Big Historical Foundations for Deep Future Speculations

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Published in:
Foundations of Science

DOI:
10.1007/s10699-015-9434-y

Publication date:
2017

Found Sci
DOI 10.1007/s10699-015-9434-y

Big Historical Foundations for Deep Future Speculations: Cosmic Evolution, Atechnogenesis, and Technocultural Civilization

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Abstract Big historians are attempting to construct a general holistic narrative of human origins enabling an approach to studying the emergence of complexity, the relation between evolutionary processes, and the modern context of human experience and actions. In this paper I attempt to explore the past and future of cosmic evolution within a big historical foundation characterized by physical, biological, and cultural eras of change. From this analysis I offer a model of the human future that includes an addition and/or reinterpretation of technological singularity theory with a new theory of biocultural evolution focused on the potential birth of technological life: the theory of atechnogenesis. Furthermore, I explore the potential deep futures of technological life and extrapolate towards two hypothetical versions of an 'Omega Civilization': expansion and compression.

Keywords Big history · Anthropology · Futures · Evolution · Singularity · Philosophy

1 Introduction

My focus is to explore the 'deep future' of 'big history' in-as-far as it can be explored given a lack of empirical data, inability to test future predictions, and an incomplete knowledge of local and global physical, biological, and cultural processes currently in operation. We can gain a new understanding of possible future trends and processes by analyzing the emerging science of cosmic evolution within the narrative architecture of big history. Although modern phenomena like technological complexification and sociopolitical convergence receive considerable attention, few researchers approach these issues from the vantage point of 13.8 billion years of interconnected evolution. Fewer still have

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Published online: 19 September 2015

detailed a working model for understanding deeper reaches of the human future despite the fact (or perhaps because of the fact) that the phenomenon of humanity has the broadest of all possible future event states. We can predict the future evolutionary possibilities for galaxies, stars, and planets on the deepest conceivable scales of time, but we have trouble predicting human possibility out even 100 years.

The most important addition to the literature offered in this paper involves taking biocultural evolution seriously as a natural phenomenon of equal significance to the hierarchy of cosmic processes that also include physicochemical and biochemical forms of evolutionary change. The failure to understand culture, and in particular the relationship between biology and culture as part of cosmic evolution, may be one of the primary failings of science in the modern world. This is a factor in holding back progress in our understanding of both the nature of humanity and the future of humanity. Therefore, in my approach to the deep future I focus on the emergence of the big historical cultural era. Specifically, I want to bring closer attention to the biocultural reproductive nature of the human phenomenon as it presents us with a peculiar cosmic evolutionary relationship that potentially offers clues regarding the future of evolutionary change and complexity construction.

This approach to culture as part of a cosmic evolutionary process is partly a response to an emerging realization that we need to understand the "nature of cosmic culture" (see Dick and Lupisella 2009), as well as the "future of culture" (see Dick 2009a). Our inability to understand the nature of cultural phenomenon and its future implications has many causes, but is made all the more difficult due to the "two cultures" divide that has pervaded academic inquiry for decades (see Snow 1959; Wilson 1998; Kauffman 2010). The heart of this divide is created by fundamentally different epistemological worldviews that emphasize different approaches to understanding natural phenomenon. Historically (and broadly) the sciences attempt an understanding of the world that is predictive and approaches objectivity through the formulation of timeless, context-independent physical laws. In contrast, the humanities have mainly focused on narrative construction and the subjective dimension of human experience, with special emphasis on context, choice, and latent possibility within any event. This epistemological division prevents the construction of unifying conversation between diverse fields within biology and anthropology, and more broadly between the 'physical/life sciences' and the 'social science/humanities'.

The most relevant consequence of the 'two cultures' divide in respect to this paper is that there has been little research that specifically attempts to understand cosmic processes connecting the development and evolution of physical and chemical systems to the development and evolution of biological, ecological, cultural, and technological systems (Heylighen 2011). As a result, no dominant academic conceptual framework comfortably situates the human phenomenon within an evolutionary context of the whole cosmos. Furthermore, dominant academic paradigms within academia do not lend themselves to such an analysis. In the sciences, many researchers have (often successfully) employed a physically reductionist program to understand life and the universe with the belief that all phenomena can be understood through an analysis of the mechanisms of its constituent parts. Consequently most 'higher phenomena' (i.e. more complex) are conceived of as representing 'epiphenomena' ultimately reducible to lower-level phenomena. The reductionist program has proven successful in many domains of physics and chemistry, but does not help us in understanding the evolution of complex adaptive systems (CAS) like organisms, ecosystems, and civilizations. Alternatively, over the past several decades, many influential social theorists have developed a postmodern relativistic program, within which grand narratives explaining the human experience are explicitly rejected, and modern notions of a historical direction towards greater 'freedom', 'equality', and 'progress' are problematized. The postmodern program has proven successful in critiquing many naïve and western-centric assumptions inherent to the original conception of the modern project, however it offers us no new alternative model within which we can construct a common humanistic sociopolitical direction.

My point here is to emphasize that both reductionism and postmodernity, albeit successful in different ways within the sciences and humanities, cannot help us in terms of formulating a better understanding of big history and its meaning for the human species moving forward into our common future. The physically reductionist program cannot explain the emergence and intensification of hierarchical local complexity, as well as the existence of goal-oriented, purposeful systems (Corning 2002a). Consequently, everything that humans are (e.g. complex, goal and value-oriented, conscious, subjects) and everything the human system exhibits (e.g. emergence, purposeful organization, autonomy) becomes alien, unnatural, and impossible to predict and reduce. In contrast, the postmodern relativistic program ignores or fails to confront the implications of rising technological complexity and global convergence, leaving human civilization goal-less on the deepest scales of time (Stewart 2010). As a result, any sociopolitical insight we can gain from understanding large-scale patterns and processes discernible over big historical scales are not fully appreciated.

However, pointing out potential flaws in worldview structures is much easier than constructing new worldview structures, and I do not hope to solve all of the problems that have characterized the two cultures divide or the problems of our modern scientific and humanistic approaches to understanding in this paper. However, what I do hope to offer is the foundations for a big historical perspective with relevance to human futures speculations (Sects. 2–2.4), an introduction and exploration of a biocultural evolutionary theory in the context of technological singularity theory (Sects. 3–3.3), and a discussion on the implications for our understanding of the deep future (Sects. 4–4.2). The end goal is to help academics work towards a more holistic and constructive understanding of humanity and our relationship to the world with general evolution, universal history, and a common future at the foundation.

For this exploration the development of cosmic evolutionary theory is of central importance. Throughout scientific history we have come to imagine ourselves as separate, marginal, or accidental by-products. In fact, it has not been uncommon for scientific progress in understanding the universe to become coupled with a type of existential nihilistic worldview in relation to the human phenomenon. Physicist Steven Weinberg most depressingly articulated this general perspective in *The First Three Minutes* (1977, p. 154):

> The more the universe seems comprehensible, the more it (also) seems pointless.

