"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

Chapter Six

The Deepening Fusion of Human Personnel and Electronic Information Systems:

Implications of Neuroprosthetic Augmentation for Enterprise Architecture[1]

Abstract. When designing target architectures for organizations, the discipline of enterprise architecture has historically relied a set of assumptions regarding the physical, cognitive, and social capacities of the human beings serving as organizational members. In this text we explore the fact that for those organizations that intentionally deploy posthumanizing neuroprosthetic technologies among their personnel, such traditional assumptions no longer hold true: the use of advanced neuroprostheses intensifies the ongoing structural, systemic, and procedural fusion of human personnel and electronic information systems in a way that provides workers with new capacities and limitations and transforms the roles available to them.

Such use of neuroprostheses has the potential to affect an organization's workers in three main areas. First, the use of neuroprostheses may affect workers' physical form, as reflected in the physical components of their bodies, the role of design in their physical form, their length of tenure as workers, the developmental cycles that they experience, their spatial extension and locality, the permanence of their physical substrates, and the nature of their personal identity. Second, neuroprostheses may affect the information processing and cognition of neurocybernetically augmented workers, as manifested in their degree of sapience, autonomy, and volitionality; their forms of knowledge acquisition; their locus of information processing and data storage; their emotionality and cognitive biases; and their fidelity of data storage, predictability of behavior, and information security vulnerabilities. Third, the deployment of neuroprostheses can affect workers' social engagement, as reflected in their degree of sociality;

[1] This text draws heavily on "The Posthuman Management Matrix: Understanding the Organizational Impact of Radical Biotechnological Convergence" in Gladden, *Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization* (2016), pp. 133-201, which explores a broader range of phenomena (such as the emerging organizational significance of social robotics and artificial life) than is considered here.

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

relationship to organizational culture; economic relationship with their employers; and rights, responsibilities, and legal status.

While ethical, legal, economic, and functional factors will prevent most organizations from deploying advanced neuroprostheses among their personnel for the foreseeable future, a select number of specialized organizations (such as military departments) are already working to develop such technologies and implement them among their personnel. The enterprise architectures of such organizations will be forced to evolve to accommodate the new realities of human-computer integration brought about by the posthumanizing neuroprosthetic technologies described in this text.

Introduction

The discipline of enterprise architecture (EA) seeks to generate alignment between an organization's electronic information systems, human resources, business processes, workplace culture, mission and strategy, and external environment in order to increase the organization's agility and enhance its ability to manage complexity, resolve internal conflicts, and adapt proactively to environmental change.[2] As part of its work of designing and implementing target architectures for organizations, enterprise architecture has historically made a series of implicit assumptions regarding the physical, cognitive, and social capacities of the human beings that serve as organizational members. These assumptions presume that an organization's human workers differ fundamentally in their nature from the electronic information systems that the organization employs. For example, EA has always been able to take for granted the fact that:[3]

- The physical components of human workers are biological, while those of computers are electronic.
- The basic physical capacities of human workers are inherited from their parents through randomized biological processes, while those of electronic computers can be purposefully designed by engineers.

[2] For definitions of enterprise architecture, see Gammelgård et al., "An IT Management Assessment Framework: Evaluating Enterprise Architecture Scenarios" (2007); Cane & McCarthy, "Measuring the Impact of Enterprise Architecture" (2007); and Land et al., "Positioning Enterprise Architecture" (2009). Regarding EA's goals and benefits, see Rohloff, "Framework and Reference for Architecture Design" (2008); Boucharas et al., "The Contribution of Enterprise Architecture to the Achievement of Organizational Goals: A Review of the Evidence" (2010); Højsgaard, "Market-Driven Enterprise Architecture" (2011); Rohloff (2008); Hoogervorst, "Enterprise Architecture: Enabling Integration, Agility and Change" (2004); Buckl et al., "A Situated Approach to Enterprise Architecture Management" (2010); and Caetano et al., "A Role-Based Enterprise Architecture Framework" (2009).

[3] For more about these assumptions, see Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

- The means of 'upgrading' the capacities of human workers include techniques such as education, experience, physical exercise, and training, while electronic information systems are upgraded through techniques such as software updates, file downloads, the installation of additional memory chips, or the attachment of new peripherals.
- The locus of information processing and data storage for a human worker is the biological neural network of his or her brain, while for computers it includes components like CPUs, RAM chips, and non-volatile digital media.
- The main information security threats that directly target human workers include social engineering techniques, while those directly targeting computers include electronic hacking and malware.

Under these traditional assumptions, it would be grossly inappropriate, for example, for an enterprise architecture plan to assign a human worker the role of serving as a database that is responsible for accurately storing and manipulating the client records of millions of customers – a task that a computerized system could perform with ease. It would be similarly incoherent to attempt to design digital software applications that could be 'run' on the biological computing platforms comprising workers' minds and brains.

However, a broad range of posthumanizing neuroprosthetic technologies is now being developed that has the potential to reshape the sensory, cognitive, and motor capacities of human agents by integrating artificial computing devices directly into the neural circuitry of their natural biological organisms. For those organizations that choose to deploy such technologies among their personnel, traditional assumptions regarding the capacities and limitations of human workers – and their relationship to organizational information systems – will become increasingly obsolete. Such use of advanced neuroprostheses for purposes of human enhancement intensifies the ongoing structural, systemic, and procedural fusion of human personnel with electronic information systems in a way that transforms the roles and activities that enterprise architectures can assign to human workers.

Scope and Limitations of Our Analysis

In this text, we will explore the fact that posthumanizing neuroprostheses have the potential to affect workers especially in the three areas of their *physical form*, *information processing and cognition*, and *social engagement*. First, neuroprostheses may affect workers' physical form, as manifested in their bodies' physical components, the extent to which their physical form is the subject of organizational design, their length of tenure as workers, the developmental and operational cycles that they experience, their spatial extension and locality, the permanence of their physical substrates, and the nature of their personal identity. Second, neuroprostheses can affect the intellects of neuroprosthetically augmented workers, as reflected in their degree of sapience, autonomy, and volitionality; their means of knowledge acquisition; their locus of information processing and data storage; their emotionality and cognitive biases; and their fidelity of data storage, predictability of behavior, and information security vulnerabilities. Finally, the deployment of neuroprostheses may affect workers' social engagement, as manifested in their degree of sociality; relationship to organizational culture; economic relationship with their employers; and rights, responsibilities, and legal status. An overview of these impacts is presented in Figure 1.

Figure 1: Impacts of Posthumanizing Neuroprostheses on Human Personnel That Are Relevant for Enterprise Architecture

Physical form

- Physical components of neuroprosthetically augmented workers
- Neuroprosthetic augmentation as a facilitator of design
- Upgradeability of physical structures
- Length of tenure
- Developmental and operational cycles
- Spatial extension and locality
- Permanence of physical substrates
- Personal identity

Information processing and cognition

- Sapience
- Autonomy
- Volitionality
- Knowledge acquisition
- Locus of information processing and data storage
- Emotionality
- Cognitive biases
- Fidelity of data storage provided by memory systems
- Predictability of behavior
- Information security vulnerabilities

Social engagement

- Degree of sociality
- Relationship to organizational culture
- Economic and financial relationship with employer
- Rights, responsibilities, and legal status of human agents

It is not claimed or expected that the types of neuroprosthetic augmentation discussed here will soon be purposefully exploited by a broad range of organizations: indeed, a complex array of ethical, legal, political, economic, and functional factors will prevent most organizations from deploying advanced neuroprostheses among their personnel for the foreseeable future. However, there already exists a small and specialized array of organizations (largely comprising military agencies and departments) that are actively seeking to develop and deploy among their personnel 'posthumanizing' neuroprosthetic technologies that grant some sensory, cognitive, or motor capacities which exceed or differ from those that are possessed by natural, unaug-

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

mented human beings and which can assist their human hosts in the performance of particular organizational roles.[4] The immediate relevance of this text is primarily for such organizations, which will be forced to transform their enterprise architecture practices and plans in order to address the deepening human-computer hybridization brought about by posthumanizing neuroprosthetic technologies.[5] The kinds of impacts discussed in this text will not be so strongly felt by organizations that include members who have personally acquired neuroprostheses (e.g., cochlear implants or deep brain stimulation devices) for therapeutic medical purposes, nor by organizations that deploy among their personnel neuroprostheses for therapeutic medical purposes (e.g., robotic prosthetic limbs provided by a military department to soldiers who have been injured during a tour of duty), insofar as the neuroprosthetic devices that are present within the workplace in such circumstances do not become integrated into an organization's institutional information systems and enterprise architecture.[6]

Finally, the discussion of particular neuroprosthetic technologies in this text should not be taken to imply that their intentional deployment and exploitation by organizations would be ethical or – necessarily – even legal. This text does not explicitly analyze the ethical or legal propriety of the organizational use of neuroprosthetic technologies; instead it investigates at a functional level the ways in which the use of posthumanizing neuroprostheses impacts the organizational structures, systems, and processes that are the objects of enterprise architecture. The problem of defining licit and illicit organ-

[4] For potential military use of neurotechnologies for human enhancement, see, e.g., Schermer, "The Mind and the Machine. On the Conceptual and Moral Implications of Brain-Machine Interaction" (2009); Brunner & Schalk, "Brain-Computer Interaction" (2009); Coker, "Biotechnology and War: The New Challenge" (2004); Graham, "Imagining Urban Warfare: Urbanization and U.S. Military Technoscience" (2008), p. 36; Krishnan, "Enhanced Warfighters as Private Military Contractors" (2015); Falconer, "Defense Research Agency Seeks to Create Supersoldiers" (2003); Moreno, "DARPA On Your Mind" (2004); Clancy, "At Military's Behest, Darpa Uses Neuroscience to Harness Brain Power" (2006); and Kourany, "Human Enhancement: Making the Debate More Productive" (2013), pp. 992-93.

[5] Similarly, our investigation of these issues may be of value to those policymakers, ethicists, futurists, and others who seek to regulate, evaluate, or anticipate the behavior of such organizations.

[6] Even in these cases, some changes to an organization's enterprise architecture might be required – e.g., to address the unique information security vulnerabilities possessed by neuroprostheses. Various enterprise architecture frameworks identify information security either as a discrete component within an architectural domain (see Hoogervorst (2004)) or as an element that underlies all architectural building blocks (see Rohloff (2008)). For the unique InfoSec challenges presented by neuroprosthetic devices, see Denning et al., "Neurosecurity: Security and Privacy for Neural Devices" (2009), and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015).

izational uses of such technologies – or determining whether such technologies are, in themselves, ethically or legally permissible – is one that requires thoughtful expert analysis. It is hoped that the questions explored in this text may support such analysis by robustly envisioning the ways in which organizations may attempt to exploit emerging neuroprosthetic technologies for strategic, operational, or tactical ends by incorporating them into their core enterprise architectures.

Impacts of Posthumanizing Neuroprosthetic Augmentation on Organizational Personnel

A neuroprosthesis can be defined as *an artificial device that is integrated into the neural circuitry of a human being*.[7] Historically, such devices have been used primarily for therapeutic medical purposes, to restore some capacity that is absent to due illness or injury; however, a growing range of neuroprostheses are being developed for purposes of human enhancement, to provide their human hosts with sensory, cognitive, or motor capacities that exceed what is possible for unmodified human beings.[8] Such 'posthumanizing' neuroprostheses help create a world in which natural biological human beings are no longer the only intelligent social agents who create meaning through their imagination, industry, and interaction; instead, artificial entities (such as social robots) and hybrid biological-electronic entities (such as neurocybernetically augmented human beings) will also contribute to the creation of meaning within the world's digital-physical ecosystems.[9]

In the following sections, we consider in detail the ways in which the deployment of posthumanizing neuroprostheses among an organization's human personnel may reshape such workers' physical form, information processing and cognition, and social engagement in ways that affect the organization's practice of enterprise architecture.

[7] See Lebedev, "Brain-Machine Interfaces: An Overview" (2014), and Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016), for more regarding the definition of a 'neuroprosthesis' and the basic division of such devices into sensory, cognitive, and motor neuroprostheses.

[8] For the distinction between 'traditional' neuroprostheses that are utilized for therapeutic medical purposes to restore some capacity that is absent to due illness or injury and more 'futuristic' neuroprostheses that are designed for purposes of human enhancement, see Gladden, *Sapient Circuits and Digitalized Flesh* (2016); Merkel et al., "Central Neural Prostheses" (2007); Gasson, "Human ICT Implants: From Restorative Applications to Human Enhancement" (2008); Gasson, "ICT implants" (2008); and McGee, "Bioelectronics and Implanted Devices" (2008).

[9] For a discussion of processes of posthumanization and the role of advanced neuroprostheses in processes of technologization and posthumanization, see, e.g., Herbrechter, *Posthumanism: A Critical Analysis* (2013); Ferrando, "Posthumanism, Transhumanism, Antihumanism, Metahumanism, and New Materialisms: Differences and Relations" (2013); and Gladden, *Sapient Circuits and Digitalized Flesh* (2016).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

Physical Form

By deploying posthumanizing neuroprostheses, organizations expand the range of physical forms and capacities available to their human personnel – such as through the use of artificial limbs or sensory organs possessing non-biological materials and non-human shapes and dynamics. Below we consider a number of physical aspects of human agents and the ways in which the assumptions regarding the nature of those characteristics that have traditionally been relied upon by enterprise architects will no longer hold for organizations utilizing posthumanizing neuroprostheses.

Physical Components of Neuroprosthetically Augmented Workers

- **Historical assumption:** Human beings are composed of biological components that significantly limit the roles they can fill.
- **Impact of neuroprosthetic augmentation:** Human beings may incorporate electronic components that expand or further constrain the organizational roles they can fill.

The nature of the human body's physical composition means that the roles which an enterprise architecture plan assigns to a human agent have traditionally differed greatly from those that can be assigned to computerized systems. For example, a conventional computer is typically composed of mass-produced electronic components that are durable and readily repairable and whose behavior can easily be analyzed and predicted.[10] Such components are often able to operate in conditions of extreme heat, cold, pressure, or radiation in which biological material would not be able to survive and function. Electronic components can also be designed to incorporate significant functional redundancy, making them more reliable in the face of adverse operating conditions. Moreover, they can be manufactured either with large physical dimensions and structural reinforcement (potentially increasing durability and ease of inspection and repair) or in miniaturized form (thereby increasing mobility and undectability), 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.

On the other hand, enterprise architecture has traditionally been required to assume that the physical forms of human workers fall within a narrow

[10] 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).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

range of possibilities and can be modified only to a very slight degree. Historically, the body of a human being is 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. Thus it is not possible 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.

For organizations that deploy posthumanizing neuroprostheses, it is anticipated that the bodies of human agents will increasingly include electronic components in the form of artificial limbs and exoskeletons, artificial sense organs, memory implants, and other kinds of neuroprosthetic devices.[11] Such changes to the physical components or capacities of a human body may dramatically expand or further constrain the roles that human agents can be assigned within an enterprise architecture plan.

The Role of Neuroprosthetic Augmentation as a Facilitator of Design

- **Historical assumption:** The basic physical characteristics of human workers result largely from randomized processes of biological inheritance.
- **Impact of neuroprosthetic augmentation:** The basic physical characteristics of human workers may be intentionally engineered using neurotechnologies.

Enterprise architecture is, in many ways, a discipline based around effective *design* – of structures, processes, and systems. A major focus of EA's work involves designing the ways in which human workers interact with computerized systems, the ways in which computers interact with one another, and the internal components and dynamics of individual computing devices. The nature of electronic computers facilitates these kinds of design efforts: historically, almost all aspects of a conventional computer's physical form and basic functionality have been intentionally planned and constructed by human scientists, engineers, manufacturers, and programmers in order to enable the computer to successfully perform particular tasks.[12]

In that regard, the nature of computers differs greatly from that of contemporary human workers. Traditionally, enterprise architecture has been constrained by the fact that the basic physical form of a particular human

[11] See Gasson (2008); Gasson et al., "Human ICT Implants: From Invasive to Pervasive" (2012); McGee (2008); Merkel et al. (2007); and Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016).

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

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

being is determined largely by genotypic factors resulting from the randomized inheritance of genetic material from the individual's biological parents; the individual's particular biological components cannot be intentionally engineered.[13]

However, for those organizations that deploy posthumanizing neuroprostheses, human beings' basic physical and cognitive capacities will no longer simply be inherited in a randomized fashion from their biological parents but will increasingly be subject to explicit design by institutions or individual human engineers through the use of neuroprosthetics and related technologies such as genetic engineering and nanorobotics that support it.[14] Besides the major moral and legal questions arising from such possibilities, there are also operational issues that confront organizations whose workforce includes human agents who have been engineered in such ways. For example, the implantation of identical mass-produced neuroprostheses into a large number of workers may create synthetic cognitive or physical characteristics that are shared broadly across that population and which reduce its genotypic diversity; such homogenization 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). On the other hand, such standardization of biological structures and cognitive processes may make it easier for effective information security mechanisms (e.g., ones designed to detect and counteract social engineering) to be developed and deployed across the population.[15]

[13] Although, for example, factors such as diet, exercise and training, environmental conditions, pharmaceuticals, 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.

[14] For different perspectives on such possibilities, see, e.g., De Melo-Martín, "Genetically Modified Organisms (GMOs): Human Beings" (2015); Regalado, "Engineering the perfect baby" (2015); Lilley, *Transhumanism and Society: The Social Debate over Human Enhancement* (2013); Nouvel, "A Scale and a Paradigmatic Framework for Human Enhancement" (2015); Section B ("Enhancement") in *The Future of Bioethics: International Dialogues*, edited by Akabayashi (2014); Mehlman, *Transhumanist Dreams and Dystopian Nightmares: The Promise and Peril of Genetic Engineering* (2012); and Bostrom, "Human Genetic Enhancements: A Transhumanist Perspective" (2012).

[15] 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 Special Publication 800-53, Revision 4: Security and Privacy Controls for Federal Information Systems and Organizations* (2013), p. F-204.

Upgradeability of the Physical Structure of Human Agents

- **Historical assumption:** The capacities of human workers can be upgraded through education, training, exercise, and experience.
- **Impact of neuroprosthetic augmentation:** The capacities of human workers can potentially be upgraded by swapping electronic components or installing software updates.

