2010), and Gladden, "Utopias and Dystopias as Cybernetic Information Systems" (2015). For more detailed taxonomies and classification systems for different kinds of potential hive minds, see Chapter 2, "Hive Mind," in Kelly, *Out of control: the new biology of machines, social systems and the economic world* (1994); Kelly, "A Taxonomy of Minds" (2007); Kelly, "The Landscape of Possible Intelligences" (2008); Yonck, "Toward a standard metric of machine intelligence" (2012); and Yampolskiy, "The Universe of Minds" (2014). For the idea of systems whose behavior resembles that of a hive mind but without a centralized controller, see Roden, *Posthuman Life: Philosophy at the Edge of the Human* (2014), p. 39. For critical perspectives on the idea of hive minds, see, e.g., Bendle, "Teleportation, cyborgs and the posthuman ideology" (2002), and Heylighen, "The Global Brain as a New Utopia" (2002). Regarding the need for society to debate the appropriateness of neuroprosthetic technologies that facilitate hive minds, see Maguire & McGee, "Implantable brain chips? Time for debate" (1999).

[167] For examples of such systems currently under development, see *Wearable Robots: Biomechatronic Exoskeletons*, edited by Pons (2008); Guizzo & Goldstein, "The rise of the body bots [robotic exoskeletons]" (2005); and Contreras-Vidal & Grossman, "NeuroRex: A clinical neural interface roadmap for EEG-based brain machine interfaces to a lower body robotic exoskeleton" (2013). For a discussion of the extent to which the form of an exoskeleton can differ from that of the human body before it becomes impossible for its human operator to interface with the exoskeleton, see Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics" (2015).

[168] See Dautenhahn, "Robots we like to live with?! - A Developmental Perspective on a Personalized, Life-long Robot Companion" (2004); Van Oost and Reed, "Towards a Sociological Understanding of Robots as Companions" (2011); Shaw-Garlock, "Loving machines: Theorizing human and sociable-technology interaction" (2011); Whitby, "Do You Want a Robot Lover? The Ethics of Caring Technologies" (2012); and *Social Robots and the Future of Social Relations*, edited by Seibt et al. (2014).

[169] See, e.g., Samani & Cheok, "From human-robot relationship to robot-based leadership" (2011); Samani et al., "Towards robotics leadership: An analysis of leadership characteristics and the roles robots will inherit in future human society" (2012); Gladden, "Leveraging the Cross-Cultural Capacities of Artificial Agents" (2014); and Gladden, "The Social Robot as 'Charismatic Leader'" (2014).

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engineered to make them especially well-suited (or poorly suited) to perform particular roles within society.[170]

Because such technological modification may dramatically affect human agents' physical and cognitive traits, their behavior can no longer be understood, predicted, or managed simply by relying on historical disciplines such as psychology, sociology, or HR management. Established and evolving fields such as genetic engineering, neural engineering, neurocybernetics, and biocybernetics will offer resources for management theorists and practitioners who must account for the existence and activity of such agents. However, it is likely that entirely new disciplines will arise – and will need to arise – in order to fill the conceptual and practical gaps that exist between those structures and dynamics that will be manifested by cyborgs and those that are addressed by existing disciplines. In particular, new disciplines may study and manage computronic human agents using many of the same techniques that have previously been employed with artificial agents. Such hypothetical new fields might include disciplines such as:

- **Psychological engineering**, which would apply practices from fields like electronics engineering to the design of a human psyche.[171] It might involve the use of genetic engineering and gene therapy, neuroprosthetic devices, immersive virtual reality, and other technologies to create and maintain human beings who possess particular (and potentially non-natural) cognitive structures, processes, and behaviors.
- **Cyborg psychology** and **cyberpsychology**, which would apply the knowledge and methods of traditional psychology to understand the cognitive

[170] Regarding such possibilities, see *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science*, edited by Bainbridge (2003); Canton (2004), pp. 186-98; and Khushf, "The use of emergent technologies for enhancing human performance: Are we prepared to address the ethical and policy issues" (2005).

[171] For earlier uses of the term 'psychological engineering' in different contexts, see, e.g., Doyle, "Big problems for artificial intelligence" (1988), p. 22, which employs the term in the context of artificial intelligence, with psychological engineering's goal being "parallel to the aim of any engineering field, namely to find economical designs for implementing or mechanizing agents with specified capacities or behaviors," and Yagi, "Engineering psychophysiology in Japan" (2000), p. 361, which defines psychological engineering to be "engineering relating to human psychological activities" and include themes such as "the development of new systems between the human mind and machines" that yield not only convenience but comfort, "the development of the technology to measure psychological effects in industrial settings," and "the development of new types of human-machine systems incorporating concepts and procedures utilizing virtual reality."

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structures and processes of human beings whose psychology is atypical as a result of neuroprosthetic augmentation, long-term immersion in virtual reality environments, or other factors.[172] Subdisciplines might include cyberpathology,[173] for example.

- **Human technology management** (or 'anthropotech management'[174]), which would apply the knowledge and practices of traditional IT management to the management of organizational resources (e.g., human employees) whose neuroprosthetic or genetic augmentation or intimate cybernetic integration with computerized systems at a structural or behavioral level allows them to be managed in ways similar to those utilized with traditional IT assets.

4. Bioroids

As described in earlier sections, organizations will increasingly need to deal with the existence of artificial agents that possess anthropic characteristics as both potential workers and consumers of the goods and services that organizations produce. Such bioroids might include social robots that resemble human beings in their physical form and cognitive capacities,[175] artificial

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[172] For other use of the term 'cyborg psychology,' see, e.g., Plowright, "Neurocomputing: some possible implications for human-machine interfaces" (1996). For earlier use of the term 'cyberpsychology' in various contexts, see, e.g., *Cyberpsychology*, edited by Gordo-López & Parker (1999); Riva & Galimberti. *Towards CyberPsychology: Mind, Cognition, and Society in the Internet Age* (2001); *Cyberpsychology: Journal of Psychosocial Research*, founded in 2007; and Norman, *Cyberpsychology: An Introduction to Human-Computer Interaction* (2008).

[173] See, e.g., Chapter 4, "Wireheading, Addiction, and Mental Illness in Machines," in Yampolskiy, *Artificial Superintelligence: A Futuristic Approach* (2015).

[174] For the use of such terminology, see, e.g., the Anthropotech project of the University of the West of England and University of Bristol that has studied the philosophical and ethical implications of "*Anthropotech*: the technological alteration of the body for the purpose of augmenting existing capacities, introducing new ones, or aesthetically improving the body" and which has drawn its inspiration explicitly from Jérôme Goffette's *Naissance de l'anthropotechnie: De la médecine au modelage de l'humain* (2006). See "Anthropotech" (2013).

[175] For an overview of different perspectives on social robots that behaviorally resemble and can interact with human beings, see, e.g., Breazeal (2003); Gockley et al., "Designing Robots for Long-Term Social Interaction" (2005); Kanda & Ishiguro (2013); *Social Robots and the Future of Social Relations*, edited by Seibt et al. (2014); *Social Robots from a Human Perspective*, edited by Vincent et al. (2015); and *Social Robots: Boundaries, Potential, Challenges*, edited by Marco Nørskov (2016).

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general intelligences[176] that process information using complex physical neural networks rather than CPU-based platforms,[177] robots possessing biological components,[178] and robots that exist in permanent symbiosis with human agents to whom they serve as bodies, colleagues, or guides.[179]

The physical forms and processes, cognitive capacities, and social engagement of such bioroids will likely differ in their underlying structures and dynamics from those of human beings, no matter how closely they outwardly resemble them. Thus traditional human-focused disciplines such as psychology, economics, and HR management cannot be applied directly and without modification to analyze, predict, or manage the behavior of bioroids. On the other hand, traditional disciplines such as computer science, electronics engineering, and IT management will not in themselves prove adequate for shaping the behavior of such unique anthropic artificial agents.

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[176] Regarding challenges inherent in the development of artificial general intelligence and potential paths toward that objective, see, e.g., *Artificial General Intelligence*, edited by Goertzel & Pennachin (2007); *Theoretical Foundations of Artificial General Intelligence*, edited by Wang & Goertzel (2012); and *Artificial General Intelligence: 8th International Conference, AGI 2015: Berlin, Germany, July 22-25, 2015: Proceedings*, edited by Bieger et al. (2015).

[177] Regarding AIs that utilize physical neural networks, see, e.g., Snider (2008); Versace & Chandler (2010); and *Advances in Neuromorphic Memristor Science and Applications*, edited by Kozma et al. (2012). For a discussion of such technologies from the perspective of information security, see Pino & Kott, "Neuromorphic Computing for Cognitive Augmentation in Cyber Defense" (2014), and Lohn et al., "Memristors as Synapses in Artificial Neural Networks: Biomimicry Beyond Weight Change" (2014).

[178] See, e.g., Ummat et al. (2005); Andrianantoandro et al. (2006); Lamm & Unger (2011); Cheng & Lu (2012); and Kawano et al., "Finding and defining the natural automata acting in living plants: Toward the synthetic biology for robotics and informatics in vivo" (2012).

[179] Regarding robots that exist in symbiotic relationships with human beings as their physical bodies (i.e., constituting a cyborg), see, e.g., Tomas, "Feedback and Cybernetics: Reimaging the Body in the Age of the Cyborg" (1995); Clark, *Natural-born cyborgs: Minds, Technologies, and the Future of Human Intelligence* (2004); and Anderson "Augmentation, symbiosis, transcendence: technology and the future(s) of human identity" (2003). For discussions of robots serving as colleagues to human workers, see, e.g., Ablett et al., "A Robotic Colleague for Facilitating Collaborative Software Development" (2006); Vänni and Korpela, "Role of Social Robotics in Supporting Employees and Advancing Productivity" (2015); and Gladden, "Leveraging the Cross-Cultural Capacities of Artificial Agents" (2014). For a notable early allusion to the possibility of robotic colleagues, see Thompson (1976). For robotic systems that serve as 'guides' to human beings in a very practical and functional sense, see, e.g., Chella et al., "A BCI teleoperated museum robotic guide" (2009), and Vogiatzis et al., "A conversant robotic guide to art collections" (2008). For robots that serve as charismatic leaders (and perhaps even spiritual guides) for human beings, see Gladden, "The Social Robot as 'Charismatic Leader'" (2014).

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Emerging fields such as synthetic biology and social robotics provide a starting point for the development and management of bioroids. As researchers attempt to create new theoretical and practical frameworks for managing such agents, we might expect to witness the development of new fields that study and manage artificial agents utilizing approaches that have traditionally been applied to human agents; these new fields might include disciplines like:

- **Artificial psychology**, which is already being formulated as a discipline[180] and which applies the extensive knowledge and techniques developed through the academic study of human psychology to understanding, designing, and controlling the psychology of synthetic beings such as artificial general intelligences or social robots.
- **Artificial marketing**, which would address the design, production, sale, and distribution of goods and services targeted at consumers who are not human beings but artificial entities.
- **AI resource management**, which would deal with the management of artificial entities within an organizational context not as though they were conventional IT assets like desktop computers but as human-like employees, drawing on the knowledge and practices developed in the field of human resource management.
- **Artificial organization development**, which would seek to bring about long-term systemic improvements in the performance of organizations whose members are synthetic entities – not by directly reprogramming them or updating their software but through the use of intervention techniques such as coaching and mentoring, surveys, team-building exercises, changes to workplace culture, and the design of strategic plans and incentive structures. This would adapt the explicitly 'humanistic' approaches of the existing field of organization development to serve new constituencies of nonhuman agents.[181]

[180] Friedenberg has introduced the concept of 'artificial psychology' as a new branch of psychology that addresses the cognitive behavior of synthetic agents; see Friedenberg (2008). 'Artificial psychology' is not simply a form of computer programming or IT management. It is psychology: just as complex and mysterious a discipline as when directed to the cognitive structures and processes of human beings, except that in this case it is directed to the cognitive structures and processes of robots or AIs.

[181] Regarding the goals and practices of organization development, see, e.g., Anderson, *Organization Development: The Process of Leading Organizational Change* (2015), and Bradford & Burke, *Reinventing Organization Development: New Approaches to Change in Organizations* (2005). For the

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C. Exploring the 'Fifth Quadrant': Hybrid Agents within Hybrid Systems

While it is true that management theory and practice must be capable of separately addressing each of the four types of entities described above, within real-world organizations it will in practice be difficult to extricate one kind of entity from its relationships with those of other kinds – just as it is already difficult to consider the performance of human workers apart from the performance of the computerized technologies that they use in carrying out their tasks.