This general pessimism can (and has) been countered by reversing Weinberg's perspective—as the late physicist Albert Einstein did—pointing out that the most remarkable thing about the human-universe relationship is in its symbiosis (Vallentin 1954, p. 24):

> The most incomprehensible thing about the universe is that it is comprehensible.

I personally share the more optimistic 'Einsteinian' view, finding it remarkable that humans can learn so much about the fundamental structure of the cosmos beyond our limited and unreliable perceptual access. The very fact that our intellectual activities have produced knowledge about the worlds of the very small, the very large, the deep past, the potential future, and everything in between, is a source of tremendous wonder.

However, at the same time, Weinberg's cosmic nihilism is not entirely ridiculous. In fact, it is impossible to ignore the fact that sciences as diverse as astronomy, cosmology, biology, and anthropology have played a role in symbolically removing humanity from 'center stage' of the cosmic drama, whether that imagined center represented a particular civilization, our species, life, our solar system, the galaxy, or the whole universe. The progressive 'de-centering' of the human story in relation to nature has been a source of collective historical psychological discomfort. What is the function and purpose of humanity? Are we mere epiphenomena, here for the blink of a cosmic eye, destined to perish on a universal stage that did not expect us and does not need us? Is the historical process really directionless and meaningless with no escape and no hope for a higher state of humanity in relation to each other and the universe?

This is where cosmic evolutionary theory has a chance to re-organize our perspective and provide new insight. Throughout the development and evolution of our local universe there has been an interconnected growth of complexity from physical, chemical and biological systems, as well as cultural and technological systems. This growth of complexity appears to open up new possibilities for the exploration of new relationships and new opportunities for experience in the universe. When we consider humanity from this perspective we find that our scientific focus shifts towards the human system which now occupies a frontier position of highest complexity and cognition. Consequently, we are capable of directing the future of evolution, and whatever emergent possibility could stem from our uniquely cultural and technological activities. Or said in another way, whatever 'act' comes next in the 'cosmic drama' it will emerge from within the domain of collective human social values, cultural creativity, and our exploration of latent technological possibility. In this way the universe gives the appearance of internalizing its future potentiality within a network of billions of biocultural nodes that in aggregate represent a phenomenon capable of producing yet another level of complex organization.

This perspective does not succumb to the trap of anthropocentrism as I am not arguing that humans are 'reclaiming centrality'. Instead I am making the philosophical argument that humans could represent an important process in the context of the growth of local complexity that is part of a much larger 'multi-local' cosmic phenomenon. Of course this is speculative but it is entirely plausible that cosmic evolutionary theory has application on a universal scale, with other analogous levels of local complexity developing via a type of 'universal culture'. Therefore, in this attempt to understand the deep future, I do not attempt to specifically focus on understanding the role of mysterious impersonal forces such as dark energy and dark matter, but rather seek to understand how intimately familiar processes related to culture, technology, language, and mind could reshape the universe and/or possess a cosmic function in the operations of the cosmos itself, consequently adding new dimensions of purpose to our lives today and hope for a higher future. In short, we stand on the frontier of cosmic evolution and a future of tremendous possibility unforeseen by most historical humans.

This exploration, being a futurist work, will also require scientifically grounded extrapolation and philosophical speculation when confronting questions that many scientists, philosophers, and historians would deem unknowable with any degree of certainty. However, we live in unprecedented times, in terms of technological complexity and geopolitical organization, when compared to any known time period throughout cosmic history, and consequently, we need new ideas to open conversation about what we are and where we may be going (Weiner 1963, pp. 5–6):

> It is the part of the scientist to entertain heretical and forbidden opinions experimentally, even if [s/]he is finally to reject them. […] It is a serious exercise, and

should be undertaken in all earnestness: it is only when it involves a real risk of heresy that there is any point to it.

Finally, like other works focused on the deep future, this analysis will leave us with far more questions than answers; but it is important to live in the questions, not the answers (e.g. Kiriakakis 2015). We are the inheritors of a deep and interconnected cosmic process, and find ourselves awkwardly navigating the highest levels of complexity our local region has ever known; within this evolutionary labyrinth a big historical inquiry may offer a light.

2 Big History

Big history is the study of the human past in relationship to the history of the universe (see Christian 2004; Spier 2011). This endeavor attempts to utilize the entire collective body of human knowledge in order to construct a deeper understanding of all natural processes (e.g. Aunger 2007a, b; Chaisson 2011a, b) from "Big Bang to Global Civilization" (e.g. Rodrigue et al. 2012). In contrast with the traditional attempt in physics to construct a 'grand unified theory' of the universe, big historians see the subject as providing the beginnings of a working "grand unified story" of the universe (Christian 2004, p. 4). From my perspective this goal should not be to eventually develop 'one unchanging objective story', but rather to develop the empirical framework for a story of our collective history that everyone can in turn relate to and utilize on a personal level. Thus big history has the opportunity to become simultaneously one story of our shared world *as well as* an infinite number of stories of how individuals can relate to that world. The usefulness of such a common origin story is that it can always be re-symbolized depending on contemporary sociopolitical context and scientific understanding. Consequently, big history offers humanity a deeper perspective and an opportunity for cosmic reflection in relation to the meaning of human life from an exploration of the processes that culminated in our existence.

In concert with this inquiry, cosmic evolution as a subject has emerged as a theoretical branch of study that attempts to understand all physical processes related to space, time, energy, and matter (STEM) (Spier 2005; Chaisson 2012). In this attempt to further generalize evolutionary change theorists have integrated physical evolution (e.g. galaxies, stars, planets), biological evolution (e.g. organisms, ecosystems), and cultural evolution (e.g. worldviews, civilization, technology) into an interconnected process characterized by growing complexity. Cosmic evolution can therefore provide an analysis of the developmental and evolutionary mechanisms within which the larger unified story of our common history unfolds. In this sense cosmic evolution and big history are complementary subjects that could transcend the 'two cultures' and ultimately share the goal of providing a sense of holistic unity for our species with all nature (e.g. Sagan 1977, 1980, 1997; Chaisson 1981, 2001, 2005; Bloom 2000; Christian 2004; Niele 2005; Dick 2009b; Kauffman 2010; Spier 2011): a history and a science, a story and a process, which can help the human species build a sense of common home and a sense of common creative origin.