Historically, enterprise architects have assumed that 'upgrading' the physical capacities and performance of human workers can only be achieved through age-old means such as education, training, physical exercise, and firsthand experience.[16] This differs from the situation of contemporary computers, which often can easily be upgraded through the addition or replacement of physical components that 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 RAM, or an increase in the size of a computer's available space for the non-volatile long-term storage of data.[17]

Human workers have not demonstrated the sort of radical physical 'upgradeability' that might involve, for example, the implantation of additional memory capacity into the brain, an alteration of the fundamental rate of electrochemical communication between neurons to increase the brain's 'processing speed,' the addition of new sensory capacities (such as infrared vision), or the addition of new or different limbs or effectors (such as wheels instead of legs).[18]

However, for organizations that deploy posthumanizing neuroprostheses, the growing use of such technologies – perhaps supported, for example, by technologies for somatic cell gene therapy – may increasingly allow the physical components and cognitive capacities of human agents to be upgraded

[16] 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. See Gasson (2012).

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

[18] For the possibility of neuroprosthetically facilitated alteration to the physical form and structure of the human body, see, e.g., Warwick, "The Cyborg Revolution" (2014), and Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics: Video Games as Tools for Posthuman 'Body Schema (Re)Engineering'" (2015).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

and expanded even after the agents have reached a stage of physical and cognitive maturity.[19] In effect, the use of implantable neuroprostheses that possess swappable or modifiable components and whose behavior can be modified through software updates[20] may allow a human being's physical capacities and cognitive processes to be regularly updated and 'upgraded' in a way similar to that of desktop computers or other electronic hardware/software platforms.

Length of Tenure of Human Agents

- **Historical assumption:** A human worker can only fill an organizational role for a limited period of time, due to factors that are largely beyond the control of enterprise architecture.
- **Impact of neuroprosthetic augmentation:** A human worker (or functionally equivalent artificial replica of that worker) may be able to fill an organizational role on an extended or even permanent basis.

The period of service (or 'lifespan') of an organization's computerized information systems is conceptualized differently from the period of service (or 'employee tenure') of the organization's human workers. 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 computers' operator needs them 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

[19] 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).

[20] Note that it is by no means certain that all or even most posthumanizing neuroprostheses will possess such modifiability; a neuroprostheses which, for example, takes the form of a physical artificial neural network implanted deep within the brain may have no physical components that can be replaced after implantation and no conventional executable 'software' governing its behavior that can be remotely updated. For the possibility of neuroprosthetic devices that involve biological components or store information in biological or biomimetic neural networks, see Merkel et al. (2007); Rutten et al., "Neural Networks on Chemically Patterned Electrode Arrays: Towards a Cultured Probe" (2007); and Stieglitz, "Restoration of Neurological Functions by Neuroprosthetic Technologies: Future Prospects and Trends towards Micro-, Nano-, and Biohybrid Systems" (2007).

Conversely, in some cases, periodic physical upgrades to an implanted neuroprosthesis may be required in order to maintain the device's functional capabilities and ensure the health and information security of its human host. See *Postmarket Management of Cybersecurity in Medical Devices: Draft Guidance for Industry and Food and Drug Administration Staff* (2016) and Gladden, "Information Security Concerns as a Catalyst for the Development of Implantable Cognitive Neuroprostheses" (2016).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

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.[21]

On the other hand, an EA plan needs to account for the fact that the identity of the human agent filling a particular role within an organization is expected to change periodically, due to circumstances beyond an enterprise architect's control – such as the relatively short average period of time during which human workers serve as members of an organization.[22] Some such changes result from workers joining or leaving an organization through processes of hiring, resignation, or termination. Other such changes may unfortunately sometimes occur as a result of the death or disability of an individual worker. While the biological lifespan of a particular human worker 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.[23] A human being who has exceeded his or her maximum lifespan is no longer alive – that is, he or she will have expired – and cannot be repaired and revived by technological means to make him or her available once again for future organizational use. Instead, he or she will be replaced by another human agent who may possess significantly different characteristics. The possibility of such eventualities is especially significant, for example, for some types of military organizations in which human workers operate in highly dangerous circumstances where the loss of life is not a rare occurrence, especially during periods of intense activity such as combat operations. In these cases, enterprise architects have historically needed to account for periodic non-continuous changes in the characteristics of the human agent filling a particular role.

However, a human agent whose neurons and neural functioning can be maintained, supplemented, or superseded by neuroprosthetic technologies after they have deteriorated or become damaged – or which can be protected from undergoing damage or deterioration in the first place – could potentially

[21] 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).

[22] For example, in the United States "the median number of years that wage and salary workers had been with their current employer was 4.2 years in January 2016, down from 4.6 years in January 2014." See "Employee Tenure Summary" (2016).

[23] 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).

experience an extended or even indefinite lifespan, although such engineering might result in detrimental side-effects that render such lifespan extension highly undesirable. Neuroprosthetic technologies may also facilitate practices such as 'mind uploading' or the creation of virtual, artificially intelligent replicas of particular human workers, thereby allowing such quasi-human agents to fill an organizational role permanently and without undergoing processes of development or decline that alter their basic capacities over time.[24]

Developmental and Operational Cycles

- **Historical assumption:** A human worker's capacities and performance characteristics are continually evolving in ways that may or may not be desirable and which are largely beyond the control of enterprise architecture.
- **Impact of neuroprosthetic augmentation:** The natural developmental cycles of human workers might potentially be slowed, accelerated, or bypassed through the use of neuroprostheses. Human workers might be able to function for extended periods of time without demonstrating undesired changes in their capacities or performance.

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 operator's knowledge or permission;[25] 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 peripheral device that has been added can be disconnected. This allows a computer to be restored to a previous physical and functional state.

Expectations for the operational cycles of human workers have always been of a different sort. Traditionally, enterprise architecture has assumed

[24] Transhumanist perspectives on mind uploading are presented, e.g., in Moravec, *Mind Children: The Future of Robot and Human Intelligence* (1990), and Koene (2012). For more critical perspectives on problems inherent in visions of technologically facilitated life extension or the replacement of a human being's entire original biological body via mind uploading, see Proudfoot, "Software Immortals: Science or Faith?" (2012); Pearce, "The Biointelligence Explosion" (2012); and Hanson, "If uploads come first: The crack of a future dawn" (1994).

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

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

that a role within an organization cannot be filled permanently by a single human agent possessing a stable and unchanging set of capacities; the unique characteristics of the human agent filling a role are transformed over time. This is due largely to the fact that the physical structure and capacities of a human being do not remain unaltered 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.[26] From the perspective of enterprise architecture, human beings are only capable of serving as workers during particular phases of this developmental cycle, and the unique strengths and weaknesses displayed by human workers vary as they move through that cycle.

An organization that deploys posthuman neuroprostheses might conceivably exploit such technologies to speed the natural biological processes that contribute to physical growth and cognitive development or to slow or block processes of physical and cognitive decline. Scholars also envision the possibility of neuroprostheses being used to allow human beings to instantly acquire new knowledge or skills through the implantation of memory chips or the downloading of information into one's mind; if indeed feasible, this could allow human cognitive capacities to be maintained or enhanced in a way that bypasses typical human processes of cognitive development and learning.[27]

Spatial Extension and Locality

- **Historical assumption:** A human worker occupies a single physical location at any given moment.
- **Impact of neuroprosthetic augmentation:** A human worker may virtually inhabit multiple environments simultaneously and interact with them using a human-like or non-human-like body.

The systems defined by an enterprise architecture are not abstract immaterial entities; they are embodied within concrete physical objects. The size, form, and mobility of such objects and the nature of their physical interfaces largely determine the kinds of organizational processes that can be executed by such systems.

[26] 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).

[27] Such possibilities are discussed, e.g., in Spohrer, "NBICS (Nano-Bio-Info-Cogno-Socio) Convergence to Improve Human Performance: Opportunities and Challenges" (2002); McGee (2008); and Warwick (2014), p. 267. Experimental technologies being tested in mice that allow the manipulation of memories are presented in Ramirez et al., "Creating a False Memory in the Hippocampus" (2013).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

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.[28] 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 even a significant degradation in functionality for – the computerized entity as a whole.

On the other hand, enterprise architecture has traditionally presumed that a particular human being occupies or comprises a particular physical biological body. Because that body is unitary – consisting of a single spatially compact unit – a human being is able to inhabit only one space at a given time. While the use of technologies such as telephony, email, instant messaging, and videoconferencing allows a human worker to engage with colleagues around the world and to be 'present' in distant locations in a limited and metaphorical sense, a human being cannot, for example, literally be physically present in multiple cities simultaneously.[29]

When posthumanizing neuroprostheses are deployed, the situation becomes more complex. The use of sensorimotor neuroprosthetic devices and virtual reality technologies may effectively allow a human agent to 'inhabit' a location different from that in which his or her physical body is being housed. The inhabited environment may be either a virtual representation of some distant real-world location or a fabricated virtual environment (such as that presented within a massively multiplayer online roleplaying game, or

[28] 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, "From Killer Machines to Doctrines and Swarms, or Why Ethics of Military Robotics Is Not (Necessarily) About Robots" (2011). Regarding the development of computerized entities with physically disjoint bodies, see Gladden, "The Diffuse Intelligent Other: An Ontology of Nonlocalizable Robots as Moral and Legal Actors" (2016).

[29] The extent to which telepresence in remote locations is cognitively and physically possible for human beings is discussed, e.g., in Salvini et al., "From robotic tele-operation to tele-presence through natural interfaces" (2006).

MMORPG) that does not depict a real-world location. Within such virtualized environments, a human agent might occupy multiple bodies that are potentially of a radically nonhuman nature.[30] He or she might also exist in a way that is extremely 'multilocal' by being present in and interacting with many different environments simultaneously.[31]

Permanence of Physical Substrates

- **Historical assumption:** All of the actions of a single human agent are performed by and associated with a single physical substrate – that human being's biological body.
- **Impact of neuroprosthetic augmentation:** Some forms of human (or quasi-human) agency may exist and act independent of a fixed biological substrate.

The physical substrates (i.e., biological bodies) within which human agents subsist and perform their work within the world have a much different nature than those electronic and electromechanical physical substrates within which computers perform their computation and other information-processing activities.

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, user files, 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.[32] This means that the computational substrate or 'body' of a given computerized system can be replaced with a new body without causing functional changes in the system's memory or behavior.[33] In the case of comput-

[30] Regarding the potential for and ramifications of long-term immersion in virtual reality environments, see, e.g., Bainbridge, *The Virtual Future* (2011); Heim, *The Metaphysics of Virtual Reality* (1993); 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 implantable systems for augmented or virtual reality, see Sandor et al., "Breaking the Barriers to True Augmented Reality" (2015), pp. 5-6. The potential role of neuroprosthetics in granting human beings virtual bodies of a radically nonhuman nature is analyzed in Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics" (2015).

[31] For a discussion of multilocality, see Gladden, "The Diffuse Intelligent Other" (2016).

[32] An overview of various aspects of information storage in electronic systems is presented in *Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments*, edited by Gnanasundaram & Shrivastava (2012).

[33] Such abilities are exploited to allow organizations to implement 'failover capacity' by which a

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

erized 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.[34]

On the other hand, enterprise architecture has traditionally assumed that the unique set of skills, knowledge, and memories possessed by a particular human worker are associated with and contained in the physical body of that worker. 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.[35] 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. The dissolution of that body entails the end of that human being's ability to act as an agent within the environment.

The deployment of posthumanizing neuroprostheses challenges these assumptions. Ontologically and ethically controversial practices such as the development of artificial neurons to replace natural biological neurons and various approaches to 'mind uploading' (many of which are facilitated by advanced neuroprosthetics) might someday 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 if terms such as 'agent' and 'agency' are understood in a transhumanist fashion whose coherency and validity are deeply disputed.[36] Similarly, the use of neuroprosthetically mediated cyber-

standby duplicate information system can automatically be brought online to take over the work of a primary information system that has suffered a major fault. See, e.g., *NIST SP 800-53* (2013), p. F-231.

[34] 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).

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

[36] Critical posthumanism offers a vigorous critique of such transhumanist and 'techno-idealist' notions of human agency; for a presentation of critical posthumanist positions, see Hayles, *How*

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

netic 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 the fact that a continual addition and loss of biological substrates may 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.[37]

Identity of Human Agents

- **Historical assumption:** Roles can be assigned to and decisions and actions attributed to individual human beings.
- **Impact of neuroprosthetic augmentation:** Roles may be filled by new types of collective human entities; actions may be unattributable to particular human beings.

In a practical sense, enterprise architecture (and the systems and processes that it administers) must often robustly track and account for the 'identity' of desktop computers, smartphones, and other devices operating within an organization's digital-physical ecosystem; various mechanisms are employed for such purposes. However, on a deeper philosophical level it is unclear wherein the unique identity of a conventional computer or computerized entity subsists, or even if such an identity exists.[38] 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.

The identity of human workers has traditionally been easier to track. Enterprise architecture has historically incorporated the assumption that a human being's body creates (or at least, plays a necessary role in creating) a

We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics (1999); Herbrechter (2013), pp. 94, 185-86; and Gladden, *Sapient Circuits and Digitalized Flesh* (2016).

[37] For classification systems for potential types of 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 critical perspectives on the possibility of hive minds, see, e.g., Bendle, "Teleportation, cyborgs and the posthuman ideology" (2002), and Heylighen, "The Global Brain as a New Utopia" (2002).

[38] From the perspective of information security, techniques for device attestation are utilized to identify and authenticate a device on the basis of its configuration and unique operating state; see *NIST SP 800-53* (2013), p. F-94. Such techniques are not infallible, however.

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

single identity for the individual that persists over time. The fact that each human body is unique and is identifiable to other human beings (e.g., that such a body is not invisible, microscopic, or 'flickering' in and out of existence from moment to moment) means that it is possible to associate some human action with the particular human being who performed it and to assign roles and functions within an organization to a particular identifiable human worker.[39]

For organizations that have deployed posthumanizing neuroprosthetic technologies, 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. For example, a single networked effector (such as a robotic armature, remote-controlled drone, or LED display screen[40]) might simultaneously belong to the bodies of multiple human agents who jointly or alternately control its behavior, and a single artificial eye might in effect simultaneously belong to the bodies of multiple human users whose minds each receive a live stream of the visual input received by the device. 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. Actions may instead be determined by and attributable to the system as a whole.[41]

Information Processing and Cognition

Posthumanizing neuroprosthetics has the potential to dramatically reshape the range of information-processing mechanisms and behaviors available to human workers – and thus the forms and degree of cognition that they are capable of displaying. Below we consider a number of intellectual characteristics of human agents and the ways in which the historical assumptions regarding the nature of those characteristics that have been relied upon by

[39] For a discussion of philosophical issues relating to the type of personal identity possessed by human beings, see Olson, "Personal Identity" (2015); see also Friedenberg, *Artificial Psychology: The Quest for What It Means to Be Human* (2008), p. 250.

[40] Regarding the existing or potential use of neuroprostheses to control external systems as diverse as desktop computers, vehicles, smart buildings, 3D printers and other manufacturing systems, domestic robots, microphones and speakers, cameras and displays, or game systems, see McGee (2008), pp. 213-15; Warwick (2014), p. 266; Gladden, "Cybershells, Shapeshifting, and Neuroprosthetics" (2015); and Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016).

[41] For the possibility of neuroprosthetically facilitated networks that make collective decisions, see the previously noted sources relating to hive minds as well as Gladden, "Utopias and Dystopias as Cybernetic Information Systems: Envisioning the Posthuman Neuropolity" (2015). A more general discussion of collectively conscious networks and a "post-internet sentient network" is found in Callaghan, "Micro-Futures" (2014).

enterprise architects will become increasingly outdated within organizations utilizing posthumanizing neuroprostheses.

Sapience

- **Historical assumption:** Human workers possess a self-awareness that allows them to recognize, analyze, and respond to ambiguous or unexpected circumstances.
- **Impact of neuroprosthetic augmentation:** Human workers' self-awareness may be impaired or destroyed in ways that are not necessarily detectable to external observers.

Enterprise architecture has historically presumed that a conventional computer does not possess sapient self-awareness or a subjective conscious experience of reality,[42] while a human worker does. The typical human worker 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 such as a coma.[43] 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.[44] This sort of self-awareness allows human workers to, for example, recognize (and recognize the need to *respond* to) changing environmental conditions, emergencies, and other exigencies that fall outside of whatever narrow task instructions they might have received from their organizational supervisors.

This situation may be altered through the deployment of posthumanizing neuroprostheses within an organization. By interfering with or altering the biological mechanisms that support consciousness and self-awareness within the brain, neuroprostheses could deprive particular human agents of sapi-

[42] For 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.

[43] Regarding the ways in which consciousness is (perhaps only temporarily) impaired during a coma, see, e.g., *Coma Science: Clinical and Ethical Implications*, edited by Laureys et al. (2009), and *Comas and Disorders of Consciousness*, edited by Schnakers & Laureys (2012).

[44] Such issues are discussed, e.g., in 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).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

ence, even if those agents outwardly appear to remain fully functional as human beings; for example, a human agent might retain his or her 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.[45]

Autonomy

- **Historical assumption:** Human workers display a high degree of intellectual and physical autonomy that allows them to act without direct supervision or support.
- **Impact of neuroprosthetic augmentation:** The degree of intellectual and physical autonomy possessed by human workers may be artificially constrained or expanded by means of neuroprostheses.

The forms of autonomy displayed by human workers and computerized systems have historically differed greatly. 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."[46] 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).[47] Although some contemporary computerized systems can be understood as being autonomous with regard to fulfilling their intended purpose – in that they can receive sensory input, process information, make decisions, 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.[48]

[45] The potential for such misuse of neuroprosthetic technologies is discussed in Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 98, 220.

[46] Bekey, *Autonomous Robots: From Biological Inspiration to Implementation and Control* (2005), p. 1.

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

[48] The degree of autonomy of different types of robots is analyzed in Gladden, "Managerial Robotics: A Model of Sociality and Autonomy for Robots Managing Human Beings and Machines" (2014).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

On the other hand, enterprise architects have historically been able to count on the fact that human workers possess a high degree of autonomy that is reflected at both the intellectual and physical levels. Through the regular action of his or her mind and body, a typical human being is able to secure energy sources and information from the external environment, set goals, make decisions, perform actions, and even (to a limited extent) repair damage that might occur to himself or herself during the course of daily activities, all without direct external guidance or control by other human agents.

Some kinds of posthumanizing neuroprostheses that may someday be deployed within organizations might 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 neuroprosthetically facilitated 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 their individual members. Neuroprosthetic augmentation that renders human agents dependent on their employer or other organizations for ongoing hardware or software upgrades or medical support would similarly reduce the autonomy of those agents at the social and economic levels.[49] 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.