In practice, the four types of entities described above will frequently work intimately with one another, either as elements in hybrid systems that have been intentionally designed or as members of systems whose participants can voluntarily join and leave and which can include any types of agents. For example, a company might maintain a persistent virtual world in which all of its human and artificial personnel come together to work rather than meeting in a physical workplace, or a firm might operate an online marketplace in which human and artificial agents of all types are welcomed to purchase or consume the company's products and services – without the firm necessarily knowing or caring whether a particular consumer is a human or artificial agent. In such cases, the focus of an organization's management efforts is not on specific agents that participate in or constitute a system but on the management of the system as a whole.

Systems that incorporate or comprise multiple types of agents might include digital-physical ecosystems; persistent immersive virtual worlds that are home to both human and artificial inhabitants; and hybrid human-robotic hive minds, workplace teams, and multi-agent systems. Moreover, after having evolved into the Internet of Things and eventually comprising all *objects* as the 'Internet of Everything,'[182] the Internet as a whole might come to encompass all *subjects* – all sapient minds and persons – thanks to the wearable and implantable computers and neuroprosthetic devices that will increasingly serve as gateways, vehicles, and virtualizing bodies that provide their human hosts and users with a permanent link to and presence in the

humanistic foundations of organization development, see, e.g., Bradford & Burke (2005); "The International Organization Development Code of Ethics" of The OD Institute; the OD Network's "Organization and Human Systems Development Credo"; IAGP's "Ethical Guidelines and Professional Standards for Organization Development and Group Process Consultants"; and the OD Network's "Principles of OD Practice."

[182] See, e.g., Evans (2012).

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world's digital-physical ecosystems. In this way, we can expect the growth of a lush, dense, complex, unruly, all-embracing digital-physical cyber-jungle that is not simply the Internet of Everything but the Internet of Everyone, the Internet of Life, the Internet of Being. Together these kinds of systems can be seen as occupying a 'fifth quadrant' that lies at the heart of the Posthuman Management Matrix and which reaches into and joins all of the other four quadrants, as reflected in Figure 4.

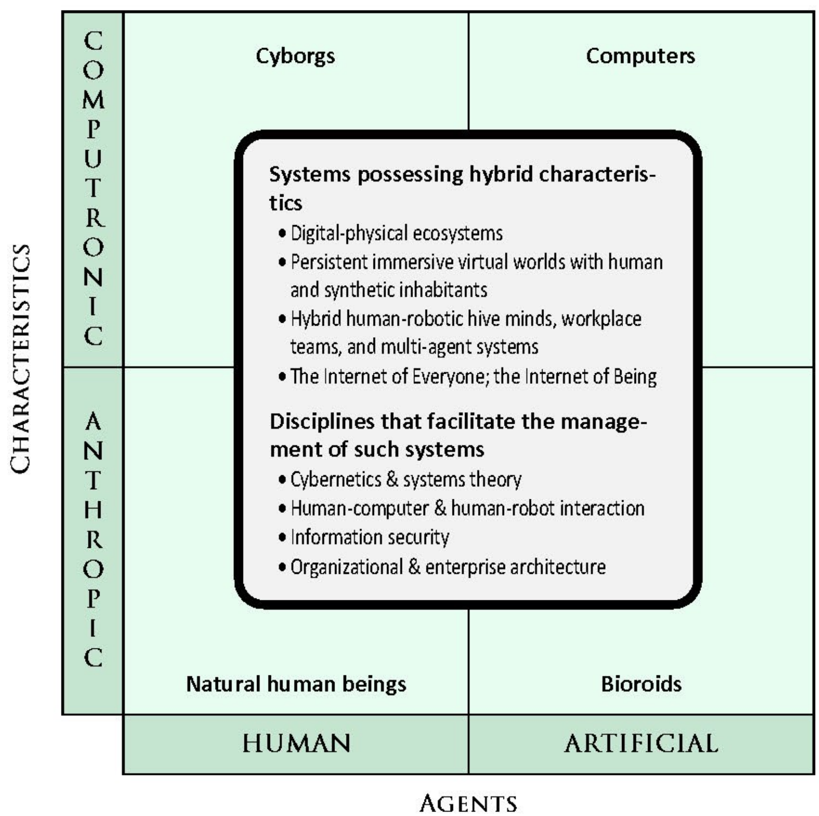

Fig. 4: The 'fifth quadrant' of the Posthuman Management Matrix, which spans and ties together all four types of entities that will be of relevance for organizational management in the Posthuman Age.

The kinds of rich and sophisticated human-artificial systems that exist within the fifth quadrant cannot be effectively managed simply by drawing insights from an array of disciplines that focus exclusively on either human

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agents *or* artificial agents. Instead, disciplines will be required whose theory and practice holistically embrace both the forms and behaviors of human *and* artificial agents as well as anthropic *and* computronic characteristics and which occupy themselves with systems in which the four possible types of entities are closely integrated or even inextricably merged.

Already, existing disciplines such as cybernetics and systems theory attempt to provide a universal conceptual framework that can account for the structures and dynamics of all kinds of viable systems, whether they be human, artificial, hybrid, or of some previously unknown form. The fields of human-computer interaction, human-robot interaction, and information security focus on the characteristics of such hybrid systems in a more specialized way. Some management disciplines such as organizational architecture and enterprise architecture have the potential – if thoughtfully and creatively elaborated – to provide conceptual and practical frameworks for the development and maintenance of such hybrid human-artificial systems, although efforts to develop those disciplines in the direction of posthumanized human-artificial systems have not yet been robustly pursued.[183]

Artificial, Xeno- and Meta- Studies

As hybrid human-robotic organizations and environments become more common, we can expect to see the development of new disciplines that attempt to understand the unique physical structures, behaviors, advantages and capacities, and weaknesses and vulnerabilities displayed by such systems. Just as 'artificial psychology' focuses on the cognitive activity of beings that are human-like in their behavior but synthetic in their construction – and 'xenopsychology' or 'exopsychology' studies the cognitive activity of agents that are radically nonhuman (e.g., hypothetical extraterrestrial intelligences) and whose behavior is not intended or expected to replicate that of

[183] For examples of some initial efforts, see, e.g., Gladden, "Leveraging the Cross-Cultural Capacities of Artificial Agents" (2014) and sources cited therein. Organizational theory may also be able to draw on contemporary work in the field of philosophy; for example, see Kowalewska (2016) for an analysis of technologically facilitated digital-physical ecosystems that draws on Actor-Network Theory (ANT) to explore the manner in which nonhuman and human actors within such ecosystems may create "hierarchies, symbioses, chains and balances" (p. 74) that do not simply resemble the structures and relations of biological ecosystems in a metaphorical sense but truly instantiate the forms and dynamics of such ecologies within a hybrid biological-synthetic system full of diverse types of actors.

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human beings,[184] so the prefix 'meta-' or words such as 'post-anthropocentric,' 'agent-independent,' or 'cybernetic' might be employed to refer to efforts at developing universal conceptual frameworks that are sufficiently abstract to be able to account for the structures and dynamics found in the activities of human agents, artificial agents resembling human beings, radically nonhuman synthetic agents, and any other kinds of agents. For example, attempts to identify the essential structures and processes that must be present in any type of agent in order for it to be considered 'cognitive' – and to explore the full spectrum of ways in which those structures and processes can manifest themselves across different types of agents – could be understood alternatively as 'metapsychology,' 'post-anthropocentric psychology,' 'agent-independent psychology,' or 'psychological cybernetics.' Similarly, a term like 'metaeconomics' might be used to refer to generalized conceptual frameworks that can account equally well for the economic activity of all kinds of entities, both human and artificial.[185]

[184] For a history of such use of 'xeno-' in both literary and scholarly contexts, see the "Preface and Acknowledgements for the First Edition" in Freitas, *Xenology: An Introduction to the Scientific Study of Extraterrestrial Life, Intelligence, and Civilization* (1979), where "[…] xenology may be defined as the scientific study of all aspects of extraterrestrial life, intelligence, and civilization. Similarly, xenobiology refers to the study of the biology of extraterrestrial lifeforms not native to Earth, xenopsychology refers to the higher mental processes of such lifeforms if they are intelligent, xenotechnology refers to the technologies they might possess, and so forth." For the use of 'exopsychology' in connection with potential extraterrestrial intelligences, see Harrison & Elms, "Psychology and the search for extraterrestrial intelligence" (1990), p. 207, where "The proposed field of exopsychology would involve the forecast, study, and interpretation of the cognitive, affective, and behavioral aspects of extraterrestrial organisms. Exopsychological research would encompass search, contact, and post-contact activities, and would include study and work with humans as well as with any extraterrestrials that might be encountered."

[185] We note that some of the terms suggested above have already been utilized by other scholars in different contexts. For example, the understanding of 'metapsychology' formulated here is different from the specialized sense in which Freud used that term; our envisioned use of the prefix 'meta-' is more closely related to the contemporary philosophical use of the term to refer to an abstracted or second-order phenomenon. Some scholars have used the prefix 'meta-' in ways that are closely aligned with our proposed use. For example, building on earlier questions posed by Kant, legal scholar Andrew Haley attempted to identify fundamental principles of law and ethics that are not specific to human biology, psychology, sociality, and culture but which would be relevant to and binding on all intelligent beings, regardless of their physical form or cognitive dynamics; such universal and legal principles could govern humanity's potential encounter with an extraterrestrial intelligence. Haley proposed 'The Great Rule of Metalaw,' which demands that all intelligent beings should "Do unto others as they would have you do unto them"; see Michaud, *Contact with Alien Civilizations: Our Hopes and Fears about Encountering Extraterrestrials* (2007), p. 374.

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V. Conclusion

A transformative convergence is underway within contemporary organizations, as human workers integrate computers ever more closely into their minds and bodies and computers themselves become ever more 'human.' Such developments create both opportunities and threats that must be carefully evaluated from ethical, legal, and managerial perspectives. In order to aid with such endeavors, in this text we have formulated the Posthuman Management Matrix, a model in which an organization's employees, consumers, and other stakeholders are divided into two different kinds of agents (human and artificial) who may possess either of two sets of characteristics (anthropic or computronic), thus defining four types of entities. Until now, the only types that have been of relevance for management theory and practice were those of human agents who possess anthropic characteristics (i.e., ordinary human beings) and artificial agents that possess computronic characteristics (as exemplified by assembly-line robots or artificially intelligent software running on desktop computers).

Management theory and practice have traditionally not addressed the remaining two types of agents that are theoretically possible, largely because such agents did not exist to serve as employees or consumers for organizations. However, we have argued that ongoing advances in neuroprosthetics, genetic engineering, virtual reality, robotics, and artificial intelligence are now giving rise to new kinds of human agents that demonstrate computronic characteristics and artificial agents that possess anthropic characteristics. If organizations are to successfully resolve the complex issues that appear when such posthumanized agents are adopted as workers or customers, new spheres of management theory and practice will need to be pioneered. A starting point may be found in existing fields such as cybernetics, systems theory, organizational design, and enterprise architecture that already offer tools for integrating human and artificial agents into the multi-agent system that constitutes an organization. Such fields will likely be complemented through the development of new disciplines such as psychological engineering, cyborg psychology, human technology management, artificial organization development, AI resource management, metapsychology, and metaeconomics that are specifically intended to confront the issues that will accompany the arrival of new kinds of posthumanized agents as organizational stakeholders. Although we cannot yet know the exact paths that such developments will take, our hope is that the framework presented in this text can prove useful in highlighting the new areas that wait to be explored and in

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informing the work of those management scholars and practitioners who choose to embrace that challenge.

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References

2001: A Space Odyssey. Directed by Stanley Kubrick. 1968. Warner Home Video, 2001. DVD.

Ablett, Ruth, Shelly Park, Ehud Sharlin, Jörg Denzinger, and Frank Maurer. "A Robotic Colleague for Facilitating Collaborative Software Development." *Proceedings of Computer Supported Cooperative Work (CSCW 2006)*. ACM, 2006.

Abrams, Jerold J. "Pragmatism, Artificial Intelligence, and Posthuman Bioethics: Shusterman, Rorty, Foucault." *Human Studies* 27, no. 3 (September 1, 2004): 241-58. doi:10.1023/B:HUMA.0000042130.79208.c6.