In light of this academic ambition, the emergence of big history and cosmic evolution represent more than just new silos of academic inquiry. Throughout modern history academia has become fragmented into many disparate disciplines, but in this fragmentation it can be hard to find the whole picture and piece together how these separate domains of knowledge relate to one another towards a higher coherence. Consequently, big history and cosmic evolution attempt to consume academic silos, and have an important and still incomplete role to play in the ongoing construction of an inclusive global worldview for the whole of humanity (e.g. Christian 2004; Dick 2009b; Vidal 2014a). Ideally such a worldview would provide higher integration, working towards building the connections and identifying the potentials for convergence within different domains of human knowledge (Heylighen 2011). From higher intellectual coherence and vision of the whole we should be able to form worldviews that can help the human species contextualize modern challenges within the broadest contexts (e.g. Niele 2005; Spier 2011), allow for the construction of future visions of humanity that represent practically realizable utopias (e.g. Heylighen 2002), or help us potentially discover processes and trends to guide evolutionary cosmic goals and purpose towards higher levels of experience (e.g. Turchin 1977; Stewart 2000; Kurzweil 2005; Vidal 2014a).

2.1 History of Big History

The study of big history as an intellectual tradition can be understood as both old and new. The subject is old because we have evidence of humans constructing complex physical and metaphysical narratives, and thinking about natural and supernatural explanations for the 'totality' of human existence in the world, for as long as we have evidence of writing. In fact, this narrative tradition may have been manifest in the human species from the dawn of complex material culture (North 2008), as all modern human groups develop cosmic cultural worldview structures (Blainey 2010), regardless of ecological organization. Consequently, the origin of our symbolic 'totalizing' behaviour is hypothesized to have emerged in concert with the emergence of full linguistic capabilities (Dunbar 2009), as the formation of human worldviews is deeply interconnected with the formation of the linguistic domain itself (Underhill 2009). The ramifications of this speculation suggests that 'big history' as a symbolic activity could in some form represent a cultural archetype of human worldviews that is at least as old as the emergence of modern humans ($\sim$150 to 200 thousand years ago) (e.g. White et al. 2003; McDougall et al. 2005).

However the early origins of academic big history in the modern Western tradition can be found in the construction of empirically based cosmic narratives. These types of histories from various scientific and philosophical perspectives started to emerge in the nineteenth century (e.g. Chambers 1844; Humboldt 1845; Fiske 1874; Spencer 1896) with the early development of modern evolutionary thinking (e.g. Darwin 1794; Lamarck 1809; Darwin 1859, 1871; Wallace 1871; Butler 1887). Early big history narratives—like many of the narratives constructed by religious, spiritual, and philosophical perspectives in premodern cultures—were always concerned with the human relationship to life and the cosmos as a whole. In these works central questions regarding the origins of the universe, life, and mind were often presented and explored, but the lack of a firm empirical grounding in the knowledge and theory of many subjects prevented the coherence of any testable scientific model. Thus the early study of big history, as well as the formulation of cosmic evolution, failed to mature or gain widespread academic credibility in the nineteenth century (Dick 2009b). Even throughout the early twentieth century there were only a few works that can be seen as important precursors to the contemporary subject (e.g. Bergson 1911; Wells 1920; Shapley 1930).

The last half of the twentieth century was characterized by a noticeable increase in large-scale interdisciplinary big history work than ever before. In retrospect, the discovery of the big bang in 1964 appears fundamental and crucial to the development of big history as we know it today. The big bang allowed for a real beginning to a cosmological narrative, as well as an empirical way to understand the connections between the worlds of cosmology, physics, and astronomy, and the worlds of chemistry, geology, biology, anthropology, sociology, psychology, cybernetics, economics, and history (e.g. McGill 1972; Sagan 1977; Cloud 1978; Jantsch 1980; Chaisson 1981; Poundstone 1985; Reeves 1985; Christian 1991). Also important were the first NASA images of the Earth from space [e.g. "Earthrise" (1968) and "Blue Marble" (1972)], which allowed humanity to see the whole planet for the first time, and reflect on our place within the cosmos with 'new eyes'. In this historical intellectual environment astronomer Carl Sagan's introduction of "The Cosmic Calendar" (1977, p. 8) marks an important symbolic moment; as this metaphor captured a clear pattern marked with a connected, directional, and accelerating set of cosmic 'events' from 'particles to people'.

The modern form of big history, in its attempt to become a rigorous academic discipline, is formulating a common conceptual framework that can be used to understand the whole of nature. Although no common framework currently exists contemporary researchers have tended to place particular emphasis on *energy flow* as a necessary component of physical change and structural complexity (Niele 2005; Spier 2005; Chaisson 2011a, b), *information processing* as a source of functional variation and organizing complexity (Smith and Szathmáry 1995; Corning 2005; Lloyd 2006), and *complexity*, which can be understood as a measure of the relationships between distinct but connected parts interacting within an integrated whole (Heylighen 2000; Davies 2013).

In this big historical system energy, and specifically the rate of energy flow utilized for internal work, is seen as important in enabling higher associative interactions. This essentially means that material complexity typically comes at an energy cost, and measuring the density of energy flow that can be maintained by a physical object or living subject, gives us an approximate understanding of its structural complexity. Information also plays a dominant role in big history by allowing us to understand changing patterns in all physical processes and the functional ability of information processors to reduce uncertainty by increasing knowledge of their environment. From this perspective the emergence of information processors: entities that develop a subject-object relation, or input–output function, remain fundamental to understanding how functional organizations emerge to purposefully maintain and direct energy flows with greater autonomy from physical and chemical processes devoid of subjects. Consequently, there is a clear break or divide in the history of the universe between living systems (or autopoietic self-maintaining/organizing systems) and physical systems. Living systems have an internalized subjective relationship (self) to the larger object (environment) within which they exist, making their behaviour a process of goal and value formation emerging from that subject-object interaction/tension.

Big historians also need to focus on the general *evolution* of all processes in the local universe. In this attempt there is a conceptual emphasis on a general systems framework, which understands the universe as a nested and hierarchical metasystem of organizations from the microscopic level (e.g. subatomic particles, atoms, molecules, etc.) to the macroscopic level (e.g. organisms, ecosystems, civilizations, etc.). In this general systems approach it is not the substrate that matters but rather the organization of substrates, i.e. the functional (cybernetic) process of the substrate to maintain organization, and the (evolutionary) mechanisms of its change over time. To understand the evolution of complexity within these systems emphasis is placed on *differentiation* as a property of subsystem variation within a larger metasystem (Heylighen 2000; Stewart 2000, 2014), as well as *integration* as a property of subsystem interconnection within a larger metasystem (Turchin 1977; Smith and Szathmáry 1995).

The evolutionary-cybernetic properties of differentiation and integration are necessary to understand the growth of complexity. This is because networked patterns of interconnected distinctions inherently characterize increasingly complex systems, irrespective of material substrate. These increasingly complex networks enable multi-level *adaptive* capabilities (i.e. higher organism-environment relations) exhibiting *emergent* properties that are completely absent at lower levels of organization. Thus by studying the way differentiation and integration have progressed via new forms of cooperation big historians can identify commonality in the evolutionary processes that enabled continuous local development of hierarchical ordered levels. From this conceptual framework we can start to build a comprehensive view of the local universe as a region of ever-complexifying relationships, which produce new levels of organization facilitated by higher levels of awareness, and consequently, new living system goals and values in relation to the cosmic object. In elucidating the complexifying connections between all historical processes we may be able to provide a foundation for understanding both our contemporary world and our potential future.