Volitionality

- **Historical assumption:** Human workers possess a conscience that allows them to self-correct unethical or otherwise problematic workplace behaviors and autonomously optimize their performance.
- **Impact of neuroprosthetic augmentation:** Neuroprostheses might artificially impair, enhance, or otherwise alter users' exercise of conscience with regard to work-related or other activities.

Enterprise architecture has historically incorporated certain assumptions regarding human workers' degree of volitionality, which relates to an entity's

[49] For the possibility that neuroprosthetic devices will render their human hosts biologically, psychologically, financially, or socially dependent on the organizations that provide or maintain such technologies, see Koops & Leenes, "Cheating with Implants: Implications of the Hidden Information Advantage of Bionic Ears and Eyes" (2012), p. 125; McGee (2008), p. 213; and Gladden, "Neural Implants as Gateways to Digital-Physical Ecosystems and Posthuman Socioeconomic Interaction" (2016).

ability to self-reflexively shape the intentions that guide its actions.[50] An entity is *nonvolitional* when 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,[51] 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.[52]

Many conventional computerized devices are nonvolitional; however, a growing number of contemporary computerized devices – including a wide variety of robots used in commercial contexts – are volitional. 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.[53]

Typical adult human beings, meanwhile, can be described as *metavolitional:* they possess what scholars have referred to as 'second-order volitions,' or intentions about intentions.[54] 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. Such metavolitionality allows human workers, for example, to avoid unethical behaviors or to decide that they wish to change their workplace behaviors in order to improve their performance or achieve particular goals.

Within organizations deploying posthumanizing neuroprostheses, workers' possession and manifestation of such cognitive dynamics may be altered. Researchers have already observed ways in which certain kinds of neuroprosthetic devices can affect their human host's capacity to possess desires,

[50] For a discussion of the volitionality of agents, see Calverley, "Imagining a non-biological machine as a legal person" (2008), pp. 529-35, and Gladden, "The Diffuse Intelligent Other" (2016).

[51] 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.

[52] See Calverley (2008), p. 529.

[53] The nature and capacities of such social robots are discussed, e.g., in Breazeal, "Toward sociable robots" (2003); Gockley et al., "Designing Robots for Long-Term Social Interaction" (2005); 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 Nørskov (2016).

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

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

knowledge, and belief;[55] 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. Conversely, neuroprostheses that enhance such basic cognitive capacities may strengthen their users' manifestations of conscience. An artificially intelligent neuroprosthesis might also serve as an external 'supplemental conscience' that detects its user's plan to perform some unethical or undesirable action, alerts the user to that fact, and attempts to persuade the user to adopt a different course of action.[56] 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 those agents participating in such systems and reduce them to a state that is less than metavolitional; each agent may no longer nurture its own individual conscience but may instead help to form (and be guided by) the conscience of the multi-agent system as a whole.

Knowledge Acquisition

- **Historical assumption:** Human workers acquire new knowledge through processes of learning, study, and experience that require an extended period of effort.
- **Impact of neuroprosthetic augmentation:** It may be possible to instantaneously 'program' workers with new knowledge or for workers themselves to download new skill-sets or acquire any desired knowledge instantly online through a mere act of will.

Many approaches exist for rapidly expanding the quantity of declarative and procedural knowledge available to a computerized information system. For example, a conventional computer may have software programs and data files copied onto its storage media, thereby instantaneously gaining new capacities and the possession of new information.[57] Alternatively, a traditional

[55] Regarding the possibility of developing neuroprostheses 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); and McGee (2008), p. 217.

[56] The notion that some types of future neuroprostheses might in effect be capable of serving as advisors or counselors for their human hosts is raised in Gladden, "Neural Implants as Gateways" (2016), and Koops & Leenes (2012), p. 119.

[57] For a discussion of the ways in which the electronic components of traditional computers carry

computer may be directly programmed or configured by a human operator. It does not 'learn' through experience, nor does it undergo a long-term formative process of education in order to acquire new knowledge or information.[58]

On the other hand, enterprise architecture has historically presumed that a very different range of practices is available for instilling new knowledge in the minds of human workers. 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.[59] 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, nor can he or she be directly 'programmed' by a software developer.

Within organizations that have deployed posthumanizing neuroprostheses, workers may have additional means of acquiring new knowledge. 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.[60] Moreover, through the use of their neuroprostheses, human workers may be able to either literally download new skillsets and knowledge into their minds or to effectively gain the same ability by

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 outcomes 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, *Biological Computation* (2011).

[58] This description of conventional computers does not apply, for example, to artificially intelligent systems that process information by means of an artificial neural network that learns over time. For a discussion of such systems, see Friedenberg (2008), pp. 55-72.

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

[60] Regarding the 'programming' of human beings through the intentional, targeted modification of their memories and knowledge, see, e.g., McGee (2008); Pearce (2012); and Spohrer (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).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

being able to instantly seek out and access any online information through a mere act of will.[61]

Locus of Information Processing and Data Storage

- **Historical assumption:** A human worker stores and processes data within the neural network of his or her biological brain.
- **Impact of neuroprosthetic augmentation:** A human worker's storage and processing of data may be performed by his or her brain's neural network in a manner enhanced or controlled by a neuroprosthesis or may be 'outsourced' to external systems by means of a neuroprosthesis.

Historically, enterprise architecture has assumed that the storage of data and processing of information performed by the mind of a human worker take place within structures whose nature differs greatly from that of the organizational desktop computers, smartphones, web servers, and other electronic information systems that EA typically deals with. A conventional contemporary computer is based on a Von Neumann architecture comprising memory, I/O devices, and one or more central processing units connected by a communication bus.[62] 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.[63]

While 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[64]), the core of a human being's information processing is performed by the neural network comprising interneurons in the individual's brain, which also stores memories in the form of engrams.[65]

---

[61] For the potential ability of neuroprostheses to provide their users with hands-free, thought-controlled access to online reference texts, see Gladden, "Information Security Concerns as a Catalyst for the Development of Implantable Cognitive Neuroprostheses" (2016).

[62] See Dumas (2006) and Friedenberg (2008), pp. 27-29.

[63] See Friedenberg (2008), pp. 30-32. The development of memristors represents one effort to design artificial computerized systems that process information using a physical network similar to that of the human brain, rather than a conventional CPU-based computing architecture. See, e.g., *Advances in Neuromorphic Memristor Science and Applications*, edited by Kozma et al. (2012), and Lohn et al., "Memristors as Synapses in Artificial Neural Networks: Biomimicry Beyond Weight Change" (2014).

[64] Such processes of transduction are discussed in Smith, *Biology of Sensory Systems* (2008), and Møller, *Sensory Systems: Anatomy and Physiology* (2014).

[65] For an overview of such processes, see, e.g., *Cognitive Psychology*, edited by Braisby & Gellatly (2012), pp. 229-65; Schwartz, *Memory: Foundations and Applications* (2014); Radvansky, *Human*

The brain constitutes an immensely large and sophisticated neural network, and despite ongoing 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.[66] The mechanisms by which this biological 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 as easy to analyze or control as the dynamics of a CPU-based computer running an executable software program.

An organization's deployment of posthumanizing neuroprostheses may significantly alter the structures within which human workers' data storage and information processing take place. Such activities 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.[67] While some forms of neuroprostheses (such as those comprising physical artificial neurons that are wholly integrated with the brain's own neural network) may potentially be able to participate directly in the storage of data in the form of engrams within their host's own brain,[68] other neuroprostheses may store memories in the form of exograms whose mnemonic contents are 'recalled' by being supplied to their user's brain through sensory organs or pathways; while such neuroprostheses might be physically located within the brain, from a functional perspective they would

Memory (2016); and Dudai, "The Neurobiology of Consolidations, Or, How Stable Is the Engram?" (2004).

[66] For example, there is still ongoing debate about the extent to which the brain's structures and processes for storing long-term memories display holographic characteristics, the role of interneuronal communication involving structures other than classical axodendritic synapses, and the role, if any, that quantum-level effects may play in neural dynamics. For a discussion of such issues, see, e.g., Longuet-Higgins, "Holographic Model of Temporal Recall" (1968); Pribram, "Prolegomenon for a Holonomic Brain Theory" (1990); Mulhauser, "On the end of a quantum mechanical romance" (1995); Andrew, "The decade of the brain: further thoughts" (1997); Pribram & Meade, "Conscious Awareness: Processing in the Synaptodendritic Web – The Correlation of Neuron Density with Brain Size" (1999); and Hameroff & Penrose, "Consciousness in the universe: A review of the 'Orch OR' theory" (2014).

[67] See, e.g., Merkel (2007); Warwick & Gasson, "Implantable Computing" (2008); and Soussou & Berger (2008).

[68] Regarding the possibility of neuroprosthetic devices that store information in the form of engrams or which participate in the brain's processes relating to its own natural biological storage of engrams, see Warwick (2014), p. 267; and Gladden, "Neural Implants as Gateways" (2016). For questions about the extent to which technological devices that directly store memories can ever become a part of the human mind, see Clowes, "The Cognitive Integration of E-Memory" (2013).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

display many characteristics of external memory-storage technologies like books, films, or online databases.[69]

Emotionality

- **Historical assumption:** The emotions of human workers play an important role in the success or failure of an organization's enterprise architecture plans but cannot easily be directly shaped by the organization.
- **Impact of neuroprosthetic augmentation:** Organizations may modulate the emotional behaviors of human workers by means of neuroprostheses in order to generate emotions that advance (or impede) the performance of work-related tasks.

Enterprise architecture must take into account the psychological, social, political, and cultural factors at work within an organization that may impede or support the design and implementation of a new enterprise architecture. Emotional factors constitute one piece of that picture.[70]

Although the rise of social robotics has begun to change the situation, it has generally been safely assumed that the kinds of conventional computerized systems administered through enterprise architecture plans do not in themselves manifest or detect emotions: 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.[71] 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 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

[69] The potential of neuroprostheses to store information in the form of exograms is raised, e.g., in Koops & Leenes (2012), pp. 115, 120, 126; McGee (2008), p. 217; and Gladden, "Neural Implants as Gateways" (2016).

[70] The impact of psychological, social, and cultural factors on the implementation of enterprise architecture plans is discussed, e.g., in Magoulas et al., "Alignment in Enterprise Architecture" (2012); Weiss & Winter, "Development of Measurement Items for the Institutionalization of Enterprise Architecture Management in Organizations" (2012); Stephan Aier, "The Role of Organizational Culture for Grounding, Management, Guidance and Effectiveness of Enterprise Architecture Principles" (2014); and Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016).

[71] For the distinction between the relatively straightforward circumstance of computers possessing some superficial display of '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.

and instructions contained within the software code and is not qualitatively determined by the computer's particular physical state.

On the other hand, the successful implementation of an EA plan requires enterprise architects to understand and account for the complex emotional needs and behaviors of human workers. Within the contemporary workplace, it is assumed that 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.[72] Indeed, some researchers suggest that the possession of emotions is necessary in order for an artificially intelligent embodied entity to demonstrate general intelligence at a human-like level.[73]

By deploying posthumanizing neuroprosthetics within its human workforce, an organization can alter and potentially control the emotional dynamics expressed by its workers. It is already known, for example, that neuroprosthetic technologies such as those for deep brain stimulation (DBS) can significantly affect the emotional behaviors of their users.[74] The use of advanced neuroprosthetic devices that can heighten, suppress, or otherwise modify the emotions of human beings may potentially 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.[75] Many serious ethical, legal, and operational questions would arise from efforts to develop and implement such technologies within a workforce. Just as an organization might employ neuroprostheses in an attempt to modulate the emotions of its own workers in a way that advances the implementation of its EA plan, attention must also be paid to the possibility that a specialized organization such as a military de-

[72] See, e.g., the influential discussion of emotional intelligence in Goleman, "What Makes a Leader?" (2004).

[73] See Friedenberg (2008), pp. 32-33, 179-200, 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).

[74] See Daigle, "Manipulating the Mind: The Ethics of Cognitive Enhancement" (2010), pp. 35-36; Kraemer (2011); Bublitz, "If Man' s True Palace Is His Mind, What Is Its Adequate Protection? On a Right to Mental Self-Determination and Limits of Interventions into Other Minds" (2011), p. 116; and Van den Berg (2012).

[75] For the possibility of developing emotional neuroprostheses of varying types, see Soussou & Berger (2008); McGee (2008), p. 217; Hatfield et al. (2009); Kraemer (2011); Fairclough, "Physiological Computing: Interfacing with the Human Nervous System" (2010); and Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016).

partment (or a corporation's competitive intelligence unit engaged in unlawful commercial espionage or sabotage against a rival) might attempt to manipulate the neuroprosthetic devices deployed within an adversarial organization in order to generate within its workforce emotional behaviors that disrupt that organization's normal functioning and undermine the implementation of its own EA plan.[76]

Cognitive Biases

- **Historical assumption:** A wide range of ubiquitous cognitive biases cause human workers to behave irrationally and undermine the successful implementation of EA plans.
- **Impact of neuroprosthetic augmentation:** Cognitive biases can be monitored and prevented and their effects minimized; workers can be trained to avoid them by means of neuroprostheses.

Enterprise architects have historically had to account for the fact that the human beings responsible for successfully implementing an EA plan regularly demonstrate thought and behaviors that are irrational and counterproductive as a result of cognitive biases. The conventional computing devices addressed by EA plans do not display such phenomena: 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.[77] However, 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.[78] While in earlier epochs such biases may have created an evolutionary advantage that aided the survival of those human beings who possessed them (e.g., by providing them with heuristics that allowed them to quickly identify and avoid potential sources of danger), these

[76] For concerns that neuroprostheses and related neurotechnologies might be used for attempted mind control (potentially by unauthorized adversaries who have gained access to such devices), see, e.g., Kohno et al., "Security and Privacy for Neural Devices" (2009); Bublitz (2011), pp. 97-98; Talan, "DARPA: On the Hunt for Neuroprosthetics to Enhance Memory" (2014), pp. 9-10; Krishnan, "From Psyops to Neurowar: What Are the Dangers?" (2014), p. 10; and Gladden, "Neuromarketing Applications of Neuroprosthetic Devices: An Assessment of Neural Implants' Capacities for Gathering Data and Influencing Behavior" (2016).

[77] It is possible, however, for a computer to indirectly demonstrate human-like cognitive biases if the human programmers who designed the 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).

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

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

biases cause contemporary human workers to frequently 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; however, they cannot be wholly eradicated.

A future organization could potentially deploy posthumanizing neuroprostheses that are designed to detect and directly modify or interrupt patterns of thought that reflect cognitive biases. Alternatively, a neuroprosthesis could be used to monitor the cognitive processes of a human being and alert that individual whenever the device detects that he or she is about to undertake a decision or action that is flawed or misguided because the person'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.[79]

Fidelity of Data Storage Provided by Memory Systems

- **Historical assumption:** Human workers store data within their minds in the form of memories that are impressionistic and compressed and which degrade significantly over time.
- **Impact of neuroprosthetic augmentation:** Neuroprostheses may provide human workers with the ability to store data in the form of memories that are of perfect fidelity, do not degrade over time, and can be copied to or from external systems.

Enterprise architecture has historically relied on the fact that conventional contemporary 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.[80] However, data stored within the minds of human workers is historically of a much

[79] A neuroprosthetic device may potentially be able to serve as a business advisor or personal coach to its human host – for example, by researching available options and providing information through an augmented reality display to support decision-making or by warning its host when he or she is about to make a flawed decision that is influenced by some human cognitive bias. See, e.g., Gladden, "Neural Implants as Gateways" (2016); Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016); Koops & Leenes (2012), p. 119; and Calverley (2008).

[80] Regarding the creation, storage, and transfer of digital data files by computers and other electronic devices, see, e.g., Austerberry, *Digital Asset Management* (2013); Coughlin, *Digital Storage in Consumer Electronics: The Essential Guide* (2008); and *Information Storage and Management* (2012).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

different qualitative sort. 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.[81] Not only are memories stored in a manner which from the beginning is compressed, impressionistic, and imperfect, but memories also degrade over time.[82] Historically, the only way to transfer memories stored within one human mind to another human mind has been for the memories to be described and expressed through some social mechanism such as oral speech or written text.

By deploying posthumanizing neuroprostheses among its personnel, an organization may be able to significantly alter the quality of information stored within its workers' minds. The use of neuroprosthetic devices 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 potentially be copied to or from external systems.[83] The processes for copying large and complex arrays of stored data from a human brain to an external system may differ radically in their nature and complexity from the processes of copying such data from an external system to a human brain, if either type of process is theoretically possible at all.[84]

[81] The concept that some people possess the power of perfect 'photographic memory' exists as a notion within popular culture; however, the existence of such a phenomenon in natural human beings has yet to be scientifically demonstrated. Cases of eidetic memory (understood in the technical definition of the term) and hyperthymesia (or 'superior autobiographical memory') have indeed been documented; however, these phenomena involve a shorter duration of retention or a more constrained subject matter than supposed cases of 'photographic memory.' Regarding hyperthymesia, see Taylor, "Hyperthymesia" (2013); regarding cases of supposed eidetic memory, see Moxon, *Memory* (2000), p. 15, and Schwartz (2014), p. 172.

[82] See Dudai (2004).

[83] 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. (2013). Regarding the use of neuroprosthetic systems to store memories as effectively lossless digital exograms, see Merkel et al. (2007); Robinett, "The consequences of fully understanding the brain" (2002); McGee (2008), p. 217; and Gladden, "Neural Implants as Gateways" (2016).

[84] Regarding the difficulty of analyzing, interpreting, or purposefully editing the contents of information stored in complex biological or biomimetic neural networks, see, e.g., Friedenberg (2008), pp. 31-32, and Gladden, "Information Security Concerns as a Catalyst for the Development of Implantable Cognitive Neuroprostheses" (2016). If holographic models of memory storage in the brain are correct, the challenge of manipulating memories in such ways would be even greater; for discussion of such models, see, e.g., Longuet-Higgins (1968) and Pribram (1990).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

Predictability of Behavior

- **Historical assumption:** The future behavior of an individual human being within a workplace setting is difficult to predict with much certainty.
- **Impact of neuroprosthetic augmentation:** Neuroprostheses may make it easier to predict the future behavior of human workers – either by gathering more detailed data about a worker's cognitive functioning or by making it possible to influence or control behavior by means of such devices.

Enterprise architects have traditionally presumed that the degree of predictability demonstrated by human workers differs significantly from that manifested by electronic information systems. 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 a human being.[85] While 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 – it is not possible to predict with full accuracy and certainty the future actions of a particular human being.

An organization may be able to modify such traditional characteristics by deploying neuroprosthetic devices among its human workers. Such devices may allow the organization to gather detailed information about the cognitive structures and processes of individual human workers that was previously inaccessible.[86] Moreover, human agents whose actions are influenced

[85] 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.