Advances in Neuromorphic Memristor Science and Applications, edited by Robert Kozma, Robinson E. Pino, and Giovanni E. Pazienza. Dordrecht: Springer Science+Business Media, 2012.

Agent-Based Manufacturing: Advances in the Holonic Approach, edited by S.M. Deen. Springer Berlin Heidelberg, 2003.

Aier, Stephan. "The Role of Organizational Culture for Grounding, Management, Guidance and Effectiveness of Enterprise Architecture Principles." *Information Systems and E-Business Management* 12, no. 1 (2014): 43-70.

Alford, John R., and John R. Hibbing. "The origin of politics: An evolutionary theory of political behavior." *Perspectives on Politics* 2, no. 04 (2004): 707-23.

Ames, Edward. "The Place of an Individual in an Economy." In *Essays in Contemporary Fields of Economics: In Honor of Emanuel T. Weiler (1914-1979)*, edited by George Horwich and James P. Quirk, pp. 24-40. West Lafayette, IN: Purdue University Press, 1981.

Anders, Günther. *Die Antiquiertheit des Menschen. Band 1: Über die Seele im Zeitalter der zweiten industriellen Revolution*, Munich: Beck, 1956 [1992].

Anderson, Donald L. *Organization Development: The Process of Leading Organizational Change*, 3e. SAGE Publications, 2015.

Anderson, Michael L. "Embodied cognition: A field guide." *Artificial intelligence* 149, no. 1 (2003): 91-130.

Anderson, Walter Truett. "Augmentation, symbiosis, transcendence: technology and the future(s) of human identity." *Futures* 35, no. 5 (2003): 535-46.

Andrianantoandro, Ernesto, Subhayu Basu, David K. Karig, and Ron Weiss. “Synthetic biology: new engineering rules for an emerging discipline.” *Molecular Systems Biology* 2, no. 1 (2006).

“Anthropotech.” http://www.anthropotech.org.uk/. 2013. Accessed January 29, 2016.

Appleseed [アップルシード / *Appurushīdo*]. Directed by Shinji Aramaki. 2004. Houston: Sentai Selects, 2010. Blu-Ray.

Aristotle, *Politics*, Book 1, Section 1253a. In *Aristotle in 23 Volumes*, Vol. 21, translated by H. Rackham. Cambridge, MA: Harvard University Press, 1944. http://www.perseus.tufts.edu/hopper/text?doc=Perseus%3Atext%3A1999.01.0058%3Abook%3D1%3Asection%3D1253a. Accessed March 4, 2016.

Arkin, Ronald C., and J. David Hobbs. “Dimensions of communication and social organization in multi-agent robotic systems.” In *From Animals to Animats 2: Proceedings of the Second International Conference on Simulation of Adaptive Behavior*, edited by Jean-Arcady Meyer, H. L. Roitblat and Stewart W. Wilson, pp. 486-93. Cambridge, MA: The MIT Press, 1993.

Artificial General Intelligence, edited by Ben Goertzel and Cassio Pennachin. Springer Berlin Heidelberg, 2007.

Artificial General Intelligence: 8th International Conference, AGI 2015: Berlin, Germany, July 22-25, 2015: Proceedings, edited by Jordi Bieger, Ben Goertzel, and Alexey Potapov. Springer International Publishing, 2015.

Asimov, Isaac. *I, Robot*. New York: Gnome Press, 1950.

Austerberry, David. *Digital Asset Management*, second edition. Burlington, MA: Focal Press, 2013.

Automated Scheduling and Planning: From Theory to Practice, edited by A. Şima Etaner-Uyar, Ender Özcan, and Neil Urquhart. Springer Berlin Heidelberg, 2013.

Badmington, Neil. “Cultural Studies and the Posthumanities,” edited by Gary Hall and Claire Birchall. *New Cultural Studies: Adventures in Theory*, pp. 260-72. Edinburgh: Edinburgh University Press, 2006.

Bainbridge, William Sims. *The Virtual Future*. London: Springer, 2011.

Băjenescu, Titu-Marius, and Marius I. Bâzu. *Reliability of Electronic Components: A Practical Guide to Electronic Systems Manufacturing*. Springer Berlin Heidelberg, 1999.

Bannat, Alexander, Thibault Bautze, Michael Beetz, Juergen Blume, Klaus Diepold, Christoph Ertelt, Florian Geiger, et al. “Artificial Cognition in Production Systems.” *IEEE Transactions on Automation Science and Engineering* 8, no. 1 (2011): 148-74.

Barca, Jan Carlo, and Y. Ahmet Sekercioglu. “Swarm robotics reviewed.” *Robotica* 31, no. 03 (2013): 345-59.

“The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence,” excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Barile, Nello. "From the Posthuman Consumer to the *Ontobranding* Dimension: Geolocalization, Augmented Reality and Emotional Ontology as a Radical Redefinition of What Is Real." *intervalla: platform for intellectual exchange,* vol. 1 (2013). http://www.fus.edu/intervalla/images/pdf/9_barile.pdf. Accessed May 18, 2016.

Barile, S., J. Pels, F. Polese, and M. Saviano. "An Introduction to the Viable Systems Approach and Its Contribution to Marketing," *Journal of Business Market Management* 5(2) (2012): 54-78 (2012).

Beer, Stafford. *Brain of the Firm*. 2nd ed. New York: John Wiley, 1981.

Bekey, G.A. *Autonomous Robots: From Biological Inspiration to Implementation and Control*. Cambridge, MA: MIT Press, 2005.

Bendle, Mervyn F. "Teleportation, cyborgs and the posthuman ideology." *Social Semiotics* 12, no. 1 (2002): 45-62.

Bera, Rajendra K. "Synthetic Biology and Intellectual Property Rights." In *Biotechnology*, edited by Deniz Ekinci. Rijeka: InTech, 2015.

Berman, Sandra. "Posthuman Law: Information Policy and the Machinic World." *First Monday* 7, no. 12 (2002). http://www.ojphi.org/ojs/index.php/fm/article/view/1011/932. Accessed March 15, 2016.

Berner, Georg. *Management in 20XX: What Will Be Important in the Future – A Holistic View*. Erlangen: Publicis Corporate Publishing, 2004.

Berrigan, Joseph R. "The Prehumanism of Benzo d'Allesandria." *Traditio* (1969): 249-63.

Better Off Dead: The Evolution of the Zombie as Post-Human, edited by Deborah Christie and Sarah Juliet Lauro. New York: Fordham University Press, 2011.

The Bible and Posthumanism, edited by Jennifer L. Koosed. Atlanta: Society of Biblical Literature, 2014.

Birnbacher, Dieter. "Posthumanity, Transhumanism and Human Nature." In *Medical Enhancement and Posthumanity*, edited by Bert Gordijn and Ruth Chadwick, pp. 95-106. The International Library of Ethics, Law and Technology 2. Springer Netherlands, 2008.

Boly, Melanie, Anil K. Seth, Melanie Wilke, Paul Ingmundson, Bernard Baars, Steven Laureys, David B. Edelman, and Naotsugu Tsuchiya. "Consciousness in humans and non-human animals: recent advances and future directions." *Frontiers in Psychology* 4 (2013).

Bostrom, Nick. "A History of Transhumanist Thought." *Journal of Evolution and Technology* vol. 14, no. 1 (2005). http://jetpress.org/volume14/bostrom.html.

Bostrom, Nick. "Human Genetic Enhancements: A Transhumanist Perspective." In *Arguing About Bioethics*, edited by Stephen Holland, pp. 105-15. New York: Routledge, 2012.

Bostrom, Nick. "Why I Want to Be a Posthuman When I Grow Up." In *Medical Enhancement and Posthumanity*, edited by Bert Gordijn and Ruth Chadwick, pp. 107-37. The International Library of Ethics, Law and Technology 2. Springer Netherlands, 2008.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Boulter, Jonathan. *Parables of the Posthuman: Digital Realities, Gaming, and the Player Experience*. Detroit: Wayne State University Press, 2015.

Bourgeois, III, L.J., Daniel W. McAllister, and Terence R. Mitchell. "The Effects of Different Organizational Environments upon Decisions about Organizational Structure." *Academy of Management Journal*, vol. 21, no. 3 (1978), pp. 508-14.

Bradford, David L., and W. Warner Burke. *Reinventing Organization Development: New Approaches to Change in Organizations*. John Wiley & Sons, 2005.

Bradshaw, Jeffrey M., Paul Feltovich, Matthew Johnson, Maggie Breedy, Larry Bunch, Tom Eskridge, Hyuckchul Jung, James Lott, Andrzej Uszok, and Jurriaan van Diggelen. "From Tools to Teammates: Joint Activity in Human-Agent-Robot Teams." In *Human Centered Design*, edited by Masaaki Kurosu, pp. 935-44. Lecture Notes in Computer Science 5619. Springer Berlin Heidelberg, 2009.

Brambilla, Manuele, Eliseo Ferrante, Mauro Birattari, and Marco Dorigo. "Swarm robotics: a review from the swarm engineering perspective." *Swarm Intelligence* 7, no. 1 (2013): 1-41.

Breazeal, Cynthia. "Toward sociable robots." *Robotics and Autonomous Systems* 42 (2003): 167-75.

Brickley, James A., Clifford W. Smith, and Jerold L. Zimmerman. "Corporate Governance, Ethics, and Organizational Architecture." *Journal of Applied Corporate Finance* 15, no. 3 (2003): 34-45.

Burton, Richard M., Børge Obel, and Dorthe Døjbak Håkonsson. *Organizational Design: A Step-by-Step Approach*. Cambridge University Press, 2015.

Cadle, James, Debra Paul, and Paul Turner. *Business Analysis Techniques: 72 Essential Tools for Success*. Swindon: British Informatics Society Limited, 2010.

Caetano, Artur, António Rito Silva, and José Tribolet. "A Role-Based Enterprise Architecture Framework." In *Proceedings of the 2009 ACM Symposium on Applied Computing*, pp. 253-58. ACM, 2009.

Callaghan, Vic. "Micro-Futures." Presentation at Creative-Science 2014, Shanghai, China, July 1, 2014.

Calverley, D.J. "Imagining a non-biological machine as a legal person." *AI & SOCIETY* 22, no. 4 (2008): 523-37.

Camenzind, Samuel. "On Clone as Genetic Copy: Critique of a Metaphor." *NanoEthics* 9, no. 1 (2015): 23-37.

Canton, James. "Designing the future: NBIC technologies and human performance enhancement." *Annals of the New York Academy of Sciences* vol. 1013, (2004): 186-98.

Casadesus-Masanell, Ramon, and Joan E. Ricart. "How to Design a Winning Business Model." *Harvard Business Review* 89, no. 1-2 (2011): 100-07.

Castronova, Edward. "Theory of the Avatar." CESifo Working Paper No. 863, February 2003. http://www.cesifo.de/pls/guestci/download/CESifo+Working+Papers+2003/CESifo+Working+Papers+February+2003+/cesifo_wp863.pdf. Accessed January 25, 2016.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Castronova, Edward. *Synthetic Worlds: The Business and Culture of Online Games*. Chicago: The University of Chicago Press, 2005.

Catechism of the Catholic Church, Second Edition. Washington, DC: United States Conference of Catholic Bishops, 2016.

Cesaroni, John L. “Designer Human Embryos as a Challenge for Patent Law and Regulation.” *Quinnipiac Law Review* 30, no. 4 (2012).

Chella, Antonio, Enrico Pagello, Emanuele Menegatti, Rosario Sorbello, Salvatore Maria Anzalone, Francesco Cinquegrani, Luca Tonin, F. Piccione, K. Prifitis, C. Blanda, E. Buttita, and E. Tranchina. “A BCI teleoperated museum robotic guide.” In *International Conference on Complex, Intelligent and Software Intensive Systems, 2009 (CISIS'09)*, pp. 783-88. IEEE, 2009.

Cheng, Allen A., and Timothy K. Lu. “Synthetic biology: an emerging engineering discipline.” *Annual Review of Biomedical Engineering* 14 (2012): 155-78.

Church, George M., Yuan Gao, and Sriram Kosuri. “Next-generation digital information storage in DNA.” *Science* 337, no. 6102 (2012): 1628.

Clancy, Frank. “At Military's Behest, Darpa Uses Neuroscience to Harness Brain Power.” *Neurology Today* 6, no. 2 (2006): 4-8.