2.2 Three Eras

The universe has been categorized into major eras both 'locally' and 'globally'. Cosmologists developed a universal categorization tool for classifying 'global' eras of the physical universe (Table 1), whereas big historians have developed a classification scheme for 'local' eras of the physical universe (Table 2). Both categorization tools are based around the concepts and perceived relationships between disorder/order and simplicity/complexity. The global classification of the universe is composed of five major temporal eras based on known (as well as by projected) thermodynamically defined matter-energy regimes. These eras include the Primordial, Stelliferous, Degenerate, Black Hole, and Dark eras respectively (Adams and Laughlin 1999) (Table 1). All of these eras can be seen as the product of the quantity and inherent physical relationship between gravitationally attractive and repulsive forces (Davies 2013).

The universe is approximately 13.772 ± 0.059 Gyr (Bennett et al. 2012). Consequently the human species currently finds itself in the Stelliferous era (Adams and Laughlin 1999). This era is characterized as the only temporal region to play host to star formation (Laughlin et al. 1997), and may therefore be the only era inhabited by complex information processing entities (Linde 1988; Krauss and Starkman 2004; Ćirković 2004), at least as we know them (see Adams and Laughlin 1999). In the Primordial era life would have been unlikely or even impossible considering that only basic molecular elements like hydrogen and helium existed. Likewise, in the Degenerate era life will either have become extinct or

Table 1 Five eras of the global physical universe

Primordial era	Big bang (0)—1 million years A.B (10^5)
Stelliferous era	1 million A.B. (10^6)—100 trillion A.B. (10^{14})
Degenerate era*	100 trillion A.B. (10^{15})—Duodecillion (10^{39})
Black hole era*	Duodecillion (10^{40})—Googol (10^{100})
Dark era*	Googol (10^{101}) and beyond

* Projected/predicted based on physical shape, matter-energy composition, as well as the current expansion rate

Table 2 Three eras of the local physical universe

Physical era	~13.8 billion years B.P. —~4.0 billion years B.P.
Biological era	~4.0 billion years B.P.—~2.0 million years B.P.
Cultural era	~2.0 billion years B.P.—present

The local matter-energy phases of big history occur in three major era based around new means of forming structures and transmitting information

will be clinging onto the last stable physical structures, as most large-scale objects like planets, stars, and galaxies will be in a state of decay removing any stable platform for living system adaptation. In the Black Hole era the universe will be entirely dominated by physical black holes making life impossible. And finally, in the Dark era the universe will likely exist in its final drift towards complete thermodynamic equilibrium, i.e. the end of heterogeneous energy gradients (or: heat death).

However there is by no means universal consensus on the potential of habitable zones post-Stelliferous era as it depends on the future resourcefulness and adaptability of living systems (see Ćirković 2003), and so we still do not know with absolute certainty whether life will remain confined to worlds with stars. But if life is denied any habitable zone post-Stelliferous era, and is thus pushed to extinction at the end of star formation, there is still a large expanse of time remaining for complex life to emerge and grow (Vidal 2014b). Several trillions of years remain in the universe to produce the structure of complexity found on Earth. Consequently, there are also trillions of years remaining for the future of evolution stemming from our own information processing and replication regime (see Bostrom 2003; Armstrong and Sandberg 2013).

In contrast to the cosmologist, the big historian attempts to understand the 'local' universe, which has existed in three temporal phases based primarily on material relationships that can be considered 'physical', 'biological', and 'cultural' in terms of informational mechanisms for ordering/organizing energy flow (Aunger 2007a) (Table 2). The first phase is called the Physical era and is characterized by the emergence of inanimate and gravitationally ordered matter-energy (Spier 2011). During the Physical era structure in the universe has been ordered from the gradual accumulation of heterogeneously distributed matter and dark matter via gravitational attraction (Massey et al. 2007). Therefore all structure producing during the Physical era—galaxies, stars, planets—can be attributed to a relatively abundant and natural source of "gravitational energy" (Dyson 1971; Corning 2002b). Gravitational energy continues to dominate the universe, providing the structural foundation for a grand and relatively uniform 'cosmic web': a universe-encompassing platform for more energy dense hierarchical processes (Massey et al. 2007; van de Weygaert and Schaap 2009).

The second phase of big history emerged with an important transition from passively ordered physical objects towards actively organized living systems (Thompson 2007; Deacon 2011). Biochemists call this transition from physical to living systems 'abiogenesis': the process whereby autocatalytic chemical systems generate 'biological' properties like autonomous (self-) growth, maintenance, and reproduction (Pross and Pascal 2013). To maintain these properties living systems are fundamentally distinct from physical systems in their ability to control available energy gradients and distribute and direct them towards processes necessary for their own continued presence (Corning 2002b, 2007). Therefore, the transition from physical to living systems is a shift towards systems with internal information processing capabilities and information reproduction (inheritance) capabilities (Aunger 2007b). Once these replicating biochemical systems achieved a dynamic stability with their environment (i.e. persistence) (see Pross and Pascal 2013), we entered a world of constructed functionality (Corning 2002b).

The functional behaviour of living systems seems to be produced by cybernetic processes of goal-directed control and feedback between organisms and their environment to maintain existence (Corning 2005). This means that all living systems must by dynamically embedded or embodied in their environment, allowing them to define context-dependent functional survival and reproduction goals, as well as overcome challenges in relationship with their socioecological circumstances (Heylighen 2014b). As a result, all living systems define, either perceptually or conceptually, boundaries between internal organization and the environment. These boundaries serve the dual function of protecting achieved internal organization (i.e. 'self') as well as enabling further growth and learning from interaction with the environment (i.e. active knowledge construction), the latter of which is bounded only by finite available energy and the internal cognitive information processing capabilities of the living system. From this perspective the life history of biological systems can be defined by this process of controlling available energy and directing it intelligently towards goals and values that have a biological or cultural relation to survival, growth, and reproduction (i.e. 'fitness') (Kaplan and Gangestad 2005).