[86] For the possibility that neuroprostheses might be used for (potentially illegal and unethical) surveillance of their hosts' cognitive activity and behaviors, see, e.g., Bonaci et al., "App Stores for the Brain" (2015), p. 35; Brunner et al., "Current Trends in Hardware and Software for Brain-Computer Interfaces (BCIs)" (2011); Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015); and Gladden, "Neuromarketing Applications of Neuroprosthetic Devices: An Assessment of Neural Implants' Capacities for Gathering Data and Influencing Behavior" (2016).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

or controlled by neuroprostheses 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.[87] Serious ethical and legal questions are raised by the potential use of such technologies.

Information Security Vulnerabilities

- **Historical assumption:** Human workers are not subject to the forms of electronic hacking and malware to which computerized information systems are vulnerable.
- **Impact of neuroprosthetic augmentation:** Possession of a neuroprosthesis may render a human worker vulnerable to electronic hacking and computer viruses and worms; at the same time, neuroprostheses may provide organizational operatives with new tools for detecting and counteracting InfoSec threats.

Maintaining information security is a major concern of enterprise architecture. For example, Hoogervorst identifies information security as a component of the element of 'quality' within the information architecture domain.[88] Other EA frameworks, such as the Siemens Framework described by Rohloff, do not explicitly identify information security as a domain or building block – not because it is unimportant, but because it underlies *all* of the architectural building blocks.[89]

An organization's 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 and can even result in unauthorized parties gaining complete control over the system.[90] Human workers have traditionally been vulnerable to efforts at compromising information security

[87] Regarding the testing and debugging of neuroprosthetic devices see Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015), pp. 176-77, 181-84, 213-14, 242-43, 262. Regarding potential efforts to employ neuroprostheses to 'debug' the behaviors of their human hosts, see Gladden, *Sapient Circuits and Digitalized Flesh* (2016), p. 181.

[88] See Hoogervorst (2004), p. 15.

[89] Rohloff (2008), p. 5.

[90] For an overview of such possibilities (as well as related preventative practices and responses), see Rao & Nayak, *The InfoSec Handbook* (2014). Information security's fundamental 'CIA Triad' of ensuring the confidentiality, integrity, and availability of information is discussed in Parker, "Toward a New Framework for Information Security" (2002); "Security Risk Assessment Framework for Medical Devices" (2014); *NIST Special Publication 1800-1b: Securing Electronic Health Records on Mobile Devices: Approach, Architecture, and Security Characteristics* (2016), p. 9; and Gladden, "Information Security Concerns as a Catalyst for the Development of Implantable Cognitive Neuroprostheses" (2016).

involving social engineering, blackmail, or other psychologically based attacks.[91] However, because human workers possess biological rather than electronic components and their minds conduct information processing through the use of an internal biological neural network rather than executable software programs stored in binary digital form, it has historically not been possible for adversaries to 'hack into' a human worker's neural information-processing system in order to access, steal, or manipulate the individual's thoughts or memories using the same electronic hacking techniques that are applied to electronic computers and computer-based systems.

The deployment of posthumanizing neuroprostheses within an organization may significantly alter the organization's ability to maintain information security. Human beings who possess electronic neuroprosthetic devices will be vulnerable to computer viruses, worms, and electronic hacking attacks similar to those that target conventional computers and may become reliant on some of the same security measures used to protect typical electronic computers (such as antivirus software and electronic firewalls).[92] 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. At the same time, neuroprostheses may provide organizational operatives with powerful new tools for identifying InfoSec vulnerabilities within an organization and detecting and counteracting information security threats.[93]

[91] Social engineering attacks are discussed in Sasse et al., "Transforming the 'weakest link' – human/computer interaction approach to usable and effective security" (2001), and Rao & Nayak (2014), pp. 307-23.

[92] Such issues are raised, e.g., in *ISO 27799:2016, Health informatics – Information security management in health using ISO/IEC 27002* (2016); Luber et al., "Non-invasive brain stimulation in the detection of deception: Scientific challenges and ethical consequences" (2009); Denning et al. (2009); "Cybersecurity for Medical Devices and Hospital Networks: FDA Safety Communication" (2013), p. 1; Bonaci et al. (2015), p. 35; Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015); and Gladden, "Neuromarketing Applications of Neuroprosthetic Devices" (2016). 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, and Gladden, *Sapient Circuits and Digitalized Flesh* (2016), p. 182.

[93] The potential use of neuroprostheses by specialized human agents such as military personnel or cybersecurity operatives in order to advance the information security of their employers (and human society more broadly) is discussed in Falconer (2003); Moreno (2004); Clancy (2006); Schermer (2009); Brunner & Schalk (2009); "Bridging the Bio-Electronic Divide" (2016); Szoldra, "The government's top scientists have a plan to make military cyborgs" (2016); and Gladden, "Information Security Concerns as a Catalyst for the Development of Implantable Cognitive Neuroprostheses" (2016). It should be noted that the use of neuroprostheses to treat or reverse the effects of conditions such as Alzheimer's disease that impair access to human beings' long-term

Social Engagement

The capacity for social behaviors, interactions, and relations possessed by human workers may be altered significantly by an organization's deployment of neuroprosthetic devices among those workers. Below we consider a number of social characteristics of human agents and the ways in which the historical assumptions regarding the nature of those characteristics that enterprise architects have relied upon will become increasingly outdated within organizations utilizing posthumanizing neuroprostheses.

Degree of Sociality

- **Historical assumption:** While it suffers from being slow, inefficient, and imprecise, social interaction is the critical means by which human workers communicate and collaborate to perform work-related tasks.
- **Impact of neuroprosthetic augmentation:** Neuroprostheses may allow human workers to receive and exchange information in a direct and instantaneous manner that bypasses the need for social interaction; such devices may also either impair or enhance workers' capacity for engaging socially with others.

Enterprise architecture has traditionally drawn sharp distinctions between the ways in which electronic computerized systems interact with one another and the ways in which human workers interact. 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 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 computers.[94] On the other hand, 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.[95] Although the social content and nature of complex communicative human actions such as speaking and writing are obvious,

memories would, in effect, increase such individuals' information security by enhancing the integrity and availability of the information contained within such memories. See Gladden, "Information Security Concerns as a Catalyst for the Development of Implantable Cognitive Neuroprostheses" (2016).

[94] 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., "Bridging the Gap between Social Animal and Unsocial Machine: A survey of Social Signal Processing" (2012) and Gladden, "Managerial Robotics" (2014).

[95] Regarding the distinction between social behaviors, interactions, and relations, see Vinciarelli

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

even such basic activities as standing, walking, and breathing have social aspects, insofar as they can convey intentions, emotions, and attitudes toward other human beings.[96] The skill and efficiency with which human workers communicate and collaborate by means of social activities vary greatly between individuals.

When deployed among an organization's workforce, neuroprosthetic devices that negatively 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.[97] On the other hand, posthumanizing neuroprostheses that reduce the impact of cognitive or emotional disorders, enhance memory, and train users to engage socially with others more effectively may optimize workers' patterns of communication and collaboration and improve overall performance. Neuroprostheses may also be used to create links between the brains of human workers that allow information to be transferred into and between workers' minds in a direct and instantaneous manner that does not require mediation through relatively slow and imprecise social behaviors such as speech or the typing of text.[98] 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.[99]

Relationship to Organizational Culture

- **Historical assumption:** Workplace culture is a critical element in the successful implementation of an EA plan, but enterprise architecture possesses only limited tools for diagnosing and shaping such culture.

---

et al. (2012) and Gladden, "Managerial Robotics" (2014).

[96] Forms of nonverbal communication such as oculesics, haptics, kinesics, and proxemics are discussed in Andersen & Andersen, "Measures of Perceived Nonverbal Immediacy" (2005). The informational content of paralanguage is discussed in Johar, *Emotion, Affect and Personality in Speech: The Bias of Language and Paralanguage* (2016).

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

[98] Regarding such possibilities, see Rao et al., "A direct brain-to-brain interface in humans" (2014), and Gladden, "Utopias and Dystopias as Cybernetic Information Systems" (2015), as well as the literature relating to hive minds cited earlier in this text.

[99] For the possibility that neuroprostheses might provide their hosts with expanded knowledge in some spheres while simultaneously diminishing their social or intellectual capacities in other areas, see Bostrom & Sandberg, "Cognitive Enhancement: Methods, Ethics, Regulatory Challenges" (2009), pp. 322-23, and Gladden, "Managing the Ethical Dimensions of Brain-Computer Interfaces in eHealth: An SDLC-based Approach" (2016).

▶ **Impact of neuroprosthetic augmentation:** Neuroprostheses may provide an organization with new tools for analyzing its existing workplace culture, modifying that culture, or even fabricating an entirely new workplace culture.

Understanding and optimizing workplace culture is critical for successfully designing and implementing an enterprise architecture plan within an organization.[100] Historically, questions of culture have been associated almost exclusively with the behavior of human agents working within an organization and not directly with the behaviors of electronic information systems. While a large number of computers can be linked to form networks that may constitute a form of computerized multi-agent society, such aggregations of conventional computers do not create or experience their own 'cultures.'[101] On the other hand, human beings create and exist within unique cultures that include particular forms of art, literature, music, architecture, history, sports and 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.

As sensors implanted within a workforce that gather diverse types of real-time data about the activities and interactions of human workers, neuroprostheses may provide an organization with a direct and powerful new means of analyzing the realities of its workplace culture. The deployment of posthumanizing neuroprostheses within an organization may also transform the nature of the workplace culture and the means by which it is created and experienced. Human agents whose thoughts, dreams, and aspirations have been attenuated or even eliminated or whose physical sensorimotor systems are controlled through the use of neuroprosthetic devices may no longer possess a desire or ability to perceive or generate certain kinds of cultural artifacts. Moreover, 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 substantially all of the aspects of culture within that virtual world, without

[100] Regarding the critical role that organizational culture and cultural knowledge play, e.g., in the management of enterprise architecture, see Aier (2014); Hoogervorst (2004); Liu et al., "A Design of Business-Technology Alignment Consulting Framework" (2011); Magoulas et al. (2012), pp. 93-95, 98; and Gladden, "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems" (2016).

[101] 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).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

the human agents who dwell in that world being able to contribute meaningfully to the process.[102]

Economic and Financial Relationship with Employer

- **Historical assumption:** An organization commonly uses financial compensation and rewards to acquire workers and incentivize particular workplace behaviors.
- **Impact of neuroprosthetic augmentation:** Implantation of a neuroprosthesis into a worker by his or her organization may make the worker permanently financially dependent on the organization and create complications regarding the ownership of intellectual property and other goods or services produced by means of the neuroprosthesis.

Enterprise architecture typically assumes that the human agents working within an organization have an economic and financial relationship to the organization (e.g., the relationship of employee to employer) that enables their participation in the organization's work and may, to some extent, be exploited in order to generate motivation and incentives for certain types of workplace behaviors and disincentives for other types of behaviors.[103]

The deployment of posthumanizing neuroprostheses within an organization may significantly change the economic and financial relationship of the organization to its affected workers. Depending on the precise contractual terms and conditions under which such components were acquired, a human agent whose body has been subject to neuroprosthetic augmentation and is partially composed of electronic components may not even fully 'own' his or her body or the products generated by it, including intellectual property in the form of thoughts and memories.[104] In order to preserve his or her psychological and physical health, a neuroprosthetically augmented individual may

[102] 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).

[103] The extent to which financial compensation actually provides motivation for workers is a subject of debate. See, for example, Herzberg, "One more time: How do you motivate employees" (1986), and Rynes et al., "The importance of pay in employee motivation: Discrepancies between what people say and what they do" (2004).

[104] Complex legal and regulatory regimes govern the ownership of information that is received, created, stored, or transmitted by neuroprosthetic devices. See Kosta & Bowman, "Implanting Implications: Data Protection Challenges Arising from the Use of Human ICT Implants" (2012); McGee (2008); Mak, "Ethical Values for E-Society: Information, Security and Privacy" (2010); McGrath & Scanaill, "Regulations and Standards: Considerations for Sensor Technologies" (2013); Shoniregun et al., "Introduction to E-Healthcare Information Security" (2010); and Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015).

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

also require continual maintenance services, medication, software updates, or replacement parts. If – due to legal, financial, or operational reasons – the individual is only able to obtain such neuroprosthetic support services from his or her employer (or from another particular corporation, government agency, or other institution) and is barred from purchasing goods or services from competing enterprises, the individual may be rendered biologically and psychologically dependent on and financially indebted to that institution throughout the rest of his or her life.[105] 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.

Rights, Responsibilities, and Legal Status of Human Agents

- **Historical assumption:** Unlike computers and other property owned by an organization, human workers possess fundamental rights that limit the ability of an EA plan to unilaterally dictate such workers' location, physical structure, and behavior.
- **Impact of neuroprosthetic augmentation:** The 'ownership' of workers' neuroprosthetically augmented physical bodies and cognitive processes and workers' legal right to control the nature and disposition of their own bodies may become more ambiguous.

Different types of resources within an organization historically possess very different legal status. An organization's human resources possess many fundamental personal rights as human beings. On the other hand, a desktop computer or web server is a piece of property that can be owned by the organization; it is not a legal person that possesses a recognized set of rights and responsibilities.[106] This distinction means that enterprise architects must

[105] Regarding the possibility that use of a neuroprosthesis may create dependencies that would result in psychological, physical, economic, or social harm to its human host if use of the device were to be discontinued, see Bostrom & Sandberg (2009), p. 323; McGee (2008), p. 213; Koops & Leenes (2012), p. 125; Gladden, "Neural Implants as Gateways" (2016); and Gladden, "Managing the Ethical Dimensions of Brain-Computer Interfaces in eHealth" (2016). For the fact that corporations or other organizations that manufacture or provide neuroprostheses may purposefully attempt to create high 'switching costs' that discourage or prevent device hosts from using the support services of competing organizations, see Gladden, *The Handbook of Information Security for Advanced Neuroprosthetics* (2015).

[106] 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 ultimately 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 temporary moral and legal placeholder until the computer's human designers, programmers, and operators can be identified and final responsibility for the computer's actions assigned

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

account for differences in the extent to which an EA plan can summarily dictate the location, physical components, and behaviors of different sorts of resources within an organization.

Just as the creation of artificially intelligent entities with the appearance of human-like self-awareness and volitionality creates ethical and legal questions regarding whether such entities possess any form of rights,[107] the creation of joint human-robotic entities (such as that of a human brain maintained within a largely cyborg body) poses new ethical and legal questions – such as whether an individual who has been heavily neuroprosthetically augmented still possesses full legal rights of self-determination and the ability to decline consent for mechanical procedures to be performed upon neuroprosthetically linked electromechanical components that are not owned by the individual in the same way that he or she would be able to decline consent for medical procedures to be performed upon natural biological components of his or her body. (Such a situation grows even more complicated, for example, when it involves neuroprosthetically linked external systems such as video cameras, web servers, vehicles, and other devices that functionally serve as a portion of the individual's cybernetically expanded 'body' but which may also be shared with other users.)

Human agents that have been intentionally neurocybernetically engineered by other human beings or organizations to grant them a radically different physical form or cognitive capacities may be subject to claims (whether ethically and legally valid or not) 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 nonhuman characteristics that clearly distinguish them from 'normal' human beings and whose design is

to the appropriate human parties. See Stahl, "Responsible Computers? A Case for Ascribing Quasi-Responsibility to Computers Independent of Personhood or Agency" (2006).

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

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

considered to be intellectual property owned by the individual or organization responsible for that engineering. Developing a legal framework that resolves such questions to the satisfaction of all stakeholders is expected to be challenging, given the number and types of institutions and social groups that possess potentially competing financial, political, cultural, or personal stakes in the outcome.[108]

Conclusion

As part of its work of designing and implementing target architectures for organizations, the discipline of enterprise architecture has historically relied on a set of assumptions regarding the physical, cognitive, and social capacities of the human beings serving as organizational members. As we have explored in this text, those traditional assumptions will become increasingly obsolete for those organizations that choose to deploy posthumanizing neuroprosthetic technologies among their personnel. The use of advanced neuroprostheses intensifies the ongoing structural, systemic, and procedural fusion of human personnel with electronic information systems in a way that creates for human workers new capacities and limitations and transforms the roles available to them.

Neuroprostheses have the potential to affect workers especially in the three areas of their physical form, intellect, and social engagement. First, neuroprostheses may affect workers' physical form, as seen in their bodies' physical components, the extent to which their physical form is the subject of organizational design, their length of tenure as workers, the developmental and operational cycles that they experience, their spatial extension and locality, the permanence of their physical substrates, and the nature of their personal identity. Second, neuroprostheses can affect the information processing and cognition of neuroprosthetically augmented workers, as reflected in their degree of sapience, autonomy, and volitionality; their means of knowledge acquisition; their locus of information processing and data storage; their emotionality and cognitive biases; and their fidelity of data storage, predictability of behavior, and information security vulnerabilities. Finally, the deployment of posthumanizing neuroprostheses may affect workers' social engagement, as manifested in their degree of sociality; relationship to organizational culture; economic relationship with their employers; and rights, responsibilities, and legal status.

It is not claimed or expected that the types of neuroprosthetic augmentation discussed here will soon be exploited purposefully by a broad range of organizations: indeed, a complex array of ethical, legal, political, economic,

[108] Similar political and legal debates have arisen, for example, surrounding the technologies for genetic engineering that enable the widespread production and commercial use of GMOs.

and functional factors will prevent most organizations from deploying advanced neuroprostheses among their personnel for the foreseeable future. However, selected organizations such as military agencies and departments are already working to develop such technologies and implement them among their personnel for highly specialized purposes. Such organizations will be forced to transform their enterprise architecture practices and plans in order to address the deepening human-computer hybridization brought about by posthumanizing neuroprosthetic technologies.

In closing, it should again be noted that we have not attempted to explore in detail the many serious ethical and legal problems that are created by any effort on the part of organizations to intentionally deploy posthumanizing neuroprostheses among their human personnel. However, this does not mean that such concerns are insignificant. Indeed, it is critical that thoughtful and comprehensive analyses of such organizational practices be undertaken from ethical and legal perspectives, and it is our hope that the investigation of neuroprosthetically facilitated human-computer fusion presented in this text may provide a useful foundation for such analyses.

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

References

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.

Adaptive Networks: Theory, Models and Applications, edited by Thilo Gross and Hiroki Sayama. Springer Berlin Heidelberg, 2009.