Clark, Andy. *Natural-born cyborgs: Minds, Technologies, and the Future of Human Intelligence*. Oxford: Oxford University Press, 2004.

Clark, Stephen R.L. *The Political Animal: Biology, Ethics and Politics*. London: Routledge, 1999.

Clarke, Arthur C. “Hazards of Prophecy: The Failure of Imagination.” In *Profiles of the Future: An Inquiry into the Limits of the Possible,* revised edition. Harper & Row, New York, 1973.

Coeckelbergh, Mark. “Can We Trust Robots?” *Ethics and Information Technology* 14 (1) (2012): 53-60. doi:10.1007/s10676-011-9279-1.

Coeckelbergh, Mark. “From Killer Machines to Doctrines and Swarms, or Why Ethics of Military Robotics Is Not (Necessarily) About Robots.” *Philosophy & Technology* 24, no. 3 (2011): 269-78.

Coker, Christopher. “Biotechnology and War: The New Challenge.” *Australian Army Journal* vol. II, no. 1 (2004): 125-40.

Communication in the Age of Virtual Reality, edited by Frank Biocca and Mark R. Levy. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers, 1995.

Contreras-Vidal, Jose L., and Robert G. Grossman. “NeuroRex: A clinical neural interface roadmap for EEG-based brain machine interfaces to a lower body robotic exoskeleton.” In *2013 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, pp. 1579-82. IEEE, 2013.

Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science, edited by William Sims Bainbridge. Dordrecht: Springer Science+Business Media, 2003.

“The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence,” excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Cosgrove, G.R. "Session 6: Neuroscience, brain, and behavior V: Deep brain stimulation." Meeting of the President's Council on Bioethics. Washington, DC, June 24-25, 2004. https://bioethicsarchive.georgetown.edu/pcbe/transcripts/june04/session6.html. Accessed June 12, 2015.

Coughlin, Thomas M. *Digital Storage in Consumer Electronics: The Essential Guide*. Burlington, MA: Newnes, 2008.

Cudworth, Erika, and Stephen Hobden. "Complexity, ecologism, and posthuman politics." *Review of International Studies* 39, no. 03 (2013): 643-64.

Curtis, H. *Biology,* 4th edition. New York: Worth, 1983.

Curtis, Neal. "The Inhuman." *Theory, Culture & Society* 23, 2-3 (2006): 434-36.

Cyberculture, Cyborgs and Science Fiction: Consciousness and the Posthuman, edited by William S. Haney II. Amsterdam: Rodopi, 2006.

Cyberpsychology, edited by Ángel J. Gordo-López and Ian Parker. New York: Routledge, 1999.

Cyberpsychology: Journal of Psychosocial Research 1, no. 1 (2007) and subsequent issues. http://www.cyberpsychology.eu/index.php. Accessed January 29, 2016.

Cybersociety 2.0: Revisiting Computer-Mediated Communication and Community, edited by Steven G. Jones. Thousand Oaks: Sage Publications, 1998.

Daft, Richard L. *Management*. Mason, OH: South-Western / Cengage Learning, 2011.

Daft, Richard L., Jonathan Murphy, and Hugh Willmott. *Organization Theory and Design.* Andover, Hampshire: Cengage Learning EMEA, 2010.

DaSilva, Carlos M., and Peter Trkman. "Business Model: What It Is and What It Is Not." *Long Range Planning* 47 (2014): 379-89.

Datteri, E. "Predicting the Long-Term Effects of Human-Robot Interaction: A Reflection on Responsibility in Medical Robotics." *Science and Engineering Ethics* vol. 19, no. 1 (2013): 139-60.

Dautenhahn, Kerstin. "Robots we like to live with?! - A Developmental Perspective on a Personalized, Life-long Robot Companion." In *Proceedings of the 2004 IEEE International Workshop on Robot and Human Interactive Communication*, pp. 17-22. IEEE, 2004.

De Melo-Martín, Inmaculada. "Genetically Modified Organisms (GMOs): Human Beings." In *Encyclopedia of Global Bioethics*, edited by Henk ten Have. Springer Science+Business Media Dordrecht. Version of March 13, 2015. doi: 10.1007/978-3-319-05544-2_210-1. Accessed January 21, 2016.

Del Val, Jaime, and Stefan Lorenz Sorgner. "A *Metahumanist* Manifesto." *The Agonist* IV no. II (Fall 2011). http://www.nietzschecircle.com/AGONIST/2011_08/METAHUMAN_MANIFESTO.html. Accessed March 2, 2016.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Del Val, Jaime, Stefan Lorenz Sorgner, and Yunus Tuncel. “Interview on the Metahumanist Manifesto with Jaime del Val and Stefan Lorenz Sorgner.” *The Agonist* IV no. II (Fall 2011). http://www.nietzschecircle.com/AGONIST/2011_08/Interview_Sorgner_Stefan-Jaime.pdf. Accessed March 2, 2016.

Dhar, Vasant. “Should You Trust Your Money to a Robot?” *Big Data* 3, no. 2 (2015): 55-58.

Doyle, Jon. “Big problems for artificial intelligence.” *AI Magazine* 9, no. 1 (1988): 19-22.

Dudai, Yadin. “The Neurobiology of Consolidations, Or, How Stable Is the Engram?" *Annual Review of Psychology* 55 (2004): 51-86.

Dumas II, Joseph D. *Computer Architecture: Fundamentals and Principles of Computer Design*. Boca Raton: CRC Press, 2006.

Duncan, Sean C. “Mandatory Upgrades: The Evolving Mechanics and Theme of Android: Netrunner.” Presentation at Well-Played Summit @ DiGRA 2014, Salt Lake City, August 3-6, 2014.

Emmons, Robert A. “Is spirituality an intelligence? Motivation, cognition, and the psychology of ultimate concern.” *The International Journal for the psychology of Religion* 10, no. 1 (2000): 3-26.

“Ethical Guidelines and Professional Standards for Organization Development and Group Process Consultants.” IAGP - International Association for Group Psychotherapy and Group Processes. http://www.iagp.com/docs/IAGPOrgEthicalguidelinesEnglishv1.0.pdf. Accessed December 20, 2014.

Evans, Dave. “The Internet of Everything: How More Relevant and Valuable Connections Will Change the World.” Cisco Internet Solutions Business Group: Point of View, 2012. https://www.cisco.com/web/about/ac79/docs/innov/IoE.pdf. Accessed December 16, 2015.

Fabbro, Franco, Salvatore M. Aglioti, Massimo Bergamasco, Andrea Clarici, and Jaak Panksepp. “Evolutionary aspects of self-and world consciousness in vertebrates.” *Frontiers in human neuroscience* 9 (2015).

Fairclough, S.H. “Physiological Computing: Interfacing with the Human Nervous System.” In *Sensing Emotions*, edited by J. Westerink, M. Krans, and M. Ouwerkerk, pp. 1-20. Philips Research Book Series 12. Springer Netherlands, 2010.

Falconer, Bruce. “Defense Research Agency Seeks to Create Supersoldiers,” *Government Executive*, November 10, 2003. http://www.govexec.com/defense/2003/11/defense-research-agency-seeks-to-create-supersoldiers/15386/. Accessed May 22, 2016.

Ferber, Jacques, Olivier Gutknecht, and Fabien Michel. “From agents to organizations: an organizational view of multi-agent systems.” In *Agent-Oriented Software Engineering IV*, pp. 214-30. Springer Berlin Heidelberg, 2004.

Ferrando, Francesca. “Posthumanism, Transhumanism, Antihumanism, Metahumanism, and New Materialisms: Differences and Relations.” *Existenz: An International Journal in Philosophy, Religion, Politics, and the Arts* 8, no. 2 (Fall 2013): 26-32.

“The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence,” excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Fleischmann, Kenneth R. "Sociotechnical Interaction and Cyborg–Cyborg Interaction: Transforming the Scale and Convergence of HCI." *The Information Society* 25, no. 4 (2009): 227-35. doi:10.1080/01972240903028359.

Ford, Martin. *Rise of the Robots: Technology and the Threat of a Jobless Future*. New York: Basic Books, 2015.

Freitas Jr., Robert A. "Preface and Acknowledgements for the First Edition." In *Xenology: An Introduction to the Scientific Study of Extraterrestrial Life, Intelligence, and Civilization*. Sacramento: Xenology Research Institute, 1979. http://www.xenology.info/Xeno/PrefaceFirstEdition.htm, last updated October 22, 2009. Accessed January 30, 2016.

Friedenberg, Jay. *Artificial Psychology: The Quest for What It Means to Be Human*, Philadelphia: Psychology Press, 2008.

Friedman, Batya, and Helen Nissenbaum. "Bias in Computer Systems." In *Human Values and the Design of Computer Technology*, edited by Batya Friedman, pp. 21-40. CSL Lecture Notes 72. Cambridge: Cambridge University Press, 1997.

Fukuyama, Francis. *Our Posthuman Future: Consequences of the Biotechnology Revolution*. New York: Farrar, Straus, and Giroux, 2002.

The Future of Automated Freight Transport: Concepts, Design and Implementation, edited by Hugo Priemus and Peter Nijkamp. Cheltenham: Edward Elgar Publishing, 2005.

The Future of Bioethics: International Dialogues, edited by Akira Akabayashi, Oxford: Oxford University Press, 2014.

Galis, Alex, Spyros G. Denazis, Alessandro Bassi, Pierpaolo Giacomin, Andreas Berl, Andreas Fischer, Hermann de Meer, J. Srassner, S. Davy, D. Macedo, G. Pujolle, J. R. Loyola, J. Serrat, L. Lefevre, and A. Cheniour. "Management Architecture and Systems for Future Internet Networks." In *Towards the Future Internet: A European Research Perspective*, edited by Georgios Tselentis, John Domingue, Alex Galis, Anastasius Gavras, David Hausheer, Srdjan Krco, Volkmar Lotz, and Theodore Zahariadis, pp. 112-22. IOS Press, 2009.

Gane, Nicholas. "Posthuman." *Theory, Culture & Society* 23, 2-3 (2006): 431-34.

Garg, Anant Bhaskar. "Embodied Cognition, Human Computer Interaction, and Application Areas." In *Computer Applications for Web, Human Computer Interaction, Signal and Image Processing, and Pattern Recognition*, pp. 369-74. Springer Berlin Heidelberg, 2012.

Gasson, M.N. "Human ICT Implants: From Restorative Application to Human Enhancement." In *Human ICT Implants: Technical, Legal and Ethical Considerations*, edited by Mark N. Gasson, Eleni Kosta, and Diana M. Bowman, pp. 11-28. Information Technology and Law Series 23. T. M. C. Asser Press, 2012.

Gasson, M.N. "ICT implants." In *The Future of Identity in the Information Society*, edited by S. Fischer-Hübner, P. Duquenoy, A. Zuccato, and L. Martucci, pp. 287-95. Springer US, 2008.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Gasson, M.N., Kosta, E., and Bowman, D.M. "Human ICT Implants: From Invasive to Pervasive." In *Human ICT Implants: Technical, Legal and Ethical Considerations*, edited by Mark N. Gasson, Eleni Kosta, and Diana M. Bowman, pp. 1-8. Information Technology and Law Series 23. T. M. C. Asser Press, 2012.

Gene Therapy of the Central Nervous System: From Bench to Bedside, edited by Michael G. Kaplitt and Matthew J. During. Amsterdam: Elsevier, 2006.

Gephart, Jr., Robert P. "Management, Social Issues, and the Postmodern Era." In *Postmodern Management and Organization Theory*, edited by David M. Boje, Robert P. Gephart, Jr., and Tojo Joseph Thatchenkery, pp. 21-44. Thousand Oaks, CA: Sage Publications, 1996.

Geraci, Robert M. "Spiritual robots: Religion and our scientific view of the natural world." *Theology and Science* 4, issue 3 (2006). doi: 10.1080/14746700600952993.

Geraci, Robert M. *Apocalyptic AI: Visions of Heaven in Robotics, Artificial Intelligence, and Virtual Reality*. New York: Oxford University Press, 2010.

Giudici, P. *Applied Data Mining: Statistical Methods for Business and Industry*. Wiley, 2003.

Gladden, Matthew E. "The Artificial Life-Form as Entrepreneur: Synthetic Organism-Enterprises and the Reconceptualization of Business." In *Proceedings of the Fourteenth International Conference on the Synthesis and Simulation of Living Systems*, edited by Hiroki Sayama, John Rieffel, Sebastian Risi, René Doursat and Hod Lipson, pp. 417-18. The MIT Press, 2014.