The third phase of big history can generally be defined by the emergence of conceptual awareness, as well as conscious awareness of other minds (i.e. groups of organisms with a 'theory of mind'). Although many species today display forms of perceptual awareness (Bermúdez 2009), it seems likely that humans are the only modern species with a comprehensive conceptual understanding of self and existence through symbol (Heyes 1998; Call and Tomasello 2008; Penn et al. 2008). This can be most saliently recognized in analyzing the human/non-human animal difference in conceptualizing death (e.g. Teleki 1973; Nakamichi et al. 1996; Hosaka et al. 2000; Warren and Williamson 2004; Anderson et al. 2010; Biro et al. 2010). The human mind is the only known type of mind with the reflexive capability to understand its own finite existence—both our gift and our curse (see Cave 2012)—as coming to terms with our own mortality often proves fundamentally challenging for most humans, but also is an important component in what makes the human experience the human experience (Heidegger 1962).

The origin of the human mind is likely an origin deeply intertwined with the origin and structural order of the human symbol system as manifest in the linguistic code (Dunbar 2009). The animal kingdom is full of phylogenetically diverse organisms that display complex social learning capabilities and express simple cultural behaviours (Laland and Hoppitt 2003). Notable examples include chimpanzees (Whiten et al. 1999; Boesch 2003), bonobos (Hohmann and Fruth 2003), gorillas (Breuer et al. 2005), orangutans (van Schaik et al. 2003), capuchin monkeys (Fragaszy et al. 2004; Ottoni and Izar 2008), whales (Garland et al. 2011; Rendell and Whitehead 2001), dolphins (Patterson and Mann 2011; Mann et al. 2012), various species of bird (Freeberg 1998; Hunt and Gray 2003; West et al. 2003; Williams et al. 2013), along with several other mammals, and even fish (see Freeberg 2000; Laland and Hoppitt 2003). But humans alone possess a symbol system structured by a universal grammar with the capability of generating the reflective and conceptual narrative, as well as adaptive cultural behaviours and artifacts with an independent evolutionary trajectory (Marks 2002). Therefore language enabled both a theory of mind (Dunbar 2009), as well as ratcheting "cumulative culture" (Tennie et al. 2009; Tomasello and Herrmann 2010).

These big historical eras can be unified by the local trend of rising complexity from the first simple galaxies to the emergence of global human civilization. From the perspective of complexity as a relational property of increasing distinctions and connections evolving in systems with multiple levels of organization we see this process of rising complexity as both interconnected and accelerating from the big bang towards the present moment. For example galaxies, the first large-scale phenomena to emerge, were diffuse gaseous bodies composed of mostly hydrogen, helium, and lithium atomic systems, which differentiated through the gravitational integration of chemical compounds into more complex constituents like carbon, nitrogen, oxygen, iron, etc. in the center of stellar bodies. However, stars gave birth to more complex planetary bodies, which diversify towards a new integration in the structure of geological formations. In turn, geological structures composed the substrate for the emergence of living systems. Living systems are more complex than any known physical systems, as they are composed of differentiated constituents that must be specifically located and expressed within integrated networks composed of millions and billions of molecules.

This trend of increasingly complex interrelationships has reached its highest expression within modern human civilization. Human civilization is an extremely complex entity which requires not only the stable platform of a home galaxy, star, and planet, but also the stable functioning of single-celled organisms, organelles, organs, individuals, groups, societies, states, and international entities (Miller 1978). All of these nested and hierarchical systems exhibit higher levels of differentiated constituents (at the atomic, molecular, cellular, neuronal, and societal, etc. levels) functionally adapted to operate within integrated networks. Thus with the emergence of physical objects, living systems, and aware minds, there has been an increase in complexity, which has progressed with the arrow of time in a clear event-based directionality.

From the growth of complexity hierarchically structured interrelationships have allowed for emergent platforms of new dynamic actions and re-actions in approximately six levels from the atomic to the superorganismal (Table 3). These new actions and re-actions possess properties that were completely absent at lower levels of organization, and enable future complexity and possibility that cannot be predicted or anticipated precisely. This means that not only is the whole *more* than the sum of its parts, but also that the whole is *completely different* than the sum of its parts (Anderson 1972). In other words, as a system becomes more complex, the quantity of possible interrelationships may increase, but also new qualities of interrelationships can emerge, that simply did not exist previously. For

Table 3 Levels of hierarchical complexity

Atomic	Relationships that occur only through simple subatomic and atomic systems (e.g. quarks, gluons, electrons, hydrogen, helium)
Molecular	Relationships that occur through the aggregation of chemical elements (e.g. amino acids, polymers)
Cellular	Relationships that occur through networks of simple single-cellular life forms (e.g. prokaryotes, eukaryotes)
Multicellular	Relationships that occur through networks of interconnected cellular bodies (e.g. animals, plants, fungi)
Societal	Relationships that occur through networks of individual multicellular organisms (e.g. groups, family/kin)
Superorganismal	Relationships that occur through networks of groups (e.g. colonies, kingdoms, nations)

example, throughout the evolution of humanity from our foraging organizations to our still developing global organization, there has been an obvious quantitative increase in the number of interrelationships that occur between humans, but this rise in quantity has also been coupled with an emergent qualitative dimension of interrelationships, like being able to interconnect with people from anywhere in the world, irrespective of spatial or temporal constraints (an unimaginable property for pre-historical and most historical humans).

However, throughout the emergence of hierarchical levels of complexity we can say that only a minority of systems that reach a particular level are able to then develop conditions for further complexification. This simply means that most systems within the atomic level do not form molecular systems, and that most molecular systems do not develop cellular systems, and so forth. For example, although the 'cellular' level emerged over $\sim$3.5 billion years ago, most living forms on our planet today have remained at the cellular level, and only a minority increased towards the multicellular level. The same goes for the 'superorganismal' level, which emerged tens of millions of years ago, but, with the exception of human civilization, is composed of organizations (e.g. ants, termites, bees, naked mole rats, etc.), which cannot further diversify to form higher levels of integration (Morris 2013). In other words, non-human superorganisms appear to be 'dead ends' in terms of the further growth of complexity.

The difference between the human superorganism and other superorganisms is cultural: culture enabled humans to evolve the ability to consciously organize information with symbols (as opposed to organizing with biochemical mechanisms). Thus the human phenomenon gives the appearance of a phenomenon capable of both higher (symbolic) diversification and (sociopolitical) integration. However, this general property of only a small subset of higher systems being able to develop further complexity appears to be a necessary pre-condition for hierarchical complexity, because the higher levels of organization often depend on the lower levels of organization for their stable existence. We can once again demonstrate this property within the human superorganism, which was only able to emerge from the societal (foraging) level through the domestication of plants and animals during the agricultural revolution (i.e. we are dependent on the lower levels of complexity to maintain our own higher complexity) (Last 2015).