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

Ahlemann, Frederik, Eric Stettiner, Marcus Messerschmidt, Christine Legner, Kunal Mohan, and Daniel Schäfczuk. "People, adoption and introduction of EAM." In *Strategic Enterprise Architecture Management*, pp. 229-263. Springer Berlin Heidelberg, 2012.

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.

Alumur, Sibel, and Bahar Y. Kara. "Network hub location problems: The state of the art." *European journal of operational research* 190, no. 1 (2008): 1-21.

Amputation, Prosthetic Use, and Phantom Limb Pain: An Interdisciplinary Perspective, edited by Craig Murray. New York: Springer Science+Business Media, 2010.

Andersen, Peter A., and Janis F. Andersen. "Measures of Perceived Nonverbal Immediacy." In *The Sourcebook of Nonverbal Measures: Going Beyond Words*, edited by Valerie Manusov. Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 2005.

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

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

Andrew, Alex M. "The decade of the brain: further thoughts." *Kybernetes* 26, no. 3 (1997): 255-264.

Ankarali, Z.E., Q.H. Abbasi, A.F. Demir, E. Serpedin, K. Qaraqe, and H. Arslan. "A Comparative Review on the Wireless Implantable Medical Devices Privacy and Security." In *2014 EAI 4th International Conference on Wireless Mobile Communication and Healthcare (Mobihealth)*, 246-49, 2014. doi:10.1109/MOBIHEALTH.2014.7015957.

ANSI/IEEE 1471-2000, IEEE Recommended Practice for Architectural Description for Software-Intensive Systems. IEEE Computer Society, 2000.

ArchiMate® 2.1 Specification. Berkshire: The Open Group, 2013.

Ariely, D., and G.S. Berns. "Neuromarketing: The Hope and Hype of Neuroimaging in Business." *Nature Reviews Neuroscience* 11, no. 4 (2010): 284-92.

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

Ayaz, Hasan, Patricia A. Shewokis, Scott Bunce, Maria Schultheis, and Banu Onaral. "Assessment of Cognitive Neural Correlates for a Functional Near Infrared-Based Brain Computer Interface System." In *Foundations of Augmented Cognition. Neuroergonomics and Operational Neuroscience*, edited by Dylan D. Schmorrow, Ivy V. Estabrooke, and Marc Grootjen, 699-708. Lecture Notes in Computer Science 5638. Springer Berlin Heidelberg, 2009.

Baars, Bernard J. *In the Theater of Consciousness.* New York, NY: Oxford University Press, 1997.

Baddeley, Alan. "The episodic buffer: a new component of working memory?" *Trends in cognitive sciences* 4, no. 11 (2000): 417-23.

Baddeley, Alan. "Working memory: theories, models, and controversies." *Annual review of psychology* 63 (2012): 1-29.

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.

Baranyi, Péter, Adam Csapo, and Gyula Sallai. "Synergies Between CogInfoCom and Other Fields." In *Cognitive Infocommunications (CogInfoCom).* Springer International Publishing, 2015.

Barfield, Woodrow. *Cyber-Humans: Our Future with Machines.* Springer Science+Business Media, 2015.

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.

Bean, Sally. "Re-Thinking Enterprise Architecture Using Systems and Complexity Approaches." *Journal of Enterprise Architecture* 6, no. 4 (2010).

Beer, Stafford. *Brain of the Firm*. Second edition. 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.

Bergey, John, Stephen Blanchette, Jr., Paul Clements, Mike Gagliardi, John Klein, Rob Wojcik, and Bill Wood. "U.S. Army Workshop on Exploring Enterprise, System of Systems, System, and Software Architectures." Technical Report CMU/SEI-2009-TR-008 / ESC-TR-2009-008. Hanscom AFB, MA: Software Engineering Institute, 2009.

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

Bhunia, Swarup, Abhishek Basak, Seetharam Narasimhan, and Maryam Sadat Hashemian. "Ultralow Power and Robust On-Chip Digital Signal Processing for Closed-Loop Neuro-Prosthesis." In *Implantable Bioelectronics: Devices, Materials, and Applications*, edited by Evgeny Katz. Weinheim: Wiley-VCH, 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.

Bischoff, Stefan, Stephan Aier, and Robert Winter. "Use It or Lose It? The Role of Pressure for Use and Utility of Enterprise Architecture Artifacts." In *2014 IEEE 16th Conference on Business Informatics*, vol. 2, pp. 133-140. IEEE, 2014.

Black, Michael J., Elie Bienenstock, John P. Donoghue, Mijail Serruya, Wei Wu, and Yun Gao. "Connecting brains with machines: the neural control of 2D cursor movement." In *Proceedings of the 1st International IEEE/EMBS Conference on Neural Engineering*, pp. 580-83, 2003.

Blank, S. Catrin, Sophie K. Scott, Kevin Murphy, Elizabeth Warburton, and Richard JS Wise. "Speech production: Wernicke, Broca and beyond." *Brain* 125, no. 8 (2002): 1829-38.

Bogue, Robert. "Brain-Computer Interfaces: Control by Thought." *Industrial Robot: An International Journal* 37, no. 2 (2010): 126-32.

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).

Bonaci, T., R. Calo, and H. Chizeck. "App Stores for the Brain." *IEEE Technology and Society Magazine,* 1932-4529/15 (2015): 32-39.

Borkar, Shekhar. "Designing reliable systems from unreliable components: the challenges of transistor variability and degradation." *Micro, IEEE* 25, no. 6 (2005): 10-16.

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, and Anders Sandberg. "Cognitive Enhancement: Methods, Ethics, Regulatory Challenges." *Science and Engineering Ethics* 15, no. 3 (2009): 311-41.

Boucharas, Vasilis, Marlies van Steenbergen, Slinger Jansen, and Sjaak Brinkkemper. "The Contribution of Enterprise Architecture to the Achievement of Organizational Goals: A Review of the Evidence." In *Trends in Enterprise Architecture Research*, 1-15. Springer, 2010.

Braddon-Mitchell, David, and John Fitzpatrick. "Explanation and the Language of Thought." *Synthese* 83, no. 1 (April 1, 1990): 3-29.

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

Brain-Computer Interfaces: Principles and Practice, edited by Jonathan R. Wolpaw and Elizabeth Winter Wolpaw. New York: Oxford University Press, 2012.

Brandt, Thomas. *Vertigo: Its Multisensory Syndromes*. Springer Verlag London, 2003.

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

"Bridging the Bio-Electronic Divide." Defense Advanced Research Projects Agency, January 19, 2016. http://www.darpa.mil/news-events/2015-01-19. Accessed May 6, 2016.

Brunner, Peter, and Gerwin Schalk. "Brain-Computer Interaction." In *Foundations of Augmented Cognition. Neuroergonomics and Operational Neuroscience*, edited by Dylan D. Schmorrow, Ivy V. Estabrooke, and Marc Grootjen, 719-23. Lecture Notes in Computer Science 5638. Springer Berlin Heidelberg, 2009.

Brunner, P., L. Bianchi, C. Guger, F. Cincotti, and G. Schalk. "Current Trends in Hardware and Software for Brain-Computer Interfaces (BCIs)." *Journal of Neural Engineering* 8, no. 2 (2011): 25001.

Bublitz, J.C. "If Man's True Palace Is His Mind, What Is Its Adequate Protection? On a Right to Mental Self-Determination and Limits of Interventions into Other Minds." In *Technologies on the Stand: Legal and Ethical Questions in Neuroscience and Robotics*, edited by B. Van Den Berg and L. Klaming. Nijmegen: Wolf Legal Publishers, 2011.

Buckl, Sabine, Christian M. Schweda, and Florian Matthes. "A Situated Approach to Enterprise Architecture Management." In *2010 IEEE International Conference on Systems, Man and Cybernetics*, 587-92. IEEE, 2010.

Buckl, Sabine, Florian Matthes, and Christian M. Schweda. "A Viable System Perspective on Enterprise Architecture Management." In *IEEE International Conference on Systems, Man and Cybernetics, 2009. SMC 2009*, 1483-88. IEEE, 2009.

Butler, Jesse. *Rethinking Introspection*. Palgrave Macmillan UK, 2013.

C4ISR Architecture Framework Version 2.0. C4ISR Architecture Working Group (AWG), US Department of Defense, December 18, 1997. http://www.afcea.org/education/courses/arch-fwk2.pdf. Accessed December 4, 2016.

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.

Cahill, Larry, and Michael T. Alkire. "Epinephrine enhancement of human memory consolidation: interaction with arousal at encoding." *Neurobiology of learning and memory* 79, no. 2 (2003): 194-98.

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.

Cameron, Oliver G. *Visceral Sensory Neuroscience: Interoception.* Oxford University Press, 2001.

Campbell, Lyle. *Historical Linguistics.* Third edition. The MIT Press, 2013.

Cane, Sheila, and Richard McCarthy. "Measuring the Impact of Enterprise Architecture." *Issues in Information Systems* 8, no. 2 (2007): 437-42.

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.

Cervera-Paz, Francisco Javier, and M. J. Manrique. "Auditory Brainstem Implants: Past, Present and Future Prospects." In *Operative Neuromodulation*, edited by Damianos E. Sakas and Brian A. Simpson, 437-42. Acta Neurochirurgica Supplements 97/2. Springer Vienna, 2007.

Chafe, Chris, and Sile O'Modhrain. "Musical muscle memory and the haptic display of performance nuance." In *Proceedings of the 1996 International Computer Music Conference*, pp. 1-4. Stanford: Stanford University, 1996.

Chan, Yolande E., and Blaize Horner Reich. "IT alignment: what have we learned?" *Journal of Information technology* 22, no. 4 (2007): 297-315.

Chang, Chia-Ke, Yu-Jung Li, and Chih-Cheng Lu. "RFID applied in recognition and identification for dental prostheses." In *Computerized Healthcare (ICCH), 2012 International Conference on*, pp. 43-45. IEEE, 2012.

Christen, Markus, and Sabine Müller. "Current status and future challenges of deep brain stimulation in Switzerland." *Swiss Medical Weekly* (2012): 142:w13570. doi:10.4414/smw.2012.13570.

"Chronic Pain and Spinal Cord Stimulation (SCS): Frequently Asked Questions." Boston Scientific, 2013. http://www.pae-eu.eu/wp-content/uploads/2015/03/NM-135814-AA-INTL-Spectra-Backgrounder_Final.pdf. Accessed December 8, 2016.

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, S.S., and K. Fu. "Recent Results in Computer Security for Medical Devices." In *Wireless Mobile Communication and Healthcare*, edited by K.S. Nikita, J.C. Lin, D.I. Fotiadis, and M.-T. Arredondo Waldmeyer, pp. 111-18. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 83. Springer Berlin Heidelberg, 2012.

Clark, Andy. "Systematicity, structured representations and cognitive architecture: A reply to Fodor and Pylyshyn." In *Connectionism and the Philosophy of Mind*, pp. 198-218. Springer Netherlands, 1991.

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

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.

Clausen, J. "Conceptual and Ethical Issues with Brain–hardware Interfaces." *Current Opinion in Psychiatry* 24, no. 6 (2011): 495-501.

Claussen, Jens Christian, and Ulrich G. Hofmann. "Sleep, Neuroengineering and Dynamics." *Cognitive Neurodynamics* 6, no. 3 (May 27, 2012): 211-14.

A Clinical Guide to Transcranial Magnetic Stimulation, edited by Paul E. Holtzheimer and William McDonald. New York: Oxford University Press, 2014.

Clowes, Robert W. "The Cognitive Integration of E-Memory." *Review of Philosophy and Psychology* 4, no. 1 (January 26, 2013): 107-33.

"Cochlear Implant Quick Facts." American Speech-Language-Hearing Association. http://www.asha.org/public/hearing/Cochlear-Implant-Quick-Facts/. Accessed December 8, 2016.

"Cochlear Implants." National Institute on Deafness and Other Communication Disorders (NIDCD), May 3, 2016. https://www.nidcd.nih.gov/health/cochlear-implants. Accessed December 8, 2016.

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.

Cognitive Psychology. Second edition. Edited by Nick Braisby and Angus Gellatly. Oxford: Oxford University Press, 2012.

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

Collins, Allison, and Norm Schultz. "A review of ethics for competitive intelligence activities." *Competitive Intelligence Review* 7, no. 2 (1996): 56-66.

Coma Science: Clinical and Ethical Implications, edited by Steven Laureys, Nicholas D. Schiff, and Adrian M. Owen. New York: Elsevier, 2009.

Comai, Alessandro. "Global code of ethics and competitive intelligence purposes: an ethical perspective on competitors." *Journal of Competitive Intelligence and Management* 1, no. 3, 2003.

Comas and Disorders of Consciousness, edited by Caroline Schnakers and Steven Laureys. Springer-Verlag London, 2012.

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

Computer Synthesized Speech Technologies: Tools for Aiding Impairment, edited by John Mullennix and Steven Stern. Hershey, PA: Medical Information Science Reference, 2010.

Conant, Roger C., and W. Ross Ashby. "Every Good Regulator of a System Must Be a Model of That System." *International journal of systems science* 1, no. 2 (1970): 89-97.

Content of Premarket Submissions for Management of Cybersecurity in Medical Devices: Guidance for Industry and Food and Drug Administration Staff. Silver Spring, MD: US Food and Drug Administration, 2014.

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

Cornwall, Warren. "In Pursuit of the Perfect Power Suit." *Science* 350, issue 6258 (2015): 270-73.

Cory, Jr., Gerald A. "Language, Brain, and Neuron." In *Toward Consilience*, pp. 193-205. Springer US, 2000.

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.

Crane, Andrew. "In the company of spies: When competitive intelligence gathering becomes industrial espionage." *Business Horizons* 48, no. 3 (2005): 233-40.

Cummings, James J., and Jeremy N. Bailenson. "How immersive is enough? A meta-analysis of the effect of immersive technology on user presence." *Media Psychology* 19, no. 2 (2016): 272-309.

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

"Cybersecurity for Medical Devices and Hospital Networks: FDA Safety Communication." US Food and Drug Administration, June 13, 2013. http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm356423.htm. Accessed May 3, 2016.

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

The Cyborg Experiments: The Extensions of the Body in the Media Age, edited by Joanna Zylinska. London: Continuum, 2002.

Cytowic, Richard E. *Synesthesia: A Union of the Senses.* Springer-Verlag New York, 1989.

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.

Daigle, K.R. "Manipulating the Mind: The Ethics of Cognitive Enhancement." Thesis, M.A. in Bioethics. Wake Forest University, 2010. https://wakespace.lib.wfu.edu/handle/10339/30407. Accessed May 8, 2016.

Dandamudi, Sivarama P. *Introduction to assembly language programming: from 8086 to Pentium processors*. Springer Science+Business Media New York, 1998.

Davies, Theresa Claire. *Audification of Ultrasound for Human Echolocation*. Dissertation, Ph.D. in Systems Design Engineering. Waterloo, Ontario: University of Waterloo, 2008.

Davis, Simon, Keith Nesbitt, and Eugene Nalivaiko. "A systematic review of cybersickness." In *Proceedings of the 2014 Conference on Interactive Entertainment*, pp. 1-9. ACM, 2014.

De Graaf, Maartje MA, and Somaya Ben Allouch. "Exploring influencing variables for the acceptance of social robots." *Robotics and Autonomous Systems* 61, no. 12 (2013): 1476-86.

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.

Deep Brain Stimulation for Parkinson's Disease, edited by Gordon H. Baltuch and Matthew B. Stern. Boca Raton: CRC Press, 2007.

Dellon, Brian, and Yoky Matsuoka. "Prosthetics, exoskeletons, and rehabilitation." *IEEE Robotics and Automation magazine* 14, no. 1 (2007): 30.

Denning, Tamara, Alan Borning, Batya Friedman, Brian T. Gill, Tadayoshi Kohno, and William H. Maisel. "Patients, pacemakers, and implantable defibrillators: Human values and security for wireless implantable medical devices." In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 917-26. ACM, 2010.

Denning, Tamara, Yoky Matsuoka, and Tadayoshi Kohno. "Neurosecurity: Security and Privacy for Neural Devices." *Neurosurgical Focus* 27, no. 1 (2009): E7.

Digital Ecosystems: Society in the Digital Age, edited by Łukasz Jonak, Natalia Juchniewicz, and Renata Włoch. Warsaw: Digital Economy Lab, University of Warsaw, 2016.

DoD Architecture Framework Version 2.02. US Department of Defense, August 2010. http://dodcio.defense.gov/Portals/0/Documents/DODAF/DoDAF_v2-02_web.pdf. Accessed December 4, 2016.

Dormer, Kenneth J. "Implantable electronic otologic devices for hearing rehabilitation." In *Handbook of Neuroprosthetic Methods*, edited by Warren E. Finn and Peter G. LoPresti, pp. 237-60. Boca Raton: CRC Press, 2003.

Drummond, Katie. "Pentagon Preps Soldier Telepathy Push." *Wired*, May 14, 2009. https://www.wired.com/2009/05/pentagon-preps-soldier-telepathy-push/. Accessed December 5, 2016.

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.

Edlinger, Günter, Cristiano Rizzo, and Christoph Guger. "Brain Computer Interface." In *Springer Handbook of Medical Technology*, edited by Rüdiger Kramme, Klaus-Peter Hoffmann, and Robert S. Pozos, 1003-17. Springer Berlin Heidelberg, 2011.

Electroreception, edited by Theodore H. Bullock, Carl D. Hopkins, Arthur N. Popper, and Richard R. Fay. New York: Springer Science+Business Media, 2005.

"Employee Tenure Summary." Washington, DC: US Department of Labor, Bureau of Labor Statistics, September 22, 2016. http://www.bls.gov/news.release/tenure.nro.htm. Accessed November 9, 2016.

Epinephrine in the Central Nervous System, edited by Jon M. Stolk, David C. U'Prichard, and Kjell Fuxe. Oxford University Press, 1988.

Ericsson, K. Anders, and Neil Charness. "Expert performance: Its structure and acquisition." *American Psychologist* 49, no. 8 (1994): 725-47.

Erikson, Jane. "Thought-Controlled Robotic Arm 'Makes a Big Negative a Whole Lot Better'." The University of Arizona Health Sciences, July 2013. http://medicine.arizona.edu/alumni/alumni-slide/thought-controlled-robotic-arm-%E2%80%98makes-big-negative-whole-lot-better%E2%80%99 Accessed December 5, 2016.

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.

Evans-Pughe, Christine. "Smarter Prosthetics: Researchers Are Working to Develop Artificial Limbs with Almost Life-like Levels of Functionality and Control." *Engineering and Technology* (June 2006): 32-36.

Evolutionary Linguistics, edited by April McMahon and Robert McMahon. New York: Cambridge University Press, 2013.