Gladden, Matthew E. "Cybershells, Shapeshifting, and Neuroprosthetics: Video Games as Tools for Posthuman 'Body Schema (Re)Engineering'." Keynote presentation at the Ogólnopolska Konferencja Naukowa Dyskursy Gier Wideo, Facta Ficta / AGH, Kraków, June 6, 2015.

Gladden, Matthew E. "The Diffuse Intelligent Other: An Ontology of Nonlocalizable Robots as Moral and Legal Actors." In *Social Robots: Boundaries, Potential, Challenges*, edited by Marco Nørskov, pp. 177-98. Farnham: Ashgate, 2016.

Gladden, Matthew E. "From Stand Alone Complexes to Memetic Warfare: Cultural Cybernetics and the Engineering of Posthuman Popular Culture." Presentation at the 50 Shades of Popular Culture International Conference. Facta Ficta / Uniwersytet Jagielloński, Kraków, February 19, 2016.

Gladden, Matthew E. *The Handbook of Information Security for Advanced Neuroprosthetics*, Indianapolis: Synthypnion Academic, 2015.

Gladden, Matthew E. "Leveraging the Cross-Cultural Capacities of Artificial Agents as Leaders of Human Virtual Teams." *Proceedings of the 10th European Conference on Management Leadership and Governance*, edited by Visnja Grozdanić, pp. 428-35. Reading: Academic Conferences and Publishing International Limited, 2014.

Gladden, Matthew E. "Managerial Robotics: A Model of Sociality and Autonomy for Robots Managing Human Beings and Machines." *International Journal of Contemporary Management* 13, no. 3 (2014), pp. 67-76.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Gladden, Matthew E. "Neural Implants as Gateways to Digital-Physical Ecosystems and Posthuman Socioeconomic Interaction." In *Digital Ecosystems: Society in the Digital Age*, edited by Łukasz Jonak, Natalia Juchniewicz, and Renata Włoch, pp. 85-98. Warsaw: Digital Economy Lab, University of Warsaw, 2016.

Gladden, Matthew E. "The Social Robot as 'Charismatic Leader': A Phenomenology of Human Submission to Nonhuman Power." In *Sociable Robots and the Future of Social Relations: Proceedings of Robo-Philosophy 2014*, edited by Johanna Seibt, Raul Hakli, and Marco Nørskov, pp. 329-39. Frontiers in Artificial Intelligence and Applications 273. IOS Press, 2014.

Gladden, Matthew E. "'Upgrading' the Human Entity: Cyberization as a Path to Posthuman Utopia or Digital Annihilation?" Lecture in the Arkana Fantastyki lecture cycle, Centrum Informacji Naukowej i Biblioteka Akademicka (CINiBA), Katowice, May 27, 2015.

Gladden, Matthew E. "Utopias and Dystopias as Cybernetic Information Systems: Envisioning the Posthuman Neuropolity." *Creatio Fantastica* nr 3 (50) (2015).

Gockley, Rachel, Allison Bruce, Jodi Forlizzi, Marek Michalowski, Anne Mundell, Stephanie Rosenthal, Brennan Sellner, Reid Simmons, Kevin Snipes, Alan C. Schultz, and Jue Wang. "Designing Robots for Long-Term Social Interaction." In *2005 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2005)*, pp. 2199-2204. 2005.

Goffette, Jérôme. *Naissance de l'anthropotechnie: De la médecine au modelage de l'humain*. Paris: Vrin, 2006.

Goicoechea, María. "The Posthuman Ethos in Cyberpunk Science Fiction." *CLCWeb: Comparative Literature and Culture* 10, no. 4 (2008): 9. http://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1398&context=clcweb. Accessed May 18, 2016.

Goodall, Noah. "Ethical decision making during automated vehicle crashes." *Transportation Research Record: Journal of the Transportation Research Board* 2424 (2014): 58-65.

Goodman, Paul S., and Linda Argote. "New Technology and Organizational Effectiveness." Carnegie-Mellon University, April 27, 1984.

Graham, Elaine. "Post/Human Conditions." *Theology & Sexuality* 10:2 (2004), pp. 10-32.

Graham, Elaine. *Representations of the Post/Human: Monsters, Aliens and Others in Popular Culture*. Manchester: Manchester University Press, 2002.

Graham, Stephen. "Imagining Urban Warfare: Urbanization and U.S. Military Technoscience." In *War, Citizenship, Territory*, edited by Deborah Cowen and Emily Gilbert. New York: Routledge, 2008.

Gray, Chris Hables. *Cyborg Citizen: Politics in the Posthuman Age*, London: Routledge, 2002.

Gray, Chris Hables. "The Ethics and Politics of Cyborg Embodiment: Citizenship as a Hypervalue." *Cultural Values* 1, no 2 (1997): 252-58.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Green, Steven J. "Malevolent gods and Promethean birds: Contesting augury in Augustus's Rome." In *Transactions of the American Philological Association*, vol. 139, no. 1, pp. 147-167. The Johns Hopkins University Press, 2009.

Grodzinsky, F.S., K.W. Miller, and M.J. Wolf. "Developing Artificial Agents Worthy of Trust: 'Would You Buy a Used Car from This Artificial Agent?'" *Ethics and Information Technology* 13, no. 1 (2011): 17-27.

Gross, Dominik. "Traditional vs. modern neuroenhancement: notes from a medico-ethical and societal perspective." In *Implanted minds: the neuroethics of intracerebral stem cell transplantation and deep brain stimulation*, edited by Heiner Fangerau, Jörg M. Fegert, and Thorsten Trapp, pp. 291-312. Bielefeld: transcript Verlag, 2011.

Guizzo, Erico, and Harry Goldstein. "The rise of the body bots [robotic exoskeletons]." *IEEE Spectrum* 42, no. 10 (2005): 50-56.

Gunkel, David J. *The Machine Question: Critical Perspectives on AI, Robots, and Ethics*. Cambridge, MA: The MIT Press, 2012.

Hamilton, S. "What Is Roman Ornithomancy? A Compositional Analysis of an Ancient Roman Ritual." *Proceedings of the Multidisciplinary Graduate Research Conference*. Lethbridge: University of Lethbridge Graduate Students Association, 2007.

Han, J.-H., S.A. Kushner, A.P. Yiu, H.-W. Hsiang, T. Buch, A. Waisman, B. Bontempi, R.L. Neve, P.W. Frankland, and S.A. Josselyn. "Selective Erasure of a Fear Memory." *Science* 323, no. 5920 (2009): 1492-96.

Handbook of Cloud Computing, edited by Borko Furht and Armando Escalante. New York: Springer, 2010. DOI 10.1007/978-1-4419-6524-0.

Handbook of Psychology, Volume 6: Developmental Psychology, edited by Richard M. Lerner, M. Ann Easterbrooks, and Jayanthi Mistry. Hoboken: John Wiley & Sons, Inc., 2003.

Hanson, R. "If uploads come first: The crack of a future dawn." *Extropy* 6, no. 2 (1994): 10-15.

Haraway, Donna. "A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s." *Socialist Review* vol. 15, no. 2 (1985), pp. 65-107.

Haraway, Donna. *Simians, Cyborgs, and Women: The Reinvention of Nature*. New York: Routledge, 1991.

Harrison, Albert A., and Alan C. Elms. "Psychology and the search for extraterrestrial intelligence." *Behavioral Science* 35, no. 3 (1990): 207-18.

Hassan, Ihab. "Prometheus as Performer: Toward a Posthumanist Culture? A University Masque in Five Scenes." *The Georgia Review* vol. 31, no. 4 (1977): 830-50.

Hatfield, B., A. Haufler, and J. Contreras-Vidal. "Brain Processes and Neurofeedback for Performance Enhancement of Precision Motor Behavior." In *Foundations of Augmented Cognition. Neuroergonomics and Operational Neuroscience*, edited by Dylan D. Schmorrow, Ivy V. Estabrooke, and Marc Grootjen, pp. 810-17. Lecture Notes in Computer Science 5638. Springer Berlin Heidelberg, 2009.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Haykin, Simon. *Neural Networks and Learning Machines*, third edition. New York: Pearson Prentice Hall, 2009.

Hayles, N. Katherine. *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*, Chicago: University of Chicago Press, 1999.

Hayles, N. Katherine. *My Mother Was a Computer: Digital Subjects and Literary Texts*. Chicago: University of Chicago Press, 2005.

Hazen, Robert. "What is life?", *New Scientist* 192, no. 2578 (2006): 46-51.

Heim, Michael. *The Metaphysics of Virtual Reality*. New York: Oxford University Press, 1993.

Heinrichs, Jan-Hendrik. "The promises and perils of non-invasive brain stimulation." *International journal of law and psychiatry* 35, no. 2 (2012): 121-29.

Herbrechter, Stefan. *Posthumanism: A Critical Analysis*. London: Bloomsbury, 2013. [Kindle edition.]

Heylighen, Francis. "The Global Brain as a New Utopia." In *Renaissance der Utopie. Zukunftsfiguren des 21. Jahrhunderts*, edited by R. Maresch and F. Rötzer. Frankfurt: Suhrkamp, 2002.

Holacracy Constitution v4.1. Spring City, PA: HolacracyOne, 2015. http://www.holacracy.org/wp-content/uploads/2015/07/Holacracy-Constitution-v4.1.pdf. Accessed May 21, 2016.

Hoogervorst, Jan. "Enterprise Architecture: Enabling Integration, Agility and Change." *International Journal of Cooperative Information Systems* 13, no. 03 (2004): 213-33.

Horling, Bryan, and Victor Lesser. "A Survey of Multi-Agent Organizational Paradigms." *The Knowledge Engineering Review* 19, no. 04 (2004): 281-316.

I, Robot. Directed by Alex Proyas. 2004. 20th Century Fox, 2005. DVD.

Ihrig, M. "Simulating Entrepreneurial Opportunity Recognition Processes: An Agent-Based and Knowledge-Driven Approach." In *Advances in Intelligent Modelling and Simulation: Simulation Tools and Applications*, edited by A. Byrski, Z. Oplatková, M. Carvalho, and M. Kisiel-Dorohinicki, pp. 27-54. Berlin: Springer-Verlag, 2012.

Industrial Applications of Holonic and Multi-Agent Systems, edited by Vladimír Mařík, Arnd Schirrmann, Damien Trentesaux, and Pavel Vrba. Lecture Notes in Artificial Intelligence 9266. Springer International Publishing AG Switzerland, 2015.

Intelligent Production Machines and Systems, edited by Duc T. Pham, Eldaw E. Eldukhri, and Anthony J. Soroka. Amsterdam: Elsevier, 2006.

Interface Zero 2.0: Full Metal Cyberpunk, developed by David Jarvis, Curtis Lyons, Sarah Lyons, Thomas Shook, David Viars, and Peter J. Wacks, Gun Metal Games, 2013.

"The International Organization Development *Code of Ethics*." Organizational Development English Library, The OD Institute. http://www.theodinstitute.org/od-library/code_of_ethics.htm. Accessed December 17, 2014.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Josselyn, Sheena A. “Continuing the Search for the Engram: Examining the Mechanism of Fear Memories.” *Journal of Psychiatry & Neuroscience : JPN* 35, no. 4 (2010): 221-28.

Kanda, Takayuki, and Hiroshi Ishiguro. *Human-Robot Interaction in Social Robotics*. Boca Raton: CRC Press, 2013.

Kawano, Tomonori, François Bouteau, and Stefano Mancuso. “Finding and defining the natural automata acting in living plants: Toward the synthetic biology for robotics and informatics in vivo.” *Communicative & Integrative Biology* 5, no. 6 (2012): 519-26.

Kedzior, Richard. *How Digital Worlds Become Material: An Ethnographic and Netnographic Investigation in Second Life*. Economics and Society: Publications of the Hanken School of Economics Nr. 281. Helsinki: Hanken School of Economics, 2014.

Kelly, Kevin. “The Landscape of Possible Intelligences.” *The Technium*, September 10, 2008. http://kk.org/thetechnium/the-landscape-o/. Accessed January 25, 2016.

Kelly, Kevin. *Out of Control: The New Biology of Machines, Social Systems and the Economic World*. Basic Books, 1994.

Kelly, Kevin. “A Taxonomy of Minds.” *The Technium*, February 15, 2007. http://kk.org/thetechnium/a-taxonomy-of-m/. Accessed January 25, 2016.