This hierarchical complexification process appears to be produced by a higher information processing capability, which in turn allows individuals to diversify and collaborate in new configurations with more agents, enabling the exploitation and control of higher and denser flows of energy, and the exploration of new modes of integration. Consequently, many big historians quantify this local trend towards higher complexity with the Energy Rate Density (ERD) metric (e.g. Chaisson 2001, 2011a, b). The ERD metric can be defined by energy (erg) flowing through non-equilibrium systems, controlled for both time (s^{-1}) and mass (g^{-1}) (Vidal 2010; Spier 2011). The quantification of local energy flow has increased legitimacy for the often proposed hypothesis that energy has played some fundamental role in the evolution of higher structure and complexity (e.g. Lamarck 1809; Boltzmann 1886; Spencer 1896; Lotka 1922; Schrödinger 1944; White 1949; Morowitz 1968; Dyson 1971; Prigogine et al. 1972a, b; Smil 1994; Spier 1996).

However, we obviously cannot reduce complexity to energy flow, which is to say that energy does not in any way dictate living system order/organization or explain the emergence of higher organization (see Corning 2002b). Energy plays a fundamental role in natural structure, but the nature of information and the relational properties of how organisms use information is of equal importance (see Corning 2007), if not greater importance (see Smart 2009; Gershenson 2012). The dynamic informational pattern, or fundamental substance of a living subject ultimately enables the flexible and active construction of an organism's self-created world, whereas energy may only be involved in presenting the subject with certain constraints or opportunities that may be either overcome or exploited depending on will and context. The problem with analyzing information as a complexity metric is that there is no practically useful method for quantifying the information processing capabilities of subjects, i.e. the living 'users', 'actors', or 'beings' of the universe (Lineweaver et al. 2013b). The originally formulated theory of information—Shannon information theory—suggests that one can quantify information processing by measuring messages between senders and receivers (see Shannon 1948; Shannon and Weaver 1949). However, the obvious problem with this measure is that quantifying messages completely ignores the contextual and meaning-laden nature, in other words the subjective nature, of functional biological and biocultural communication (Kauffman 2000; Logan 2014). Consequently, in reality there is no correlation between Shannon Information and living system order (Corning 2007).

The subjective nature of information control has led some to assert that an objective and universal measure of information will prove elusive (Maturana and Varela 1980; Heylighen and Joslyn 2001), and will certainly not be found in a reductive framework (Morin 2007). However, there have been attempts to measure biotic information in a non-reductive framework (e.g. Corning 2007; Kauffman et al. 2007; Gershenson 2012; Fernàndez et al. 2013), although many still view ERD as the most useful general complexity metric over the course of cosmic evolution (for more information about ERD see Chaisson 2001). In the future, there should be progress in this area of understanding local universe complexity, partly because it seems critical to understanding the future of twenty-first century human civilization. However, for now we should emphasize that the 'three eras' of ordered and organizing complexity, which have led to the emergence of physical order, living systems, and aware conceptual beings, share an overarching informational unity in increasing distinctions and connections. In this trend towards increasingly complex material relations we see the power of cosmic evolution.

2.3 Three Evolutionary Processes

Cosmic evolutionary theory unifies the narrative of big history by utilizing the idea of 'evolution' in a hyper-generalized way (Baker 2013). Evolution in cosmic evolution refers generally to change over time in any physical system in the universe (Chaisson 2009b). The changing variation could be developmental, generational, or in real-time, as well as physical, biological, or cultural (Smart 2009), with non-random selection 'targets' in biological and cultural evolution operating at multiple levels of organization (Corning 2005; Burtsev and Turchin 2006), from genes to superorganisms (Hölldobler and Wilson 2008; Stewart 2014). The only real constraint placed on evolution in this context is that it must be applied to open and non-equilibrium systems (Chaisson 2011a). This means that evolution is a concept applicable to all systems that interact with an environment and possess ordered or organizing properties. In this sense, cosmic evolution offers a theoretical framework that can unify all sciences (Chaisson 2003, 2013) and piece together the cosmic evolutionary connections from particles to people (Sagan 1973; Dick 2009b).

Throughout cosmic evolution physical, biological, and cultural evolution has emerged in a directional process with the arrow of time (Chaisson 2009a). The first evolution was a developmental gravitational process that allowed subatomic particles like quarks to bond as the universe first began its expansion. As the universe continued to expand, it cooled, and the force of gravity became a universal material attractor creating levels of structural order in a hierarchical fashion (Springel et al. 2005). Subatomic particles formed baryons, which captured electrons to form the first hydrogen, helium, and lithium atoms (Trefil 2013). These simple atoms formed within the structural edifice of dark matter (presumably), allowing for the formation of proto-galaxies (Loeb and Furlanetto 2013). Further intensification of this gravitational process led to the generation of the first stars, which provided the densities and temperatures necessary for the generation of more complex chemicals like carbon, nitrogen, and oxygen (Impey 2007).

The emergence of the first stars ignited a new evolutionary mechanism: physical evolution based on developmental *and* generational change, not only because of the continued expansion of space, but also because second and third generation stars had more diverse chemical materials for the construction of solar systems (i.e. stars with rocky and gaseous planetary bodies) (Impey 2007). Solar systems represent a new type of order in the universe due to both the increased diversity of chemical arrangements and also the new ordered forms that provide a platform for further evolutionary processes (Spier 2011).

The most complex structural entities constructed by physical evolution, i.e. stars and planets, go through both developmental and generational changes based on gravitational attraction and chemical variation (Chaisson 2009a). However, with the advent of biological evolution we see the emergence of a new type of evolution, which encompasses developmental and generational change, but also generational selection (Corning 2002b) (Table 3). Individual biological entities change in time (developmental), they change as they replicate (generational), but the success of the next generation in terms of survival and reproduction is naturally selected by socioecological environmental factors (Gould 2002). As a result, biological evolution operates on the fundamental basis of genetic variation and the selection of that variation in relation to environmental conditions (Ruse and Travis 2009). A population of replicating genes must sustain their own metabolic activity, but due to scarcity of available energy, there will also be variation in how well individuals within a population of biochemical entities can achieve this end (Kaplan and Gangestad 2005). Selection then acts as a computation-like information processor maintaining specified functional complexity for work related to energy protection, acquisition, and distribution (Corning 2002b).

Throughout biological evolution a remarkable degree of complex biological organization has emerged (Smith and Szathmáry 1995, 2000; Stewart 2014). This complexity is the result of billions of years of replicating chemical competition and cooperation structured within genetic codes (Corning 2005). Although selection itself is notoriously non-directional in terms of simplicity/complexity only seeking to maximize fitness depending on environmental context (see Gould 1996), the benefits of synergistic cooperative behaviour can be selected in certain environments (i.e. cooperation can outcompete competition) at all levels of biological organization (see Corning 2005). As a result, the evolutionary process as a whole tends to build and stabilize higher structural complexity over time, even though selection itself is not biased in any particular simplicity/complexity direction (Stewart 2014). Biological organizations accomplish higher structural complexity with the selection for bio-energetic information technologies that increase their ability to efficiently capture and distribute energy (Corning 2002b). Several theorists have identified that the major transitions in the evolutionary process (e.g. abiogenesis, eukaryotes, multicellularity, etc.) can be correlated with significant advances in the functional ability to process and reproduce information (see Smith and Szathmáry 1995), and the structural capabilities to regulate energy flow (see Niele 2005). These innovations enable the emergence of biological organizations that drift further away from thermodynamic equilibrium (Aunger 2007a, b), with the use of sophisticated information-based controls on organization (Turchin 1977; Corning 2002b, 2007).