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).

Fairchild, Alea M. *Technological Aspects of Virtual Organizations: Enabling the Intelligent Enterprise*. Springer Science+Business Media Dordrecht, 2004.

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.

Farina, Dario, and Oskar Aszmann. "Bionic limbs: clinical reality and academic promises." *Science Translational Medicine* 6, no. 257 (2014): 257ps12.

Fayerman, Pamela. "Funding, doctors needed if brain stimulation surgery to expand in B.C." *Vancouver Sun*, 03.06.2013. http://www.vancouversun.com/health/Funding+doctors+needed+brain+stimulation+surgery+expand/8054047/story.html. Accessed December 8, 2016.

Federal Enterprise Architecture Framework, version 2. Washington, DC: Office of Management and Budget, January 29, 2013. https://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/fea_v2.pdf. Accessed November 18, 2016.

Fernandez-Lopez, Helena, José A. Afonso, J. H. Correia, and Ricardo Simoes. "The Need for Standardized Tests to Evaluate the Reliability of Data Transport in Wireless Medical Systems." In *Sensor Systems and Software*, edited by Francisco Martins, Luís Lopes, and Hervé Paulino, pp. 137-45. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 102. Springer Berlin Heidelberg, 2012.

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.

Fiehler, Katja, Immo Schütz, Tina Meller, and Lore Thaler. "Neural correlates of human echolocation of path direction during walking." *Multisensory research* 28, no. 1-2 (2015): 195-226.

"FIPA Device Ontology Specification." Foundation for Intelligent Physical Agents (FIPA), May 10, 2002. http://www.fipa.org/assets/XC00091D.pdf. Accessed February 9, 2015.

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.

Fountas, Kostas N., and J. R. Smith. "A Novel Closed-Loop Stimulation System in the Control of Focal, Medically Refractory Epilepsy." In *Operative Neuromodulation*, edited by Damianos E. Sakas and Brian A. Simpson, 357-62. Acta Neurochirurgica Supplements 97/2. Springer Vienna, 2007.

Frewer, Lynn J., Ivo A. van der Lans, Arnout RH Fischer, Machiel J. Reinders, Davide Menozzi, Xiaoyong Zhang, Isabelle van den Berg, and Karin L. Zimmermann. "Public perceptions of agri-food applications of genetic modification – A systematic review and meta-analysis." *Trends in Food Science & Technology* 30, no. 2 (2013): 142-52.

Frewer Lynn, Jesper Lassen, B. Kettlitz, Joachim Scholderer, Volkert Beekman, and Knut G. Berdal. "Societal aspects of genetically modified foods." *Food and Chemical Toxicology* 42, no. 7 (2004): 1181-93.

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.

Fritz, Robert. *Corporate Tides: The Inescapable Laws of Organizational Structure*. San Francisco: Berret-Koehler, 1996.

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

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

Gallego, Juan Álvaro, Eduardo Rocon, Juan Manuel Belda-Lois, and José Luis Pons. "A neuroprosthesis for tremor management through the control of muscle co-contraction." *Journal of neuroengineering and rehabilitation* 10, no. 1 (2013): 1.

Gammelgård, Magnus, Mårten Simonsson, and Åsa Lindström. "An IT Management Assessment Framework: Evaluating Enterprise Architecture Scenarios." *Information Systems and E-Business Management* 5, no. 4 (2007): 415-35.

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.

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.

Gen, Mitsuo, Runwei Cheng, and Lin Lin. *Network Models and Optimization: Multiobjective Genetic Algorithm Approach.* Springer-Verlag London Limited, 2008.

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

Gill, Satinder P. "Socio-Ethics of Interaction with Intelligent Interactive Technologies." *AI & SOCIETY* 22, no. 3 (October 26, 2007): 283-300.

Giustozzi, Emilie Steele, and Betsy Van der Veer Martens. "The new competitive intelligence agents: 'Programming' competitive intelligence ethics into corporate cultures." *Webology* 8, no. 2 (2011): 1.

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. "Cryptocurrency with a Conscience: Using Artificial Intelligence to Develop Money that Advances Human Ethical Values." *Annales: Ethics in Economic Life* 18, no. 4 (2015): 85-98.

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. "Enterprise Architecture for Neurocybernetically Augmented Organizational Systems: The Impact of Posthuman Neuroprosthetics on the Creation of Strategic, Structural, Functional, Technological, and Sociocultural Alignment." Thesis project, MBA in Innovation and Data Analysis. Warsaw: Institute of Computer Science, Polish Academy of Sciences, 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. "Implantable Computers and Information Security: A Managerial Perspective." In *Posthuman Management: Creating Effective Organizations in an Age of Social Robotics, Ubiquitous AI, Human Augmentation, and Virtual Worlds*. Second edition, pp. 285-300. Indianapolis: Defragmenter Media, 2016.

Gladden, Matthew E. "Information Security Concerns as a Catalyst for the Development of Implantable Cognitive Neuroprostheses." In *9^{th} Annual EuroMed Academy of Business (EMAB) Conference: Innovation, Entrepreneurship and Digital Ecosystems (EUROMED 2016) Book of Proceedings*, edited by Demetris Vrontis, Yaakov Weber, and Evangelos Tsoukatos, pp. 891-904. Engomi: EuroMed Press, 2016.

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): 67-76.

Gladden, Matthew E. "Managing the Ethical Dimensions of Brain-Computer Interfaces in eHealth: An SDLC-based Approach." In *9^{th} Annual EuroMed Academy of Business (EMAB) Conference: Innovation, Entrepreneurship and Digital Ecosystems (EUROMED 2016) Book of*

Proceedings, edited by Demetris Vrontis, Yaakov Weber, and Evangelos Tsoukatos, pp. 876-90. Engomi: EuroMed Press, 2016.

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. "Neuromarketing Applications of Neuroprosthetic Devices: An Assessment of Neural Implants' Capacities for Gathering Data and Influencing Behavior." In *9th Annual EuroMed Academy of Business (EMAB) Conference: Innovation, Entrepreneurship and Digital Ecosystems (EUROMED 2016) Book of Proceedings*, edited by Demetris Vrontis, Yaakov Weber, and Evangelos Tsoukatos, pp. 905-18. Engomi: EuroMed Press, 2016.

Gladden, Matthew E. "Organization Development and the Robotic-Cybernetic-Human Workforce: Humanistic Values for a Posthuman Future?" In *Posthuman Management: Creating Effective Organizations in an Age of Social Robotics, Ubiquitous AI, Human Augmentation, and Virtual Worlds*. Second edition, pp. 239-55. Indianapolis: Defragmenter Media, 2016.

Gladden, Matthew E. *Posthuman Management: Creating Effective Organizations in an Age of Social Robotics, Ubiquitous AI, Human Augmentation, and Virtual Worlds*. Second edition. Indianapolis: Defragmenter Media, 2016.

Gladden, Matthew E. *Sapient Circuits and Digitalized Flesh: The Organization as Locus of Technological Posthumanization*. Indianapolis: Defragmenter Media, 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. "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.

Goldstein, E. Bruce. *Sensation and Perception.* Ninth edition. Belmont, CA: Wadsworth / CENGAGE Learning, 2014.

Goleman, Daniel. "What Makes a Leader?" *Harvard Business Review* 82 (1) (2004): 82-91.

Goodman, H. Maurice. *Basic Medical Endocrinology.* Fourth edition. Burlington, MA: Academic Press, 2009.

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.

Greve, Andrea, and Richard Henson. "What We Have Learned about Memory from Neuroimaging." In *The Wiley Handbook on the Cognitive Neuroscience of Memory*, edited by Donna Rose Addis, Morgan Barense, and Audrey Duarte, pp. 1-20. Malden, MA: John Wiley & Sons Ltd., 2015.

Grottke, M., H. Sun, R.M. Fricks, and K.S. Trivedi. "Ten fallacies of availability and reliability analysis." In *Service Availability*, pp. 187-206. Lecture Notes in Computer Science 5017. Springer Berlin Heidelberg, 2008.

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

Gutnick, Tamar, Ruth A. Byrne, Binyamin Hochner, and Michael Kuba. "Octopus vulgaris uses visual information to determine the location of its arm." *Current Biology* 21, no. 6 (2011): 460-62.

Haki, Mohammad Kazem, Christine Legner, and Frederik Ahlemann. "Beyond EA Frameworks: Towards an Understanding of the Adoption of Enterprise Architecture Management." *ECIS 2012 Proceedings*, 2012.

Hameroff, Stuart, and Roger Penrose. "Consciousness in the universe: A review of the 'Orch OR' theory." *Physics of Life Reviews* 11, no. 1 (2014): 39-78.

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.

Hand, Eric. "Maverick scientist thinks he has discovered magnetic sixth sense in humans." *Science*, June 23, 2016. doi:10.1126/science.aaf5803. Accessed December 8, 2016.

Handbook of Cloud Computing, edited by Borko Furht and Armando Escalante. New York: Springer, 2010.

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

Hargrove, Levi J., Ann M. Simon, Aaron J. Young, Robert D. Lipschutz, Suzanne B. Finucane, Douglas G. Smith, and Todd A. Kuiken. "Robotic leg control with EMG decoding in an amputee with nerve transfers." *New England Journal of Medicine* 369, no. 13 (2013): 1237-42.

Harman, Gilbert. *Thought.* Princeton: Princeton University Press, 1973.

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.

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.

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

Henderson, John C., and H. Venkatraman. "Strategic alignment: Leveraging information technology for transforming organizations." *IBM systems journal* 32, no. 1 (1993): 472-84.

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

Herzberg, Frederick. "One more time: How do you motivate employees." In *The Leader-Manager*, edited by John N. Williamson, pp. 433-48. New York: John Wiley & Sons, Inc., 1986.

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.

Hochmair, Ingeborg. "Cochlear Implants: Facts." MED-EL, September 2013. http://www.medel.com/cochlear-implants-facts. Accessed December 8, 2016.

Hoffmann, Klaus-Peter, and Silvestro Micera. "Introduction to Neuroprosthetics." In *Springer Handbook of Medical Technology*, edited by Rüdiger Kramme, Klaus-Peter Hoffmann, and Robert S. Pozos, pp. 785-800. Springer Berlin Heidelberg, 2011.

Højsgaard, Hjalte. "Market-Driven Enterprise Architecture." *Journal of Enterprise Architecture* 7, no. 1 (2011), 28.

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.

Howard, Robert. "The CEO as Organizational Architect: An Interview with Xerox's Paul Allaire." *Harvard Business Review* 70 (5) (1992): 106-21.

Hutchinson, Douglas T. "The quest for the bionic arm." *Journal of the American Academy of Orthopaedic Surgeons* 22, no. 6 (2014): 346-51.

Iacob, Maria-Eugenia, Lucas O. Meertens, Henk Jonkers, Dick A.C. Quartel, Lambert J.M. Nieuwenhuis, and M.J. Van Sinderen. "From Enterprise Architecture to Business Models and Back." *Software & Systems Modeling* 13, no. 3 (2012): 1059-83.

Implantable Biomedical Microsystems: Design Principles and Applications, edited by Swarup Bhunia, Steve Majerus, and Mohamad Sawan. Oxford: William Andrew, 2015.

Implantable Neuroprostheses for Restoring Function, edited by Kevin Kilgore. Cambridge: Woodhead Publishing, 2015.

Implantable Sensor Systems for Medical Applications, edited by Andreas Inmann and Diana Hodgins. Woodhead Publishing, 2013.

Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments. Second edition. Edited by Somasundaram Gnanasundaram and Alok Shrivastava. Indianapolis: John Wiley & Sons, Inc., 2012.

ISO 15704:2000, Industrial automation systems – Requirements for enterprise-reference architectures and methodologies. ISO/TC 184/SC5. Geneva: ISO, 2000.

ISO 19439:2006, Enterprise integration – Framework for enterprise modelling. ISO/TC 184/SC5. Geneva: ISO, 2006.

ISO 27799:2016, Health informatics – Information security management in health using ISO/IEC 27002. ISO/TC 215. Geneva: ISO, 2016.

ISO/IEC 15288:2002, Systems engineering – System life cycle processes. ISO/IEC JTC 1/SC 7. Geneva: ISO, 2002.

ISO/IEC 7498-1:1994, Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model. ISO/IEC JTC 1. Geneva: ISO, 1994.

ISO/IEC/IEEE 42010:2010, Systems and software engineering – Architecture description. ISO/IEC JTC 1/SC 7. Geneva: ISO, 2011.

Johar, Swati. *Emotion, Affect and Personality in Speech: The Bias of Language and Paralanguage*. SpringerNature, 2016.

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.

Jürgens, Uta, and Danko Nikolić. "Ideaesthesia: conceptual processes assign similar colours to similar shapes." *Translational Neuroscience* 3, no. 1 (2012): 22-27.

Kalat, James W. *Biological Psychology.* Ninth edition. Belmont, CA: Thomson Wadsworth, 2007.

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

Kandjani, Hadi, Peter Bernus, and Lian Wen. "Enterprise Architecture Cybernetics for Complex Global Software Development: Reducing the Complexity of Global Software Development Using Extended Axiomatic Design Theory." In *2012 IEEE Seventh International Conference on Global Software Engineering*, pp. 169-73. IEEE, 2012.

Kaplan, Robert S., and David P. Norton. *The Strategy-Focused Organization: How Balanced Scorecard Companies Thrive in the New Business Environment*. Boston: Harvard Business School Press, 2001.

Katz, Gregory. "The hypothesis of a genetic protolanguage: An epistemological investigation." *Biosemiotics* 1, no. 1 (2008): 57-73.

Kazienko, Przemysław, Radosław Michalski, and Sebastian Palus. "Social Network Analysis as a Tool for Improving Enterprise Architecture." In *Agent and Multi-Agent Systems: Technologies and Applications*, edited by James O'Shea, Ngoc Thanh Nguyen, Keeley Crockett, Robert J. Howlett, and Lakhmi C. Jain, pp. 651-60. Lecture Notes in Computer Science 6682. Springer Berlin Heidelberg, 2011.

Keenan, James F. "Enhancing Prosthetics for Soldiers Returning from Combat with Disabilities." *ET Studies* 4, no. 1 (2013): 69-88.

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

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.

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

Kim, Kwang Jin, Xiaobo Tan, Hyouk Ryeol Choi, and David Pugal. *Biomimetic Robotic Artificial Muscles.* Singapore: World Scientific Publishing Co. Pte. Ltd., 2013.

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

KleinOsowski, A., Ethan H. Cannon, Phil Oldiges, and Larry Wissel. "Circuit design and modeling for soft errors." *IBM Journal of Research and Development* 52, no. 3 (2008): 255-63.

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.

Kohno, T., T. Denning, and Y. Matsuoka. "Security and Privacy for Neural Devices." *Neurosurgical Focus* 27 (2009): 1-4.

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.

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture," Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017. ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

Kosta, E., and D.M. Bowman, "Implanting Implications: Data Protection Challenges Arising from the Use of Human ICT Implants." In *Human ICT Implants: Technical, Legal and Ethical Considerations*, edited by Mark N. Gasson, Eleni Kosta, and Diana M. Bowman, pp. 97-112. Information Technology and Law Series 23. T. M. C. Asser Press, 2012.

Kostov, Aleksander, and Mark Polak. "Parallel man-machine training in development of EEG-based cursor control." *IEEE Transactions on Rehabilitation Engineering* 8, no. 2 (2000): 203-05.

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

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.

Krishnan, Armin. "From Psyops to Neurowar: What Are the Dangers?" ISAC-ISSS 2014 Annual Conference on Security Studies. University of Texas, Austin, Texas, November 16, 2014. http://web.isanet.org/Web/Conferences/ISSS%20Austin%202014/Archive/b137347c-6281-466d-b9e7-ef7e0e5d363c.pdf. Accessed May 8, 2016.

Kruchten, Philippe B. "The 4+1 view model of architecture." *IEEE software* 12, no. 6 (1995): 42-50.

Kshirsagar, Sumedha, Chris Joslin, Won-Sook Lee, and Nadia Magnenat-Thalmann. "Personalized Face and Speech Communication over the Internet." In *Proceedings of IEEE Virtual Reality 2001*, edited by Haruo Takemura and Kiyoshi Kiyokawa, pp. 37-44. Los Alamitos, CA: IEEE, 2001.

Kusek, Kristen. "The $3 Million Suit: Wyss Institute Wins DARPA Grant to Further Develop its Soft Exosuit." *Harvard Gazette*, September 11, 2014. http://news.harvard.edu/gazette/story/2014/09/the-3-million-suit/. Accessed December 5, 2016.

Kyllonen, Patrick C., and Raymond E. Christal. "Reasoning ability is (little more than) working-memory capacity?!" *Intelligence* 14, no. 4 (1990): 389-433.

LaFleur, Karl, Kaitlin Cassady, Alexander Doud, Kaleb Shades, Eitan Rogin, and Bin He. "Quadcopter control in three-dimensional space using a noninvasive motor imagery-based brain-computer interface." *Journal of neural engineering* 10, no. 4 (2013): 046003.

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

Land, Martin Op 't, Erik Proper, Maarten Waage, Jeroen Cloo, and Claudia Steghuis. "Positioning Enterprise Architecture." In *Enterprise Architecture*, pp. 25-47. The Enterprise Engineering Series. Springer Berlin Heidelberg, 2009.

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

Leder, Felix, Tillmann Werner, and Peter Martini. "Proactive Botnet Countermeasures: An Offensive Approach." In *The Virtual Battlefield: Perspectives on Cyber Warfare,* volume 3, edited by Christian Czosseck and Kenneth Geers, pp. 211-25. IOS Press, 2009.

Leed, Maren. *Offensive Cyber Capabilities at the Operational Level: The Way Ahead*. Washington, DC: Center for Strategic and International Studies, 2013.

Li, S., F. Hu, and G. Li, "Advances and Challenges in Body Area Network." In *Applied Informatics and Communication*, edited by J. Zhan, pp. 58-65. Communications in Computer and Information Science 22. Springer Berlin Heidelberg, 2011.

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

Lin, James C. "Hearing microwaves: The microwave auditory phenomenon." *IEEE Antennas and Propagation Magazine* 43, no. 6 (2001): 166-68.

Lind, Jürgen. "Issues in agent-oriented software engineering." In *Agent-Oriented Software Engineering*, pp. 45-58. Springer Berlin Heidelberg, 2001.

Lindström, Åsa, Pontus Johnson, Erik Johansson, Mathias Ekstedt, and Mårten Simonsson. "A Survey on CIO Concerns – Do Enterprise Architecture Frameworks Support Them?" *Information Systems Frontiers* 8, no. 2 (2006).