Kerr, Paul K., John Rollins, and Catherine A. Theohary. “The Stuxnet Computer Worm: Harbinger of an Emerging Warfare Capability.” Congressional Research Service, 2010.

Khushf, George. “The use of emergent technologies for enhancing human performance: Are we prepared to address the ethical and policy issues.” *Public Policy and Practice* 4, no. 2 (2005): 1-17.

Kinicki, Angelo, and Brian Williams. *Management: A Practical Introduction*, 5th edition. New York: McGraw Hill, 2010.

Koene, Randal A. “Embracing Competitive Balance: The Case for Substrate-Independent Minds and Whole Brain Emulation.” In *Singularity Hypotheses*, edited by Amnon H. Eden, James H. Moor, Johnny H. Søraker, and Eric Steinhart, pp. 241-67. The Frontiers Collection. Springer Berlin Heidelberg, 2012.

Koltko-Rivera, Mark E. “The potential societal impact of virtual reality.” *Advances in virtual environments technology: Musings on design, evaluation, and applications* 9 (2005).

Koops, B.-J., and R. Leenes. “Cheating with Implants: Implications of the Hidden Information Advantage of Bionic Ears and Eyes.” In *Human ICT Implants: Technical, Legal and Ethical Considerations*, edited by Mark N. Gasson, Eleni Kosta, and Diana M. Bowman, pp. 113-34. Information Technology and Law Series 23. T. M. C. Asser Press, 2012.

Kourany, J.A. “Human Enhancement: Making the Debate More Productive.” *Erkenntnis* 79, no. 5 (2013): 981-98.

“The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence,” excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Kowalewska, Agata. “Symbionts and Parasites – Digital Ecosystems.” In *Digital Ecosystems: Society in the Digital Age*, edited by Łukasz Jonak, Natalia Juchniewicz, and Renata Włoch, pp. 73-84. Warsaw: Digital Economy Lab, University of Warsaw, 2016.

Kraemer, Felicitas. “Me, Myself and My Brain Implant: Deep Brain Stimulation Raises Questions of Personal Authenticity and Alienation.” *Neuroethics* 6, no. 3 (May 12, 2011): 483-97. doi:10.1007/s12152-011-9115-7.

Krishnan, Armin. “Enhanced Warfighters as Private Military Contractors.” In *Super Soldiers: The Ethical, Legal and Social Implications*, edited by Jai Galliott and Mianna Lotz. London: Routledge, 2015.

Krüger, Oliver. *Virtualität und Unsterblichkeit: Die Visionen des Posthumanismus* [Virtuality and Immortality]. Freiburg: Rombach, 2004.

Krzywinska, Tanya, and Douglas Brown. “Games, Gamers and Posthumanism.” In *The Palgrave Handbook of Posthumanism in Film and Television*, pp. 192-201. Palgrave Macmillan UK, 2015.

Kurzweil, Ray. *The Age of Spiritual Machines: When Computers Exceed Human Intelligence*. New York: Penguin Books, 2000.

Kurzweil, Ray. *The Singularity is Near: When Humans Transcend Biology*. New York: Viking Penguin, 2005.

Lamm, Ehud, and Ron Unger. *Biological Computation*, Boca Raton: CRC Press, 2011.

Le Breton, David. *L’Adieu au corps*. Paris: Métaillé, 1999.

Lebedev, M. “Brain-Machine Interfaces: An Overview.” *Translational Neuroscience* 5, no. 1 (March 28, 2014): 99-110.

Lee, Joseph. “Cochlear implantation, enhancements, transhumanism and posthumanism: some human questions.” *Science and engineering ethics* 22, no. 1 (2016): 67-92.

Lilley, Stephen. *Transhumanism and Society: The Social Debate over Human Enhancement*. Springer Science & Business Media, 2013.

Litzsinger, Lukas. *Android: Netrunner* [card game]. Roseville, MN: Fantasy Flight Games, 2012.

Lohn, Andrew J., Patrick R. Mickel, James B. Aimone, Erik P. Debenedictis, and Matthew J. Marinella. “Memristors as Synapses in Artificial Neural Networks: Biomimicry Beyond Weight Change.” In *Cybersecurity Systems for Human Cognition Augmentation*, edited by Robinson E. Pino, Alexander Kott, and Michael Shevenell, pp. 135-50. Springer International Publishing, 2014.

Longuet-Higgins, H.C. “Holographic Model of Temporal Recall.” *Nature* 217, no. 5123 (1968): 104. doi:10.1038/217104a0.

Lovecraft, Howard Phillips. *At the Mountains of Madness and Other Novels.* Sauk City, Wisconsin: Arkham House, 1985.

Lovecraft, Howard Phillips. *The Dunwich Horror and Others.* Sauk City, Wisconsin: Arkham House, 1983.

“The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence,” excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Lune, Howard. *Understanding Organizations*, Cambridge: Polity Press, 2010.

Lyon, David. "Beyond Cyberspace: Digital Dreams and Social Bodies." In *Education and Society*, third edition, edited by Joseph Zajda, pp. 221-38. Albert Park: James Nicholas Publishers, 2001.

Magoulas, Thanos, Aida Hadzic, Ted Saarikko, and Kalevi Pessi. "Alignment in Enterprise Architecture: A Comparative Analysis of Four Architectural Approaches." *Electronic Journal Information Systems Evaluation* 15, no. 1 (2012).

Magretta, Joan. "Why Business Models Matter." *Harvard Business Review* 80, no. 5 (2002): 86-92.

Maguire, Gerald Q., and Ellen M. McGee. "Implantable brain chips? Time for debate." *Hastings Center Report* 29, no. 1 (1999): 7-13.

Man Is by Nature a Political Animal: Evolution, Biology, and Politics, edited by Peter K. Hatemi and Rose McDermott. Chicago: The University of Chicago Press, 2011.

Mara, Andrew, and Byron Hawk. "Posthuman rhetorics and technical communication." *Technical Communication Quarterly* 19, no. 1 (2009): 1-10.

Martinez, Dolores. "Bodies of future memories: the Japanese body in science fiction anime." *Contemporary Japan* 27, no. 1 (2015): 71-88.

Mazlish, Bruce. *The Fourth Discontinuity: The Co-Evolution of Humans and Machines*. New Haven: Yale University Press, 1993.

McBurney, Peter, and Simon Parsons. "Engineering democracy in open agent systems." In *ESAW* vol. 3071, pp. 66-80. 2003.

McGee, E.M. "Bioelectronics and Implanted Devices." In *Medical Enhancement and Posthumanity*, edited by Bert Gordijn and Ruth Chadwick, pp. 207-24. The International Library of Ethics, Law and Technology 2. Springer Netherlands, 2008.

McGrath, Rita Gunther. *The End of Competitive Advantage: How to Keep Your Strategy Moving as Fast as Your Business*. Boston: Harvard Business Review Press, 2013.

McIndoe, Robert S. "Health Kiosk Technologies." In *Ethical Issues and Security Monitoring Trends in Global Healthcare: Technological Advancements: Technological Advancements*, edited by Steven A. Brown and Mary Brown, pp. 66-71. Hershey: Medical Information Science Reference, 2010.

McIntosh, Daniel. "The Transhuman Security Dilemma." *Journal of Evolution and Technology* 21, no. 2 (2010): 32-48.

Medical Enhancement and Posthumanity, edited by Bert Gordijn and Ruth Chadwick. The International Library of Ethics, Law and Technology 2. Springer Netherlands, 2008.

Mehlman, Maxwell J. *Transhumanist Dreams and Dystopian Nightmares: The Promise and Peril of Genetic Engineering*. Baltimore: The Johns Hopkins University Press, 2012.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Merdan, Munir, Thomas Moser, W. Sunindyo, Stefan Biffl, and Pavel Vrba. "Workflow scheduling using multi-agent systems in a dynamically changing environment." *Journal of Simulation* 7, no. 3 (2013): 144-58.

Merkel, R., G. Boer, J. Fegert, T. Galert, D. Hartmann, B. Nuttin, and S. Rosahl. "Central Neural Prostheses." In *Intervening in the Brain: Changing Psyche and Society*, 117-60. Ethics of Science and Technology Assessment 29. Springer Berlin Heidelberg, 2007.

Miah, Andy. "A Critical History of Posthumanism." In *Medical Enhancement and Posthumanity*, edited by Bert Gordijn and Ruth Chadwick, pp. 71-94. The International Library of Ethics, Law and Technology 2. Springer Netherlands, 2008.

Michaud, M.A.G. *Contact with Alien Civilizations: Our Hopes and Fears about Encountering Extraterrestrials*. New York: Springer, 2007.

Milán, Victor. "Transfigurations" and "Appendix: The Science of the Wild Card Virus: Excerpts from the Literature." In *Wild Cards*, edited by George R. R. Martin. Bantam Books: 1986.

Miller, Jr., Gerald Alva. "Conclusion: Beyond the Human: Ontogenesis, Technology, and the Posthuman in Kubrick and Clarke's 2001." In *Exploring the Limits of the Human through Science Fiction*, pp. 163-90. American Literature Readings in the 21st Century. Palgrave Macmillan US, 2012.

Moravec, Hans. *Mind Children: The Future of Robot and Human Intelligence*. Cambridge: Harvard University Press, 1990.

Moreno, Jonathan. "DARPA On Your Mind." *Cerebrum* vol. 6 issue 4 (2004): 92-100.

Mueller, Scott. *Upgrading and Repairing PCs, 20th Edition*. Indianapolis: Que, 2012.

Murphy, Robin. *Introduction to AI Robotics*. Cambridge, MA: The MIT Press, 2000.

Nadler, David, and Michael Tushman. *Competing by Design: The Power of Organizational Architecture*. Oxford University Press, 1997. [Kindle edition.]

Nahin, Paul J. "Religious Robots." In *Holy Sci-Fi!*, pp. 69-94. Springer New York, 2014.

Naufel, Stephanie. "Nanotechnology, the Brain, and Personal Identity." In *Nanotechnology, the Brain, and the Future*, edited by Sean A. Hays, Jason Scott Robert, Clark A. Miller, and Ira Bennett, pp. 167-78. Dordrecht: Springer Science+Business Media, 2013.

Nazario, Marina. "I went to Best Buy and encountered a robot named Chloe – and now I'm convinced she's the future of retail." *Business Insider*, October 23, 2015. http://www.businessinsider.com/what-its-like-to-use-best-buys-robot-2015-10. Accessed May 20, 2016.

Nealon, Jeffrey T. *Foucault Beyond Foucault*. Stanford, CA: Stanford University Press, 2008.

Neohumanist Educational Futures: Liberating the Pedagogical Intellect, edited by Sohail Inayatullah, Marcus Bussey, and Ivana Milojević. Tansui, Taipei: Tamkang University Press, 2006. http://www.metafuture.org/Books/nh-educational-futures-foreword.htm. Accessed March 16, 2016.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

NIST Special Publication 800-53, Revision 4: Security and Privacy Controls for Federal Information Systems and Organizations. Joint Task Force Transformation Initiative. Gaithersburg, Maryland: National Institute of Standards & Technology, 2013.

Norman, Kent L. *Cyberpsychology: An Introduction to Human-Computer Interaction*. New York: Cambridge University Press, 2008.

Nourbakhsh, Illah Reza. "The Coming Robot Dystopia." *Foreign Affairs* 94, no. 4 (2015): 23.

Nouvel, Pascal. "A Scale and a Paradigmatic Framework for Human Enhancement." In *Inquiring into Human Enhancement*, edited by Simone Bateman, Jean Gayon, Sylvie Allouche, Jérôme Goffette, and Michela Marzano, pp. 103-18. Palgrave Macmillan UK, 2015.

Novaković, Branko, Dubravko Majetić, Josip Kasać, and Danko Brezak. "Artificial Intelligence and Biorobotics: Is an Artificial Human Being our Destiny?" In *Annals of DAAAM for 2009 & Proceedings of the 20th International DAAAM Symposium "Intelligent Manufacturing & Automation: Focus on Theory, Practice and Education,"* edited by Branko Katalinic, pp. 121-22. Vienna: DAAAM International, 2009.

Null, Linda, and Julia Lobur. *The Essentials of Computer Organization and Architecture*, second edition. Sudbury, MA: Jones and Bartlett Publishers, 2006.