Throughout the great majority of Earth history, biological evolution alone organized matter-energy into new functions and structures. This changed with the rise of the genus *Homo* ~2 million years ago, as early humans acquired the unique ability to engage in the cultural evolutionary process (Richerson and Boyd 2008). Unlike biological evolution, which operates on the generational selection of functional chemical information structured by the genome, cultural evolution operates on the real-time selection of functional symbolic information structured by language (Deacon 1997; Marks 2002) (Table 3). As a consequence, biological structures like genes, chromosomes, and genomes—as well as cultural structures like ideas, theories, and worldviews—are subject to evolutionary selection pressures in humans. This functional symbolic information can produce both adaptive behaviours and adaptive technology (Caldwell and Millen 2008). Therefore, culture is code for inner conceptual experience, outward conceptual behaviour, as well as code for technological structures; in the same way that biochemicals code for inner perceptual experience, outwards perceptual behaviours, as well as code for biological structures. As a result, organisms subject to cultural evolution are not just in competition and cooperation for energy based on perceptual sensory knowledge of the universe, but also conceptual abstract knowledge (Logan 2007). In modern human civilization adaptive complexity is predominantly cultural, as opposed to biological. This means that for human civilizations, energy control and distribution primarily depends on forms of cultural selection, not biological selection (Last 2014a).

Cultural evolution vastly accelerates the speed of the evolutionary process because cultural beings can 'save' socioecological and subjective conceptual knowledge acquired in real-time, as well as store and transmit information learned in real-time faithfully across many generations using symbols (Tomasello et al. 1993; Laland 2008) (Table 4). Like selection for chemical information in biological evolution, selection for symbolic information has no inherent direction within individual cultural beings. Instead, change is always flexibly produced in relationship to socioecologies (and/or socioeconomies). However, selection for more complex cultural information (experiential, behavioural, and technical) can collectively take a progressive directional quality within a *cultural society*. This will be dependent almost entirely on the behaviour and relationship of societal controls (e.g. state structures/institutions) on the flow of/access to information, and the technical medium utilized for the storage and transmission of the linguistic code (e.g.

Table 4 Three evolutions

Physical evolution	Developmental
	Generational
Biological evolution	Developmental
	Generational
	Selection (generational)
Cultural evolution	Developmental
	Generational
	Selection (generational)
	Selection (real-time)

The big history of the universe has seen the emergence of three evolutionary change mechanisms. Each mechanism accelerates the speed of the evolutionary process, allowing for the emergence of ever-more complex structures in ever-shorter periods of time writing, printing press, telecommunications, internet) (Last 2015). As a general principle, the more faithfully a society can store and transmit cultural information between cultural beings and across cultural generations, the less functional cultural information is lost (i.e. 'backward slippage'), and the easier it becomes for any given cultural collective to build upon the complexity of inherited cultural knowledge (i.e. 'ratcheting') (Tennie et al. 2009). In this sense, the speed of cultural change is a rough function of the qualitative efficiency and quantitative number of conversations (i.e. idea sharing/sex) being conducted within and between individuals and populations (Ridley 2010).

From a cosmic evolutionary perspective, one of the primary differences between biological and cultural evolution fundamentally remains in the reproduction capability and pathway (see Last 2014a). Biological evolution is a mature and independent process that does not require culture to exist. In contrast, cultural evolution is still very much a young and dependent process, requiring biological mechanisms to exist. This of course makes all of human evolution biocultural, and not simply biological or cultural (Marks 2012, 2013). There are no cultural beings that come into existence and remain in existence without the aid of a biological substrate. Consequently, all cultural beings are the ultimate products of biological reproduction and a chemically based genetic code, as opposed to the ultimate product of cultural reproduction and a symbolic linguistic code (Last 2014a). However, we do already see the signs that cultural evolution, or the reproduction of symbolic code, will not necessarily remain dependent on a biological substrate indefinitely. The future of cultural evolution could be the attainment of a stage of independent maturity in the same way biological evolution earned its own independence from physical evolution (see Sect. 3.2).

The second crucial difference between biological and cultural evolution appears in a distinction between the fundamental natures of each process. In biological evolution there is an endless and aimless differentiation of biological subjects whose future struggles and trajectories are independent. In other words there is a struggle of genes, individuals, species, etc. within the biological order, but *the biological order itself* is not in a struggle towards any 'common whole' or 'common direction' (Gould 2002). Instead the biological order is simply and unconsciously becoming more diverse for as long as the cycle is able to continue (for more: Sect. 2.4), without leading towards any internal closure of the process. In contrast, in cultural evolution there appears a shared ground between all participating biocultural subjects whose future struggles and trajectories are not only dependent but *increasingly dependent* as if converging towards a common whole. In other words, there is a struggle of ideas, theories, and worldviews within the symbolic order, but this struggle is an increasingly conscious struggle *for the universality of the symbolic order itself*. Thus in the cultural evolutionary context progressive symbolic diversification does give the signal of approaching an internal closure of the process itself (the opposite of biological evolution).

2.4 The End of Order?

The three eras and evolutionary processes of big history help us to organize and understand vast periods of time that connect seemingly unrelated phenomena into one interrelated process contextualizing the existence of modern humans in the twenty-first century. However, what can this insight tell us about the overall trend and patterns of cosmic evolution into the deep future?

The likely future of the Physical and Biological eras is to some extent well known, or at least seemingly simple to extrapolate. Of course, Earth's biological complexity is dependent on local physical complexity, and so the Biological era's future is intricately dependent on the future of our own solar system. Our home star, the Sun, is approximately 4.567 billion years old (Connelly et al. 2012), and is in the middle of a 10 billion years 'main-sequence' phase characterized by hydrogen fusion (Beech 2008). Over the course of the main sequence phase the Sun's luminosity and radius will gradually increase on geologic and astronomical timescales as its hydrogen reserves are steadily exhausted (Ribas 2009). This process will result in Earth developing a Venus-like atmosphere in ~3 billion years (Franck et al. 2005).