Ling, Geoffrey SF, Peter Rhee, and James M. Ecklund. "Surgical innovations arising from the Iraq and Afghanistan wars." *Annual review of medicine* 61 (2010): 457-68.

Linsenmeier, Robert A. "Retinal Bioengineering." In *Neural Engineering*, edited by Bin He, pp. 421-84. Bioelectric Engineering. Springer US, 2005.

Liu, Hanjun, and Manwa L. Ng. "Electrolarynx in voice rehabilitation," *Auris Nasus Larynx* 34, no. 3 (2007): 327-32.

Liu, Kecheng, Lily Sun, Dian Jambari, Vaughan Michell, and Sam Chong. "A Design of Business-Technology Alignment Consulting Framework." In *Advanced Information Systems Engineering*, edited by Haralambos Mouratidis and Colette Rolland, pp. 422-35. Lecture Notes in Computer Science 6741. Springer Berlin Heidelberg, 2011.

Lloyd, David. "Biological Time Is Fractal: Early Events Reverberate over a Life Time." *Journal of Biosciences* 33, no. 1 (March 1, 2008): 9-19.

LoBello, Lucia, and Emanuele Toscano. "An adaptive approach to topology management in large and dense real-time wireless sensor networks." *IEEE Transactions on Industrial Informatics* 5, no. 3 (2009): 314-24.

Logan, Lynne Romeiser. "Rehabilitation techniques to maximize spasticity management." *Topics in stroke rehabilitation* 18, no. 3 (2011): 203-11.

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.

Lorence, Daniel, Anusha Sivaramakrishnan, and Michael Richards. "Transaction-Neutral Implanted Data Collection Interface as EMR Driver: A Model for Emerging Distributed Medical Technologies." *Journal of Medical Systems* 34, no. 4 (March 20, 2009): 609-17.

Luber, B., C. Fisher, P.S. Appelbaum, M. Ploesser, and S.H. Lisanby. "Non-invasive brain stimulation in the detection of deception: Scientific challenges and ethical consequences." *Behavioral Sciences and the Law* 27, no. 2 (2009): 191-208.

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.

Ma, Jianhua, Kim-Kwang Raymond Choo, Hui-huang Hsu, Qun Jin, William Liu, Kevin Wang, Yufeng Wang, and Xiaokang Zhou. "Perspectives on Cyber Science and Technology for Cyberization and Cyber-Enabled Worlds." In *2016 IEEE 14th International Conference on Dependable, Autonomic and Secure Computing, 14th International Conference on Pervasive Intelligence and Computing, 2nd International Conference on Big Data Intelligence and Computing and Cyber Science and Technology Congress (DASC/PiCom/DataCom/CyberSciTech)*, pp. 1-9. IEEE, 2016.

Ma, Wei Ji, Masud Husain, and Paul M. Bays. "Changing concepts of working memory." *Nature neuroscience* 17, no. 3 (2014): 347-56.

MacLennan, Elzavita, and Jean-Paul Van Belle. "Factors Affecting the Organizational Adoption of Service-Oriented Architecture (SOA)." *Information Systems and E-Business Management* 12, no. 1 (January 5, 2013): 71-100.

MacVittie, Kevin, Jan Halámek, Lenka Halámková, Mark Southcott, William D. Jemison, Robert Lobel, and Evgeny Katz. "From 'cyborg' lobsters to a pacemaker powered by implantable biofuel cells." *Energy & Environmental Science* 6, no. 1 (2013): 81-86.

Magnetic Stimulation in Clinical Neurophysiology. Second edition. Edited by Mark Hallett and Sudhansu Chokroverty. Philadelphia: Elsevier Butterworth Heinemann, 2005.

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).

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

Maitra, Amit K. "Offensive cyber-weapons: technical, legal, and strategic aspects." *Environment Systems and Decisions* 35, no. 1 (2015): 169-82.

Mak, Stephen. "Ethical Values for E-Society: Information, Security and Privacy." In *Ethics and Policy of Biometrics*, edited by Ajay Kumar and David Zhang, 96-101. Lecture Notes in Computer Science 6005. Springer Berlin Heidelberg, 2010.

Mangun, George R. *The Neuroscience of Attention: Attentional Control and Selection*. Oxford University Press, 2012.

Martin, Richard, and Edward Robertson. "A Comparison of Frameworks for Enterprise Architecture Modeling." In *Conceptual Modeling - ER 2003*, edited by Il-Yeol Song, Stephen W. Liddle, Tok-Wang Ling, and Peter Scheuermann. Lecture Notes in Computer Science 2813. Springer Berlin Heidelberg, 2003.

Mascarenhas, S., R. Prada, A. Paiva, and G.J. Hofstede. "Social Importance Dynamics: A Model for Culturally-Adaptive Agents." In *Intelligent Virtual Agents*, pp. 325-38. Lecture Notes in Computer Science no. 8108. Springer Berlin Heidelberg, 2013.

McCullagh, P., G. Lightbody, J. Zygierewicz, and W.G. Kernohan, "Ethical Challenges Associated with the Development and Deployment of Brain Computer Interface Technology." *Neuroethics* 7, no. 2 (July 28, 2013): 109-22.

McCulloh, Ian A., Helen L. Armstrong, and Anthony N. Johnson. *Social Network Analysis with Applications.* Hoboken, NJ: John Wiley & Sons, Inc., 2013.

McGaugh, James L., and Benno Roozendaal. "Role of adrenal stress hormones in forming lasting memories in the brain." *Current opinion in neurobiology* 12, no. 2 (2002): 205-10.

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, Michael J., and Cliodhna Ní Scanaill. "Regulations and Standards: Considerations for Sensor Technologies." In *Sensor Technologies*, pp. 115-35. Apress, 2013.

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

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

Mercanzini, André, and Philippe Renaud. *Microfabricated Cortical Neuroprostheses*. Boca Raton: CRC Press, 2010.

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*, pp. 117-60. Ethics of Science and Technology Assessment 29. Springer Berlin Heidelberg, 2007.

Mezzanotte, Sr., Dominic M., and Josh Dehlinger. "Enterprise Architecture: A Framework Based on Human Behavior Using the Theory of Structuration." In *Software Engineering Research, Management and Applications 2012*, edited by Roger Lee, pp. 65-79. Studies in Computational Intelligence 430. Springer Berlin Heidelberg, 2012.

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.

Miller, Kai J., and Jeffrey G. Ojemann. "A Simple, Spectral-Change Based, Electrocorticographic Brain–Computer Interface." In *Brain-Computer Interfaces*, edited by Bernhard Graimann, Gert Pfurtscheller, and Brendan Allison, pp. 241-58. The Frontiers Collection. Springer Berlin Heidelberg, 2009.

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.

Min Neo, Hui, and Romain Fonsegrives. "For these 'cyborgs,' keys are so yesterday." AFP / Yahoo! Tech, September 4, 2015. https://www.yahoo.com/tech/cyborgs-keys-yesterday-114442441.html. Accessed December 8, 2016.

"Mind over Mouth? Study Could Lead to Communicating via Thoughts." UCI News, August 13, 2008. https://news.uci.edu/briefs/mind-over-mouth-study-could-lead-to-communicating-via-thoughts/. Accessed December 5, 2016.

Mitcheson, Paul D. "Energy harvesting for human wearable and implantable bio-sensors." In *Engineering in Medicine and Biology Society (EMBC), 2010 Annual International Conference of the IEEE,* pp. 3432-36. IEEE, 2010.

Mizraji, Eduardo, Andrés Pomi, and Juan C. Valle-Lisboa. "Dynamic Searching in the Brain." *Cognitive Neurodynamics* 3, no. 4 (June 3, 2009): 401-14.

Møller, Aage R. *Sensory Systems: Anatomy and Physiology*. Third edition. Aage R Møller, 2014.

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.

Moxon, David. *Memory.* Oxford: Heinemann Educational Publishers, 2000.

Mubin, Omar, Christoph Bartneck, Loe Feijs, Hanneke Hooft van Huysduynen, Jun Hu, and Jerry Muelver. "Improving speech recognition with the robot interaction language." *Disruptive Science and Technology* 1, no. 2 (2012): 79-88.

Mubin, Omar, Joshua Henderson, and Christoph Bartneck. "Talk ROILA to your Robot." In *Proceedings of the 15th Conference on International conference on multimodal interaction*, pp. 317-18. ACM, 2013.

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

Mulhauser, Gregory R. "On the end of a quantum mechanical romance." *Psyche* 2, no. 5 (1995).

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

Muscolino, Joseph E. *Kinesiology: The Skeletal System and Muscle Function.* Third edition. St. Louis: Elsevier, 2017.

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

Nakakawa, Agnes, Patrick van Bommel, and H. A. Erik Proper. "Quality Enhancement in Creating Enterprise Architecture: Relevance of Academic Models in Practice." In *Advances in Enterprise Engineering II*, edited by Erik Proper, Frank Harmsen, and Jan L. G. Dietz, pp. 109-33. Lecture Notes in Business Information Processing 28. Springer Berlin Heidelberg, 2009.

The Nature of Time: Geometry, Physics and Perception, edited by Rosolino Buccheri, Metod Saniga, and William Mark Stuckey. Springer Science+Business Media Dordrecht, 2003.

Nayar, Pramod K. *An Introduction to New Media and Cybercultures.* Chichester: John Wiley & Sons Ltd., 2010.

Negoescu, R. "Conscience and Consciousness in Biomedical Engineering Science and Practice." In *International Conference on Advancements of Medicine and Health Care through Technology*, edited by Simona Vlad, Radu V. Ciupa, and Anca I. Nicu, pp. 209-14. IFMBE Proceedings 26. Springer Berlin Heidelberg, 2009.

Neubauer, André, Jürgen Freudenberger, and Volker Kühn. *Coding Theory: Algorithms, Architectures and Applications*. Chichester: John Wiley & Sons Ltd., 2007.

Neuper, Christa, and Gert Pfurtscheller. "Neurofeedback Training for BCI Control." In *Brain-Computer Interfaces*, edited by Bernhard Graimann, Gert Pfurtscheller, and Brendan Allison, pp. 65-78. The Frontiers Collection. Springer Berlin Heidelberg, 2009.

Neuroimaging and Memory, edited by Jonathan K. Foster. Hove, East Sussex: Psychology Press Ltd., 1999.

The Neuroscience of Sleep, edited by Robert Stickgold and Matthew P. Walker. London: Elsevier, 2009.

Neuweiler, Gerhard. "Evolutionary aspects of bat echolocation." *Journal of Comparative Physiology A* 189, no. 4 (2003): 245-256.

Niku, Saeed B. *Introduction to Robotics: Analysis, Control, Applications.* Second edition. Hoboken: John Wiley & Sons, Inc., 2011.

NIST Special Publication 1800-1b: Securing Electronic Health Records on Mobile Devices: Approach, Architecture, and Security Characteristics. Leah Kauffman, editor-in-chief. Gaithersburg, MD: National Institute of Standards & Technology, 2015.

NIST Special Publication 800-100: Information Security Handbook: A Guide for Managers. Edited by P. Bowen, J. Hash, and M. Wilson. Gaithersburg, MD: National Institute of Standards & Technology, 2006.

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

Niven, Jeremy E. "Invertebrate neurobiology: Visual direction of arm movements in an octopus." *Current Biology* 21, no. 6 (2011): R217-R218.

Noran, Ovidiu. “A Mapping of Individual Architecture Frameworks (GRAI, PERA, C4ISR, CIMOSA, ZACHMAN, ARIS) onto GERAM.” In *Handbook on Enterprise Architecture*, edited by Peter Bernus, Laszlo Nemes, and Günter Schmidt, pp. 65-210. International Handbooks on Information Systems. Springer Berlin Heidelberg, 2003.

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.

Obaid, M., I. Damian, F. Kistler, B. Endrass, J. Wagner, and E. André. “Cultural Behaviors of Virtual Agents in an Augmented Reality Environment.” In *Intelligent Virtual Agents*, pp. 412-18. Lecture Notes in Computer Science no. 7502. Springer Berlin Heidelberg, 2012.

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.

Okun, Michael S. “Parkinson’s Disease: Guide to Deep Brain Stimulation Therapy.” Second edition. National Parkinson Foundation, 2014. http://www.parkinson.org/sites/default/files/Guide_to_DBS_Stimulation_Therapy.pdf. Accessed December 8, 2016.

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.

Osterwalder, Alexander, and Yves Pigneur. *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons, 2010.

The Oxford Handbook of Philosophy of Perception, edited by Mohan Matthen. Oxford: Oxford University Press, 2015.

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

Panoulas, Konstantinos J., Leontios J. Hadjileontiadis, and Stavros M. Panas. “Brain-Computer Interface (BCI): Types, Processing Perspectives and Applications.” In *Multimedia Services in Intelligent Environments*, edited by George A. Tsihrintzis and Lakhmi C. Jain, pp. 299-321. Smart Innovation, Systems and Technologies 3. Springer Berlin Heidelberg, 2010.

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, pp. 3185-3200. Heidelberg/Berlin: Springer, 2009.

Parker, Donn B. “Toward a New Framework for Information Security.” In *The Computer Security Handbook*, fourth edition, edited by Seymour Bosworth and M. E. Kabay. John Wiley & Sons, 2002.

Patel, Rajeev, Robert J. Torres, and Peter Rosset. “Genetic engineering in agriculture and corporate engineering in public debate: risk, public relations, and public debate over genetically modified crops.” *International journal of occupational and environmental health* 11, no. 4 (2005).

Patil, P.G., and D.A. Turner. “The Development of Brain-Machine Interface Neuroprosthetic Devices.” In *Neurotherapeutics* 5, no. 1 (January 1, 2008): 137-46.

Patoine, Brenda. "Progress Report 2010: Deep Brain Stimulation – The 2010 Progress Report on Brain Research." The Dana Foundation, January 2010. http://www.dana.org/Publications/ReportDetails.aspx?id=44348. Accessed December 8, 2016.

Payr, S., and Trappl, R. "Agents across Cultures." In *Intelligent Virtual Agents*, pp. 320-24. Lecture Notes in Computer Science 2792. Springer Berlin Heidelberg, 2003.

Pazzaglia, Mariella, and Marco Molinari. "The embodiment of assistive devices – from wheelchair to exoskeleton." *Physics of Life Reviews* 16 (2016): 163-75.

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.

Peigneux, Philippe. "Neuroimaging Studies of Sleep and Memory in Humans." In *Sleep, Neuronal Plasticity and Brain Function*, edited by Peter Meerlo, Ruth M. Benca, and Ted Abel, pp. 239-68. Springer Berlin Heidelberg, 2015.

Pérez Ríos, José. "Systems Thinking, Organisational Cybernetics and the Viable System Model." In *Design and Diagnosis for Sustainable Organizations*, pp. 1-64. Springer Berlin Heidelberg, 2012.

Peterson, David J. *The Art of Language Invention: From Horse-Lords to Dark Elves, The Words Behind World-Building*. New York: Penguin Books, 2015.

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.

Polcar, Jiri, and Petr Horejsi. "Knowledge Acquisition and Cyber Sickness: A Comparison of VR Devices in Virtual Tours." *MM Science Journal* (June 2015): 613-16.

Pollatsek, Alexander. "The Role of Sound in Silent Reading." In *The Oxford Handbook of Reading*, edited by Alexander Pollatsek and Rebecca Treiman, pp. 185-201. New York: Oxford University Press, 2015.

Postmarket Management of Cybersecurity in Medical Devices: Draft Guidance for Industry and Food and Drug Administration Staff. Silver Spring, MD: US Food and Drug Administration, 2016.

Prestes, E., J.L. Carbonera, S. Rama Fiorini, V.A.M. Jorge, M. Abel, R. Madhavan, A. Locoro, et al. "Towards a Core Ontology for Robotics and Automation." *Robotics and Autonomous Systems* 61, no. 11 (November 2013): 1193-1204.

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.

Primer on the Autonomic Nervous System. Third edition. Edited by David Robertson, Italo Biaggioni, Geoffrey Burnstock, Phillip A. Low, and Julian F.R. Paton. London: Academic Press, 2012.

Principe, José C., and Dennis J. McFarland. "BMI/BCI Modeling and Signal Processing." In *Brain-Computer Interfaces*, pp. 47-64. Springer Netherlands, 2008.

"Products and Procedures." Medtronic, 2016. http://professional.medtronic.com/pt/neuro/dbs-md/prod/index.htm. Accessed December 8, 2016.

"Prosthetics: Sponsor." Johns Hopkins Applied Physics Laboratory. http://www.jhuapl.edu/prosthetics/program/sponsor.asp. Accessed December 5, 2016.

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.

Putnam, Hilary. *Reason, Truth and History*. Cambridge: Cambridge University Press, 1981.

Radvansky, Gabriel A. *Human Memory.* Second edition. New York: Routledge, 2016.

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.

Rao, R.P.N., A. Stocco, M. Bryan, D. Sarma, T.M. Youngquist, J. Wu, and C.S. Prat. "A direct brain-to-brain interface in humans." *PLoS ONE* 9, no. 11 (2014).

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.

Rehm, M., André, E., and Nakano, Y. "Some Pitfalls for Developing Enculturated Conversational Agents." In *Human-Computer Interaction: Ambient, Ubiquitous and Intelligent Interaction*, pp. 340-48. Lecture Notes in Computer Science 5612. Springer Berlin Heidelberg, 2009.

Rehm, M., Y. Nakano, E. André, T. Nishida, N. Bee, B. Endrass, M. Wissner, A.A. Lipi, and H. Huang, "From observation to simulation: generating culture-specific behavior for interactive systems." *AI & SOCIETY* vol. 24, no. 3 (2009): 267-80.

Reynolds, Dwight W., Christina M. Murray, and Robin E. Germany. "Device Therapy for Remote Patient Management." In *Electrical Diseases of the Heart*, edited by Ihor Gussak, Charles Antzelevitch, Arthur A. M. Wilde, Paul A. Friedman, Michael J. Ackerman, and Win-Kuang Shen, pp. 809-25. Springer London, 2008.

Robertazzi, Thomas G. *Networks and Grids: Technology and Theory*. Springer-Verlag New York, 2007.

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.

Rodriguez, Ana Maria. *Autism Spectrum Disorders*. Minneapolis: Twenty-First Century Books, 2011.

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. Accessed October 21, 2015.

Rookes, Paul, and Jane Willson. *Perception: Theory, Development and Organisation.* London: Routledge, 2000.