Ochsner, Beate, Markus Spöhrer, and Robert Stock. "Human, non-human, and beyond: cochlear implants in socio-technological environments." *NanoEthics* 9, no. 3 (2015): 237-50.

Olson, Eric T. "Personal Identity." *The Stanford Encyclopedia of Philosophy* (Fall 2015 Edition), edited by Edward N. Zalta. http://plato.stanford.edu/archives/fall2015/entries/identity-personal/. Accessed January 17, 2016.

"Organization and Human Systems Development Credo." OD Network. http://www.odnetwork.org/?page=ODCredo. Accessed December 17, 2014.

Panno, Joseph. *Gene Therapy: Treating Disease by Repairing Genes*. New York: Facts on File, 2005.

Park, M.C., M.A. Goldman, T.W. Belknap, and G.M. Friehs. "The Future of Neural Interface Technology." In *Textbook of Stereotactic and Functional Neurosurgery*, edited by A.M. Lozano, P.L. Gildenberg, and R.R. Tasker, 3185-3200. Heidelberg/Berlin: Springer, 2009.

Payr, S., and Trappl, R. "Agents across Cultures." In *Intelligent Virtual Agents*, Lecture Notes in Computer Science, No. 2792, pp. 320-24. 2003.

Pearce, David. "The Biointelligence Explosion." In *Singularity Hypotheses*, edited by A.H. Eden, J.H. Moor, J.H. Søraker, and E. Steinhart, pp. 199-238. The Frontiers Collection. Berlin/Heidelberg: Springer, 2012.

Pepperell, R. *The Posthuman Condition: Consciousness Beyond the Brain*. Bristol, UK: Intellect Books, 2003.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Pereira, Alexandre L.D. "Intellectual Property and Medical Biotechnologies." In *Legal and Forensic Medicine*, edited by Roy G. Beran, pp. 1735-54. Springer Berlin Heidelberg, 2013.

Pérez, Jimena Escudero. "Sympathy for the Clone: (Post) Human Identities Enhanced by the 'Evil Science' Construct and its Commodifying Practices in Contemporary Clone Fiction." *Between* 4, no. 8 (2014).

Perez-Marin, D., and I. Pascual-Nieto. *Conversational Agents and Natural Language Interaction: Techniques and Effective Practices*. Hershey, PA: IGI Global, 2011.

Perlberg, James. *Industrial Robotics*. Boston: Cengage Learning, 2016.

Philips, M. "How the Robots Lost: High-Frequency Trading's Rise and Fall." *BloombergView* June 6, 2012. http://www.bloomberg.com/bw/articles/2013-06-06/how-the-robots-lost-high-frequency-tradings-rise-and-fall. Accessed April 29, 2015.

Pinedo, Michael L. *Scheduling: Theory, Algorithms, and Systems*, fourth edition. New York: Springer Science+Business Media, 2012.

Pino, Robinson E., and Alexander Kott. "Neuromorphic Computing for Cognitive Augmentation in Cyber Defense." In *Cybersecurity Systems for Human Cognition Augmentation,* edited by Robinson E. Pino, Alexander Kott, and Michael Shevenell, pp. 19-46. Springer International Publishing, 2014.

Plowright, Stephen. "Neurocomputing: some possible implications for human-machine interfaces." *ASHB News* 8, no. 2 (1996): pp. 4-6.

Ponsteen, Albert, and Rob J. Kusters. "Classification of Human and Automated Resource Allocation Approaches in Multi-Project Management." *Procedia – Social and Behavioral Sciences* 194 (2015): 165-73.

Porterfield, Andrew. "Be Aware of Your Inner Zombie." *ENGINEERING & SCIENCE* (Fall 2010): 14-19.

Poster, Mark. *What's the Matter with the Internet?* Minneapolis: University of Minnesota Press, 2001.

Posthuman Bodies, edited by Judith Halberstam and Ira Livingstone. Bloomington, IN: Indiana University Press, 1995.

Posthumanist Shakespeares, edited by Stefan Herbrechter and Ivan Callus. Palgrave Shakespeare Studies. Palgrave Macmillan UK, 2012.

Pribram, K.H. "Prolegomenon for a Holonomic Brain Theory." In *Synergetics of Cognition*, edited by Hermann Haken and Michael Stadler, pp. 150-84. Springer Series in Synergetics 45. Springer Berlin Heidelberg, 1990.

Pribram, K.H., and S.D. Meade. "Conscious Awareness: Processing in the Synaptodendritic Web – The Correlation of Neuron Density with Brain Size." *New Ideas in Psychology* 17, no. 3 (December 1, 1999): 205-14. doi:10.1016/S0732-118X(99)00024-0.

Pride, W., R. Hughes, and J. Kapoor. *Foundations of Business*, 4e. Stamford, CT: Cengage Learning, 2014.

Primate Politics, edited by Glendon Schubert and Roger D. Masters. Carbondale: Southern Illinois University Press, 1991.

"Principles of OD Practice." OD Network. http://www.odnetwork.org/?page=PrinciplesOfODPracti. Accessed December 17, 2014.

Proudfoot, Diane. "Software Immortals: Science or Faith?" In *Singularity Hypotheses*, edited by Amnon H. Eden, James H. Moor, Johnny H. Søraker, and Eric Steinhart, pp. 367-92. The Frontiers Collection. Springer Berlin Heidelberg, 2012.

Provost, Foster, and Tom Fawcett. *Data Science for Business*. Sebastopol, CA: O'Reilly Media, Inc., 2013.

Pulver, David L. *GURPS Robots*. Austin, TX: Steve Jackson Games, 1995.

Pulver, David L. *Transhuman Space*, second edition. Austin, TX: Steve Jackson Games, 2002.

Puranam, Phanish, Marlo Raveendran, and Thorbjørn Knudsen. "Organization Design: The Epistemic Interdependence Perspective." *Academy of Management Review* 37, no. 3 (July 1, 2012): 419-40.

Ramirez, S., X. Liu, P.-A. Lin, J. Suh, M. Pignatelli, R.L. Redondo, T.J. Ryan, and S. Tonegawa. "Creating a False Memory in the Hippocampus." *Science* 341, no. 6144 (2013): 387-91.

Rankin, T. Murray. "Business Secrets Across International Borders: One Aspect of the Transborder Data Flow Debate." *Canadian Business Law Journal* 10 (1985): 213.

Rao, Umesh Hodeghatta, and Umesha Nayak. *The InfoSec Handbook*. New York: Apress, 2014.

Regalado, Antonio. "Engineering the perfect baby." *MIT Technology Review* 118, no. 3 (2015): 27-33.

Rijntjes, Tom. "On the Viability of Automated Entrepreneurship." Presentation of Media Technology MSc program graduation project, Universiteit Leiden, Leiden, January 22, 2016.

Riva, Giuseppe, and Carlo Galimberti. *Towards CyberPsychology: Mind, Cognition, and Society in the Internet Age*, edited by Giuseppe Riva and Carlo Galimberti. Amsterdam: IOS Press, 2001.

Robertson, Brian J. *Holacracy: The New Management System for a Rapidly Changing World*. New York: Henry Holt, 2015.

Robinett, W. "The consequences of fully understanding the brain." In *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science*, edited by M.C. Roco and W.S. Bainbridge, pp. 166-70. National Science Foundation, 2002.

Roden, David. *Posthuman Life: Philosophy at the Edge of the Human*. Abingdon: Routledge, 2014.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Rohloff, Michael. "Framework and Reference for Architecture Design." In *AMCIS 2008 Proceedings*, 2008. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.231.8261&rep=rep1&type=pdf.

Rosenau, Pauline Marie. *Post-Modernism and the Social Sciences: Insights, Inroads, and Intrusions*. Princeton, NJ: Princeton University Press, 1992.

Rowlands, Mark. *Can Animals Be Moral?* Oxford: Oxford University Press, 2012.

Rubin, Charles T. "What Is the Good of Transhumanism?" In *Medical Enhancement and Posthumanity*, edited by Bert Gordijn and Ruth Chadwick, pp. 137-56. The International Library of Ethics, Law and Technology 2. Springer Netherlands, 2008.

Rutten, W. L. C., T. G. Ruardij, E. Marani, and B. H. Roelofsen. "Neural Networks on Chemically Patterned Electrode Arrays: Towards a Cultured Probe." In *Operative Neuromodulation*, edited by Damianos E. Sakas and Brian A. Simpson, pp. 547-54. Acta Neurochirurgica Supplements 97/2. Springer Vienna, 2007.

Sachs, Jeffrey D., Seth G. Benzell, and Guillermo LaGarda. "Robots: Curse or Blessing? A Basic Framework." NBER Working Papers Series, Working Paper 21091. Cambridge, MA: National Bureau of Economic Research, 2015.

Salvini, Pericle, Cecilia Laschi, and Paolo Dario. "From robotic tele-operation to telepresence through natural interfaces." In *The First IEEE/RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics, 2006. BioRob 2006*, pp. 408-13. IEEE, 2006.

Samani, Hooman Aghaebrahimi, and Adrian David Cheok. "From human-robot relationship to robot-based leadership." In *2011 4th International Conference on Human System Interactions (HSI),* pp. 178-81. IEEE, 2011.

Samani, Hooman Aghaebrahimi, Jeffrey Tzu Kwan Valino Koh, Elham Saadatian, and Doros Polydorou. "Towards Robotics Leadership: An Analysis of Leadership Characteristics and the Roles Robots Will Inherit in Future Human Society." In *Intelligent Information and Database Systems*, edited by Jeng-Shyang Pan, Shyi-Ming Chen, and Ngoc Thanh Nguyen, pp. 158-65. Lecture Notes in Computer Science 7197. Springer Berlin Heidelberg, 2012.

Samuelson, William F., and Stephen G. Marks. *Managerial Economics*, seventh edition. Hoboken: John Wiley & Sons, 2012.

Sanbonmatsu, John. *The Postmodern Prince: Critical Theory, Left Strategy, and the Making of a New Political Subject*. New York: Monthly Review Press, 2004.

Sandberg, Anders. "Ethics of brain emulations." *Journal of Experimental & Theoretical Artificial Intelligence* 26, no. 3 (2014): 439-57.

Sandor, Christian, Martin Fuchs, Alvaro Cassinelli, Hao Li, Richard Newcombe, Goshiro Yamamoto, and Steven Feiner. "Breaking the Barriers to True Augmented Reality." arXiv preprint, *arXiv:1512.05471 [cs.HC]*, December 17, 2015. http://arxiv.org/abs/1512.05471. Accessed January 25, 2016.

Sarkar, Prabhat Rainjan. "Neohumanism Is the Ultimate Shelter (Discourse 11)." In *The Liberation of Intellect: Neohumanism*. Kolkata: Ananda Marga Publications, 1982.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Sasse, Martina Angela, Sacha Brostoff, and Dirk Weirich. "Transforming the 'weakest link'—a human/computer interaction approach to usable and effective security." *BT technology journal* 19, no. 3 (2001): 122-31.

Schacht, Kurt N. "The Buzz about Robo-Advisers." *CFA Institute Magazine* 26, no. 5 (2015): 49.

Schmeink, Lars. "Dystopia, Alternate History and the Posthuman in Bioshock." *Current Objectives of Postgraduate American Studies* 10 (2009). http://copas.uni-regensburg.de/article/viewArticle/113/137. Accessed May 19, 2016.

Scopino, G. "Do Automated Trading Systems Dream of Manipulating the Price of Futures Contracts? Policing Markets for Improper Trading Practices by Algorithmic Robots." *Florida Law Review,* vol. 67 (2015): 221-93.

Shadowrun: Core Rulebook 5, edited by Kevin Killiany and Katherine Monasterio. Lake Stevens, Washington: Catalyst Game Labs, 2013.

Sharf, S. "Can Robo-Advisors Survive A Bear Market?" *Forbes,* January 28, 2015. http://www.forbes.com/sites/samanthasharf/2015/01/28/can-robo-advisors-survive-a-bear-market/. Accessed April 29, 2015.

Sharkey, Noel. "Killing Made Easy: From Joysticks to Politics." In *Robot Ethics: The Ethical and Social Implications of Robotics*, edited by Patrick Lin, Keith Abney, and George A. Bekey, pp. 111-28. Cambridge, MA: The MIT Press, 2012.

Shaw-Garlock, Glenda. "Loving machines: Theorizing human and sociable-technology interaction." In *Human-Robot Personal Relationships*, edited by Maarten H. Lamers and Fons J. Verbeek, pp. 1-10. Springer Berlin Heidelberg, 2011.