Roosendaal, Arnold. "Implants and Human Rights, in Particular Bodily Integrity." In *Human ICT Implants: Technical, Legal and Ethical Considerations*, edited by Mark N. Gasson, Eleni Kosta, and Diana M. Bowman, pp. 81-96. Information Technology and Law Series 23. T. M. C. Asser Press, 2012.

Rosenbaum, David A. *Human Motor Control.* Second edition. Burlington, MA: Elsevier, 2010.

Rotter, Pawel, Barbara Daskala, and Ramon Compañó. "Passive Human ICT Implants: Risks and Possible Solutions." In *Human ICT Implants: Technical, Legal and Ethical Considerations*, edited by Mark N. Gasson, Eleni Kosta, and Diana M. Bowman, pp. 55-62. Information Technology and Law Series 23. T. M. C. Asser Press, 2012.

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

Royakkers, Lambèr, and Rinie van Est. "A literature review on new robotics: automation from love to war." *International journal of social robotics* 7, no. 5 (2015): 549-70.

Rozhok, Andrii. *Orientation and Navigation in Vertebrates.* Springer-Verlag Berlin Heidelberg, 2008.

Rugg, Michael D., Jeffrey D. Johnson, and Melina R. Uncapher. "Encoding and Retrieval in Episodic Memory: Insights from fMRI." In *The Wiley Handbook on the Cognitive Neuroscience of Memory*, edited by Donna Rose Addis, Morgan Barense, and Audrey Duarte, pp. 84-107. Malden, MA: John Wiley & Sons, 2015.

Rutherford, Andrew, Gerasimos Markopoulos, Davide Bruno, and Mirjam Brady-Van den Bos. "Long-Term Memory: Encoding to Retrieval." In *Cognitive Psychology*, second edition, edited by Nick Braisby and Angus Gellatly, pp. 229-65. Oxford: Oxford University Press, 2012.

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.

Rynes, Sara L., Barry Gerhart, and Kathleen A. Minette. "The importance of pay in employee motivation: Discrepancies between what people say and what they do." *Human Resource Management* 43, no. 4 (2004): 381-94.

Saha, S.K. *Introduction to Robotics.* New Delhi: Tata McGraw-Hill Publishing Company Limited, 2008.

Sakas, Damianos E., I. G. Panourias, B. A. Simpson, and E. S. Krames. "An Introduction to Operative Neuromodulation and Functional Neuroprosthetics, the New Frontiers of Clinical Neuroscience and Biotechnology." In *Operative Neuromodulation*, edited by Damianos E. Sakas and Brian A. Simpson, pp. 2-10. Acta Neurochirurgica Supplements 97/1. Springer Vienna, 2007.

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

Sanchez, Justin C. *Neuroprosthetics: Principles and Applications.* Boca Raton: CRC Press, 2016.

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.

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.

Sayood, Khalid. *Introduction to Data Compression.* Waltham, MA: Morgan Kaufmann, 2012.

Sayrafian-Pour, K., W.-B. Yang, J. Hagedorn, J. Terrill, K. Yekeh Yazdandoost, and K. Hamaguchi. "Channel Models for Medical Implant Communication." *International Journal of Wireless Information Networks* 17, no. 3-4 (December 9, 2010): 105-12.

Schermer, Maartje. "The Mind and the Machine. On the Conceptual and Moral Implications of Brain-Machine Interaction." *NanoEthics* 3, no. 3 (December 1, 2009): 217-30.

Schwartz, Bennett L. *Memory: Foundations and Applications.* Second edition. Thousand Oaks, CA: SAGE Publications, Inc., 2014.

"Security Risk Assessment Framework for Medical Devices." Washington, DC: Medical Device Privacy Consortium, 2014.

Self-Organizing Networks (SON): Self-Planning, Self-Optimization and Self-Healing for GSM, UMTS, and LTE, edited by Juan Ramiro and Khalid Hamied. Chichester: John Wiley & Sons Ltd., 2012.

Sensory Evolution on the Threshold: Adaptations in Secondarily Aquatic Vertebrates, edited by J.G.M. Thewissen and Sirpa Nummela. Berkeley: University of California Press, 2008.

Settle-Murphy, Nancy M. *Leading Effective Virtual Teams: Overcoming Time and Distance to Achieve Exceptional Results*. Boca Raton: CRC Press, 2012.

Shahinpoor, Mohsen, Kwang J. Kim, and Mehran Mojarrad. *Artificial Muscles: Applications of Advanced Polymeric Nanocomposites*. Boca Raton: Taylor & Francis, 2007.

Shekhar, Sandhya. *Managing the Reality of Virtual Organizations*. Springer India, 2016.

Sherwood, Lauralee. *Fundamentals of Human Physiology.* Fourth edition. Belmont, CA: Brooks/Cole, 2012.

Shoniregun, Charles A., Kudakwashe Dube, and Fredrick Mtenzi. "Introduction to E-Healthcare Information Security." In *Electronic Healthcare Information Security*, pp. 1-27. Advances in Information Security 53. Springer US, 2010.

Siegel, Allan, and Hreday Sapru. *Essential Neuroscience*. Baltimore: Lippincott Williams & Wilkins, 2006.

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.

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, C.U.M., *Biology of Sensory Systems*. Second edition. Chichester: John Wiley & Sons Ltd., 2008.

Smolensky, Paul. "The constituent structure of connectionist mental states: A reply to Fodor and Pylyshyn." *The Southern Journal of Philosophy* 26, no. S1 (1988): 137-61.

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

Snyder, Allan W., Elaine Mulcahy, Janet L. Taylor, D. John Mitchell, Perminder Sachdev, and Simon C. Gandevia. "Savant-like skills exposed in normal people by suppressing the left fronto-temporal lobe." *Journal of integrative neuroscience* 2, no. 02 (2003): 149-58.

Snyder, Allan. "Explaining and inducing savant skills: privileged access to lower level, less-processed information." *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 364, no. 1522 (2009): 1399-1405.

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.

Sohl-Dickstein, Jascha, Santani Teng, Benjamin M. Gaub, Chris C. Rodgers, Crystal Li, Michael R. DeWeese, and Nicol S. Harper. "A device for human ultrasonic echolocation." *IEEE Transactions on Biomedical Engineering* 62, no. 6 (2015): 1526-34.

Sosinsky, Barrie. *Networking Bible*. Indianapolis: Wiley Publishing Inc., 2009.

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

"Spinal Cord Stimulation." American Association of Neurological Surgeons, October 2008. http://www.aans.org/Patient%20Information/Conditions%20and%20Treatments/Spinal%20Cord%20Stimulation.aspx. Accessed December 8, 2016.

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, VA: National Science Foundation, 2002.

Srinivasan, G. R. "Modeling the cosmic-ray-induced soft-error rate in integrated circuits: an overview." *IBM Journal of Research and Development* 40, no. 1 (1996): 77-89.

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.

Stallings, William. *Cryptography and Network Security: Principles and Practice*. Seventh edition. Harlow: Pearson Education Limited, 2017.

Starr, Cecie, and Beverly McMillan. *Human Biology.* Eleventh edition. Boston: Cengage Learning, 2016.

Stelzer, Dirk. "Enterprise Architecture Principles: Literature Review and Research Directions." In *Service-Oriented Computing. ICSOC/ServiceWave 2009 Workshops*, pp. 12-21. Springer, 2010.

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, pp. 435-42. Acta Neurochirurgica Supplements 97/1. Springer Vienna, 2007.

Streib, James T. *Guide to Assembly Language: A Concise Introduction.* Springer-Verlag London Limited, 2011.

"Studies Find Disparities in Use of Deep Brain Stimulation." Parkinson's Disease Foundation, January 29, 2014. http://www.pdf.org/en/science_news/release/pr_1391019029. Accessed December 8, 2016.

Sundberg, Hakan P. "Building the Enterprise Architecture: A Bottom-Up Evolution?" In *Advances in Information Systems Development*, edited by Wita Wojtkowski, W. Gregory Wojtkowski, Jože Zupancic, Gabor Magyar, and Gabor Knapp, 287. Springer US, 2007.

"Surgeons Publish Study on Auditory Brainstem Implant Procedure." *The Hearing Review*, May 22, 2015. http://www.hearingreview.com/2015/05/surgeons-publish-study-auditory-brainstem-implant-procedure/. Accessed December 8, 2016.

"The Deepening Fusion of Human Personnel and Electronic Information Systems: Implications of Neuroprosthetic Augmentation for Enterprise Architecture,"
Chapter Six in Gladden, Matthew E., Neuroprosthetic Supersystems Architecture, pp. 210-52. Indianapolis: Synthypnion Academic, 2017.
ISBN 978-1-944373-07-8 (print edition) and 978-1-944373-08-5 (ebook).

Synaesthesia: Theoretical, artistic and scientific foundations, edited by María José de Córdoba Serrano, Dina Riccò, and Sean A. Day. Granada: International Foundation Artecittà Publishing, 2014.

Szoldra, P. "The government's top scientists have a plan to make military cyborgs." *Tech Insider*, January 22, 2016. http://www.techinsider.io/darpa-neural-interface-2016-1. Accessed May 6, 2016.

Talan, J. "DARPA: On the Hunt for Neuroprosthetics to Enhance Memory." *Neurology Today* 14, no. 20 (2014): 8-10.

Tang, Hao, Yun Fu, Jilin Tu, Mark Hasegawa-Johnson, and Thomas S. Huang. "Humanoid audio–visual avatar with emotive text-to-speech synthesis." *IEEE Transactions on multimedia* 10, no. 6 (2008): 969-81.

Targeted Muscle Reinnervation: A Neural Interface for Artificial Limbs, edited by Todd A. Kuiken, Aimee E. Schultz Feuser, and Ann K. Barlow. Boca Raton: CRC Press, 2014.

Tarín, C., L. Traver, P. Martí, and N. Cardona. "Wireless Communication Systems from the Perspective of Implantable Sensor Networks for Neural Signal Monitoring." In *Wireless Technology*, edited by S. Powell and J.P. Shim, pp. 177-201. Lecture Notes in Electrical Engineering 44. Springer US, 2009.

Taylor, N. R., and J. G. Taylor. "The Neural Networks for Language in the Brain: Creating LAD." In *Computational Models for Neuroscience*, edited by Robert Hecht-Nielsen and Thomas McKenna, pp. 245-65. Springer London, 2003.

Taylor, Annette Kujawski, "Hyperthymesia." In *Encyclopedia of Human Memory*, edited by Annette Kujawski Taylor, pp. 547-50. Santa Barbara: Greenwood, 2013.

Taylor, Dawn M. "Functional Electrical Stimulation and Rehabilitation Applications of BCIs." In *Brain-Computer Interfaces*, pp. 81-94. Springer Netherlands, 2008.

Taylor, Dawn M., Stephen I. Helms Tillery, and Andrew B. Schwartz. "Direct cortical control of 3D neuroprosthetic devices." *Science* 296, no. 5574 (2002): 1829-32.

Teng, Santani, and David Whitney. "The acuity of echolocation: spatial resolution in the sighted compared to expert performance." *Journal of visual impairment & blindness* 105, no. 1 (2011): 20-32.

Tennison, Michael N., and Jonathan D. Moreno. "Neuroscience, Ethics, and National Security: The State of the Art." *PLOS Biology*, March 20, 2012. http://dx.doi.org/10.1371/journal.pbio.1001289. Accessed December 5, 2016.

Thanos, Solon, P. Heiduschka, and T. Stupp. "Implantable Visual Prostheses." In *Operative Neuromodulation*, edited by Damianos E. Sakas and Brian A. Simpson, pp. 465-72. Acta Neurochirurgica Supplements 97/2. Springer Vienna, 2007.

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

Thorpe, Julie, Paul C. van Oorschot, and Anil Somayaji. "Pass-thoughts: authenticating with our minds." In *Proceedings of the 2005 Workshop on New Security Paradigms*, pp. 45-56. ACM, 2005.

TOGAF® Version 9.1. Berkshire: The Open Group, 2011.

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.

Transcranial Magnetic Stimulation in Clinical Psychiatry, edited by Mark S. George and Robert H. Belmaker. Washington, DC: American Psychiatric Publishing, Inc., 2007.

Treffert, Darold A. "Accidental Genius." *Scientific American* 311, no. 2 (2014): 52-57.

Treffert, Darold A. "The savant syndrome: an extraordinary condition. A synopsis: past, present, future." *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 364, no. 1522 (2009): 1351-57.

Troyk, Philip R., and Stuart F. Cogan. "Sensory Neural Prostheses." In *Neural Engineering*, edited by Bin He, pp. 1-48. Bioelectric Engineering. Springer US, 2005.

Turner, Patrick, John Gøtze, and Peter Bernus. "Architecting the Firm – Coherency and Consistency in Managing the Enterprise." In *On the Move to Meaningful Internet Systems: OTM 2009 Workshops*, edited by Robert Meersman, Pilar Herrero, and Tharam Dillon, pp. 162-71. Lecture Notes in Computer Science 5872. Springer Berlin Heidelberg, 2009.

Upper Motor Neurone Syndrome and Spasticity: Clinical Management and Neurophysiology, second edition, edited by Michael P. Barnes and Garth R. Johnson. Cambridge: Cambridge University Press, 2008.

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 der Raadt, Bas and Hans van Vliet. "Assessing the Efficiency of the Enterprise Architecture Function." In *Advances in Enterprise Engineering II*, edited by Erik Proper, Frank Harmsen, and Jan L. G. Dietz, 63. Lecture Notes in Business Information Processing 28. Springer Berlin Heidelberg, 2009.

Van der Torre, Leendert, Marc M. Lankhorst, Hugo ter Doest, Jan T. P. Campschroer, and Farhad Arbab. "Landscape Maps for Enterprise Architectures." In *Advanced Information Systems Engineering*, edited by Eric Dubois and Klaus Pohl. Lecture Notes in Computer Science 4001. Springer Berlin Heidelberg, 2006.

Van Drongelen, Wim, Hyong C. Lee, and Kurt E. Hecox. "Seizure Prediction in Epilepsy." In *Neural Engineering*, edited by Bin He, pp. 389-419. Bioelectric Engineering. Springer US, 2005.

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.

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.

Viola, M. V., and Aristides A. Patrinos. "A Neuroprosthesis for Restoring Sight." In *Operative Neuromodulation*, edited by Damianos E. Sakas and Brian A. Simpson, pp. 481-86. Acta Neurochirurgica Supplements 97/2. Springer Vienna, 2007.

Virtual Organizations: Systems and Practices, edited by Luis M. Camarinha-Matos, Hamideh Afsarmanesh, and Martin Ollus. Boston: Springer Science+Business Media, 2005.

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

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.

Weiland, James D., Wentai Liu, and Mark S. Humayun. "Retinal Prosthesis." *Annual Review of Biomedical Engineering* 7, no. 1 (2005): 361-401.

Weinberger, Sharon. "Pentagon to Merge Next-Gen Binoculars with Soldiers' Brains." *Wired*, May 1, 2007. https://www.wired.com/2007/05/binoculars/. Accessed December 5, 2016.

Weiss, Simon, and Robert Winter. "Development of Measurement Items for the Institutionalization of Enterprise Architecture Management in Organizations." In *Trends in Enterprise Architecture Research and Practice-Driven Research on Enterprise Transformation*, edited by Stephan Aier, Mathias Ekstedt, Florian Matthes, Erik Proper, and Jorge L. Sanz, pp. 268-83. Lecture Notes in Business Information Processing 131. Springer Berlin Heidelberg, 2012.

Wells, M.J. *Octopus: Physiology and Behaviour of an Advanced Invertebrate*. Springer Netherlands, 1978.

Westlake, Philip R. "The possibilities of neural holographic processes within the brain." *Biological Cybernetics* 7, no. 4 (1970): 129-53.

White, Stephen E. "Brave new world: Neurowarfare and the limits of international humanitarian law." *Cornell International Law Journal* 41 (2008): 177.

Widge, A.S., C.T. Moritz, and Y. Matsuoka. "Direct Neural Control of Anatomically Correct Robotic Hands." In *Brain-Computer Interfaces*, edited by D.S. Tan and A. Nijholt, pp. 105-19. Human-Computer Interaction Series. London: Springer, 2010.

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.]

Wilkinson, Jeff, and Scott Hareland. "A cautionary tale of soft errors induced by SRAM packaging materials." *IEEE Transactions on Device and Materials Reliability* 5, no. 3 (2005): 428-33.

Williams, Theodore J., and Hong Li. "PERA and GERAM – Enterprise Reference Architectures in Enterprise Integration." In *Information Infrastructure Systems for Manufacturing II*, edited by John J. Mills and Fumihiko Kimura, pp. 3-30. IFIP – The International Federation for Information Processing 16. Springer US, 1999.

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

Wise, Kensall D., Amir M. Sodagar, Ying Yao, Mayurachat Ning Gulari, Gayatri E. Perlin, and Khalil Najafi. "Microelectrodes, microelectronics, and implantable neural microsystems." *Proceedings of the IEEE* 96, no. 7 (2008): 1184-1202.

Wise, Kensall D., D. J. Anderson, J. F. Hetke, D. R. Kipke, and K. Najafi. "Wireless implantable microsystems: high-density electronic interfaces to the nervous system." *Proceedings of the IEEE* 92, no. 1 (2004): 76-97.

Woisetschläger, David M. "Consumer Perceptions of Automated Driving Technologies: An Examination of Use Cases and Branding Strategies." In *Autonomous Driving*, pp. 687-706. Springer Berlin Heidelberg, 2016.

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

Wooldridge, M., and N. R. Jennings. "Intelligent agents: Theory and practice." *The Knowledge Engineering Review*, 10(2) (1995): 115-52.

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.

Yonck, Richard. "Toward a standard metric of machine intelligence." *World Future Review* 4, no. 2 (2012): 61-70.

Zebda, Abdelkader, S. Cosnier, J.-P. Alcaraz, M. Holzinger, A. Le Goff, C. Gondran, F. Boucher, F. Giroud, K. Gorgy, H. Lamraoui, and P. Cinquin. "Single glucose biofuel cells implanted in rats power electronic devices." *Scientific Reports* 3, article 1516 (2013).

Zhao, QiBin, LiQing Zhang, and Andrzej Cichocki. "EEG-Based Asynchronous BCI Control of a Car in 3D Virtual Reality Environments." *Chinese Science Bulletin* 54, no. 1 (January 11, 2009): 78-87.

Zofi, Yael. *A Manager's Guide to Virtual Teams.* New York: American Management Association, 2012.

Zullo, Letizia, German Sumbre, Claudio Agnisola, Tamar Flash, and Binyamin Hochner. "Non-somatotopic organization of the higher motor centers in octopus." *Current Biology* 19, no. 19 (2009): 1632-36.