Short, Sue. *Cyborg Cinema and Contemporary Subjectivity*. New York: Palgrave Macmillan, 2005.

Siewert, Charles. "Consciousness and Intentionality." *The Stanford Encyclopedia of Philosophy* (Fall 2011 Edition), edited by Edward N. Zalta. http://plato.stanford.edu/archives/fall2011/entries/consciousness-intentionality/.

Siewiorek, Daniel, and Robert Swarz. *Reliable Computer Systems: Design and Evaluation*, second edition. Burlington: Digital Press, 1992.

Singh, Kshitij Kumar. *Biotechnology and Intellectual Property Rights: Legal and Social Implications*. Springer, 2014.

Singularity Hypotheses, edited by A.H. Eden, J.H. Moor, J.H. Søraker, and E. Steinhart. The Frontiers Collection. Berlin/Heidelberg: Springer, 2012.

Sixth World Almanac, edited by Jason Hardy and John Helfers. The Topps Company, 2010.

Sloman, Aaron. "Some Requirements for Human-like Robots: Why the recent over-emphasis on embodiment has held up progress." In *Creating brain-like intelligence*, pp. 248-77. Springer Berlin Heidelberg, 2009.

Smith, Andrew James. *Genetic Gold: The Post-human Homunculus in Alchemical and Visual Texts*. M.A. Thesis. University of Pretoria, 2009.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Snider, Greg S. "Cortical Computing with Memristive Nanodevices." *SciDAC Review* 10 (2008): 58-65.

Social Robots and the Future of Social Relations, edited by Johanna Seibt, Raul Hakli, and Marco Nørskov. Amsterdam: IOS Press, 2014.

Social Robots from a Human Perspective, edited by Jane Vincent, Sakari Taipale, Bartolomeo Sapio, Giuseppe Lugano, and Leopoldina Fortunati. Springer International Publishing, 2015.

Social Robots: Boundaries, Potential, Challenges, edited by Marco Nørskov. Farnham: Ashgate Publishing, 2016.

Sorbello, R., A. Chella, and R. C. Arkin. "Metaphor of Politics: A Mechanism of Coalition Formation." *vectors* 1, no. 40 (2004): 20.

Soussou, Walid V., and Theodore W. Berger. "Cognitive and Emotional Neuroprostheses." In *Brain-Computer Interfaces*, pp. 109-23. Springer Netherlands, 2008.

Sparrow, R. "Killer Robots." *Journal of Applied Philosophy* vol. 24, no. 1 (2007): 62-77.

Spohrer, Jim. "NBICS (Nano-Bio-Info-Cogno-Socio) Convergence to Improve Human Performance: Opportunities and Challenges." In *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science*, edited by M.C. Roco and W.S. Bainbridge, pp. 101-17. Arlington, Virginia: National Science Foundation, 2002.

Stahl, B. C. "Responsible Computers? A Case for Ascribing Quasi-Responsibility to Computers Independent of Personhood or Agency." *Ethics and Information Technology* 8, no. 4 (2006): 205-13.

Stieglitz, Thomas. "Restoration of Neurological Functions by Neuroprosthetic Technologies: Future Prospects and Trends towards Micro-, Nano-, and Biohybrid Systems." In *Operative Neuromodulation*, edited by Damianos E. Sakas, Brian A. Simpson, and Elliot S. Krames, 435-42. Acta Neurochirurgica Supplements 97/1. Springer Vienna, 2007.

Stiles, Noelle R.B., and Shinsuke Shimojo. "Sensory substitution: A new perceptual experience." In *The Oxford Handbook of Perceptual Organization*, edited by Johan Wagemans. Oxford: Oxford University Press, 2016.

Surbrook, Michael. *Kazei-5*. Hero Games, 1998.

Teilhard de Chardin, Pierre. *Le Phénomène humain.* Paris: Seuil, 1955.

Thacker, Eugene. "Data made flesh: biotechnology and the discourse of the posthuman." *Cultural Critique* 53, no. 1 (2003): 72-97.

Thacker, Eugene. "What Is Biomedia?" *Configurations* 11 (2003): 47-79.

Theoretical Foundations of Artificial General Intelligence, edited by Pei Wang and Ben Goertzel. Paris: Atlantis Press, 2012.

Thompson, David A. "The Man-Robot Interface in Automated Assembly." In *Monitoring Behavior and Supervisory Control*, edited by Thomas B. Sheridan and Gunnar Johannsen, pp. 385-91. NATO Conference Series 1. New York: Plenum Press, 1976.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E.,
Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Thomsen, Mads Rosendahl. *The New Human in Literature: Posthuman Visions of Change in Body, Mind and Society after 1900*. London: Bloomsbury, 2013.

Thornton, Stephanie. *Understanding Human Development: Biological, Social and Psychological Processes from Conception to Adult Life*. New York: Palgrave Macmillan, 2008.

Tomas, David. "Feedback and Cybernetics: Reimaging the Body in the Age of the Cyborg." In *Cyberspace, Cyberbodies, Cyberpunk: Cultures of Technological Embodiment*, edited by Mike Featherstone and Roger Burrows, pp. 21-43. London: SAGE Publications, 1995.

Truong, Jean-Michel. *Totalement inhumaine*. Paris: Seuil, 2001.

The Turing Test: The Elusive Standard of Artificial Intelligence, edited by James H. Moor. Studies in Cognitive Systems 30. Springer Netherlands, 2003.

Turner, John N. "The right to privacy in a computronic age." In *Position Papers of the Conference on Computers, Privacy and Freedom of Information.* Kingston: Queen's University, 1970.

Turner, Matt. "The computers have won, and Wall Street will never be the same." *Business Insider*, May 10, 2016. http://www.businessinsider.com/quant-funds-dominate-hedge-fund-rich-list-2016-5. Accessed June 5, 2016.

Tweedale, Jeffrey W., and Lakhmi C. Jain. "Agent Oriented Programming." In *Embedded Automation in Human-Agent Environment*, pp. 105-24. Adaptation, Learning, and Optimization 10. Springer Berlin Heidelberg, 2011.

Ullrich, Günter. *Automated Guided Vehicle Systems: A Primer with Practical Applications*, translated by Paul A. Kachur. Springer Berlin Heidelberg, 2015.

Ummat, Ajay, Atul Dubey, and Constantinos Mavroidis. "Bionanorobotics: A Field Inspired by Nature." In *Biomimetics: Biologically Inspired Technologies*, edited by Yoseph Bar-Cohen, pp. 201-26. Boca Raton: CRC Press, 2005.

Van den Berg, Bibi. "Pieces of Me: On Identity and Information and Communications Technology Implants." In *Human ICT Implants: Technical, Legal and Ethical Considerations*, edited by Mark N. Gasson, Eleni Kosta, and Diana M. Bowman, pp. 159-73. Information Technology and Law Series 23. T. M. C. Asser Press, 2012.

Van Oost, Ellen, and Darren Reed. "Towards a Sociological Understanding of Robots as Companions." In *Human-Robot Personal Relationships*, edited by Maarten H. Lamers and Fons J. Verbeek, pp. 11-18. Springer Berlin Heidelberg, 2011.

Vänni, Kimmo J., and Annina K. Korpela. "Role of Social Robotics in Supporting Employees and Advancing Productivity." In *Social Robotics*, pp. 674-83. Springer International Publishing, 2015.

Versace, Massimiliano, and Ben Chandler. "The Brain of a New Machine." *IEEE spectrum* 47, no. 12 (2010): 30-37.

Viirre, Erik, Françoise Baylis, and Jocelyn Downie. "Promises and perils of cognitive performance tools: A dialogue." *Technology* 11, no. 1 (2008): 9-25.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Vinciarelli, A., M. Pantic, D. Heylen, C. Pelachaud, I. Poggi, F. D'Errico, and M. Schröder. "Bridging the Gap between Social Animal and Unsocial Machine: A survey of Social Signal Processing." *IEEE Transactions on Affective Computing* 3:1 (January-March 2012): 69-87.

Vogiatzis, D., Dimitrios Galanis, V. Karkaletsis, Ion Androutsopoulos, and C. D. Spyropoulos. "A conversant robotic guide to art collections." In *Proceedings of the 2nd Workshop on Language Technology for Cultural Heritage Data, Language Resources and Evaluation Conference, Marrakech, Morocco*, pp. 55-60. 2008.

Wallach, Wendell, and Colin Allen. *Moral machines: Teaching robots right from wrong*. Oxford University Press, 2008.

Warkentin, Merrill, Vijayan Sugumaran, and Robert Sainsbury. "The Role of Intelligent Agents and Data Mining in Electronic Partnership Management." *Expert Systems with Applications* 39, no. 18 (2012): 13277-88.

Warwick, K. "The Cyborg Revolution." *Nanoethics* 8 (2014): 263-73.

Warwick, K., and M. Gasson. "Implantable Computing." In *Digital Human Modeling*, edited by Y. Cai, pp. 1-16. Lecture Notes in Computer Science 4650. Berlin/Heidelberg: Springer, 2008.

Wasay, A., M. Athanassoulis, and S. Idreos. "Queriosity: Automated Data Exploration." In *2015 IEEE International Congress on Big Data (BigData Congress)*, pp. 716-19, 2015. doi:10.1109/BigDataCongress.2015.116.

Wearable Robots: Biomechatronic Exoskeletons, edited by Jose L. Pons. Chichester: John Wiley & Sons, 2008.

Whitby, Blay. "Do You Want a Robot Lover? The Ethics of Caring Technologies." In *Robot Ethics: The Ethical and Social Implications of Robotics*, edited by Patrick Lin, Keith Abney, and George A. Bekey, pp. 233-48. Cambridge, MA: The MIT Press, 2012.

Wiener, Norbert. *Cybernetics: Or Control and Communication in the Animal and the Machine*, second edition. Cambridge, MA: The MIT Press, 1961. [Quid Pro ebook edition for Kindle, 2015.]

Wilson, Margaret. "Six views of embodied cognition." *Psychonomic bulletin & review* 9, no. 4 (2002): 625-36.

Wiltshire, Travis J., Dustin C. Smith, and Joseph R. Keebler. "Cybernetic Teams: Towards the Implementation of Team Heuristics in HRI." In *Virtual Augmented and Mixed Reality. Designing and Developing Augmented and Virtual Environments*, edited by Randall Shumaker, pp. 321-30. Lecture Notes in Computer Science 8021. Springer Berlin Heidelberg, 2013.

Witt, Ronald. "Francesco Petrarca and the Parameters of Historical Research." *Religions* 3, no. 3 (2012): 699-709.

Wolf-Meyer, Matthew. "Fantasies of extremes: Sports, war and the science of sleep." *BioSocieties* 4, no. 2 (2009): 257-71.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).

Wolin, Richard. "Foucault the Neohumanist?" *The Chronicle of Higher Education.* The Chronicle Review (September 1, 2006).

Xu, J., B. Archimede, and A. Letouzey. "A Distributed Multi-Agent Framework for Shared Resources Scheduling." *Information Control Problems in Manufacturing* 14, no. 1 (2012): 775-80.

Yagi, Akihiro. "Engineering psychophysiology in Japan." In *Engineering psychophysiology: Issues and applications*, edited by Richard W. Backs and Wolfram Boucsein, pp. 361-68. Mahwah, NJ: Lawrence Erlbaum Associates, Publishers, 2000.

Yampolskiy, Roman V. "The Universe of Minds." arXiv preprint, *arXiv:1410.0369 [cs.AI]*, October 1, 2014. http://arxiv.org/abs/1410.0369. Accessed January 25, 2016.

Yampolskiy, Roman V. *Artificial Superintelligence: A Futuristic Approach*. Boca Raton: CRC Press, 2015.

Yampolskiy, Roman V., and Joshua Fox. "Artificial General Intelligence and the Human Mental Model." In *Singularity Hypotheses*, edited by Amnon H. Eden, James H. Moor, Johnny H. Søraker, and Eric Steinhart, pp. 129-45. The Frontiers Collection. Springer Berlin Heidelberg, 2012.

Yonck, Richard. "Toward a standard metric of machine intelligence." *World Future Review* 4, no. 2 (2012): 61-70.

"The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence," excerpted from Gladden, Matthew E., Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization. Indianapolis: Defragmenter Media, 2016, pp. 133-201. ISBN 978-1-944373-00-9 (print) and 978-1-944373-01-6 (ebook).