In this hypothesized future, biological life has a gloomy ultimate fate. Throughout the evolution of life history there have been major transitions towards increased complexity with the emergence of prokaryotes, eukaryotes, and multicellular eukaroytes (i.e. plants, animals, fungi) (Stewart 2014). These forms of life evolved in a directional order: prokaryotes (3.5 Gyr) (Bada and Lazcano 2009), eukaryotes (2.0 Gyr) (Tomitani et al. 2006), multicellular eukaryotes (1–0.5 Gyr) (Knoll et al. 2006; Grosberg and Strathmann 2007). Current models suggest that, as our Sun's luminosity and radius increase, increased energy inputs will disrupt Earth's carbon cycle, causing several intensive, successive, and irreversible disturbances in complex life's ability to survive (O'Malley-James et al. 2013). This is hypothesized to cause the extinction of major forms of life in reverse chronological order to their original appearance: multicellular eukaryotes (0.8 Gyr), eukaroytes (1.3 Gyr), prokaryotes (1.6 Gyr) (Franck et al. 2005). Therefore, Earth will possess an atmosphere with astrobiological 'Earth-like' qualities for a relatively brief period of its overall existence (~2 billion years) (Brownlee 2010). However, depending on prokaryotic adaptive resilience (which seems to be quite high), these simple life forms could exist as many as 2.8 billion years into Earth's future (O'Malley-James et al. 2013). That still leaves a couple billion years for our planet to boil back to a lifeless hell (i.e. gloomy ultimate fate).

The future of the Physical era proves to be even gloomier. In our local universe the Sun will eventually enter its 'red giant' phase largely driven by higher rates of helium fusion (i.e. our star will finally exhaust its available 'fuel') (Beech 2008). Current estimates suggest that this could occur around 5–8 billion years from the present (Boothroyd and Juliana Sackmann 1999; Schröder and Smith 2007). In its red giant phase, the Sun will swell in diameter to ~2 astronomical units (AU), eventually consuming Mercury, Venus, and most likely Earth (Rybicki and Denis 2001). However, the Sun will not explode in a supernova. Instead, it is likely to enter a short 10 thousand year phase as a planetary nebula, ejecting ionized gas into its surrounding spatial medium (Bloecker 1995). After this phase, the Sun will finally settle into a cool white dwarf phase, which could survive for trillions of years before eventually burning out entirely (Bloecker 1995; Veras et al. 2014). It is amazing to consider the possibility that the majority of the Sun's life may be spent in such an alien form.

During the Sun's stellar development, our solar system will be undergoing a larger galactic transformation. Currently our solar system exists within the Milky Way galaxy: a barred spiral galaxy composed of 200–400 billion stars (Gerhard 2002), at least 200–400 billion planets (Cassan et al. 2012), and a ~100 to 120 thousand light year diameter (Gerhard 2002). However, in ~4 billion years the Milky Way will collide with its closest neighbouring galaxy, Andromeda, producing 'Milkomeda' an elliptical galaxy predicted to be composed of ~1 trillion stars (Cox and Loeb 2007; Cowen 2012; Goldsmith 2012). Throughout the Milky Way-Andromeda collision our solar system should remain undisturbed. However, the collision is likely to affect our system's position vis-à-vis the galactic core (Cox and Loeb 2007).

In the deeper future of the Stelliferous era (i.e. 1–10 trillion years) most or all galactic structures in Laniakea, our home supercluster of galaxies (see Brent Tulley et al. 2014; Gibney 2014) will eventually merge with Milkomeda as an even larger elliptical galaxy (Adams and Laughlin 1997). During this time all galaxies external to the Local Group will recede from our local universe's horizon (Loeb 2011). Towards the end of the Stelliferous era and the beginnings of the Degenerate era (Table 1) only planets, white dwarfs, and neutron stars will remain (Adams and Laughlin 1997). This will likely mark the end of life, and the beginning of the universe's practically infinite descent into thermodynamic equilibrium (Adams and Laughlin 1999). Although, it must be noted that this future for physical evolution is dependent on the nature of the dark universe (i.e. dark matter and energy): two very important *somethings* comprising 95.1 % of our universe (Ade et al. 2013), but whose nature(s) remain largely mysterious (see Livio 2010). The range of speculation on the nature of dark matter and energy is beyond the scope of this paper, however it is safe to say that a deeper understanding of these currently missing components of the cosmic picture will affect our understanding of the deep future of the physical universe, and maybe the living universe too.

Extrapolating our current understanding of the universe leaves little room for optimism. A future with no structure or available energy is a future with no complexity, no information processing and replication, no humanity, and no mind. This has had a profoundly negative and very real psychological affect on the consciousness of the scientific mind, and particularly the Western scientific mind. Our vision has been trapped by the abstract concept of entropy. We cannot imagine a hope in the enterprise of life. Throughout the modern world, we have had to come to terms with a strange type of cosmic nihilism, a perspective captured well by philosopher and mathematician Bertrand Russell (1903, p. 7):

> All the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction… The whole temple of Man's achievements must inevitably by buried beneath the debris of a universe in ruins.

Cyberneticist Norbert Wiener famously echoed Russell's basic sentiments (1950, p. 40):

> It is a foregone conclusion that the lucky accident which permits the continuation of life in any form on this earth, even without restricting life to something like human life, is bound to come to a complete and disastrous end. […] In a very real sense we are shipwrecked passengers on a doomed planet. We shall go down, but let it be in a manner to which we may look forward as worthy of our dignity.

But can we say for certain that life has no hope in the deep future? Could the decisions and actions of agents with purposive knowledge derived from higher goals and values have something constructive to say about the end of the universe? We often discuss the deep future as if life and intelligence will not be an *active* part of it: intelligent thought and action as shaping and directing the future (e.g. Wheeler 1988). After all: "life and intelligence are the wildcards in the universal deck." (McKenna 1994). In this framework, when we discuss the deep future of cosmic evolution, the most recent emergent era of human awareness, and the most recent emergent evolution of cultural evolution, must be *seriously* contemplated as playing a fundamental role. Cultural evolution is still increasing complexity in the universe via the development of more advanced information technologies, and the regulation of denser energy flows. Cultural evolution is also still capable of engaging in the major trends of evolving complexity towards higher integration (connections) through higher diversification (distinctions).

Therefore, if we are going to find optimism in the deep future we can say that cultural evolution presents us with a process that gives the appearance of the 'leading edge' of complex growth: a process that could still develop into an emergent possibility space that many have not factored into models of the deep future. However, despite detailed knowledge of the future biosphere and solar system, we have a remarkably poor understanding of the deep future potential of culture as both a creative process and as an evolutionary mechanism to change the future nature of both biological and physical evolution (see Vidal 2014b). The way forward is clear: we must develop an understanding of the nature and potential future of the cultural evolutionary pathway, what is being termed "cosmic culture" (see Dick and Lupisella 2009). The symbols of the cultural evolutionary pathway shape our behaviour and conceptions, and allow us to construct technological product. Understanding cosmic culture could offer us an alternative glimpse of the future of universe, life, and mind. After all: "One of the main purposes of science is to investigate the future evolution of life in the universe." (Linde 1988, p. 29).

3 Human Future

Since the symbols of culture influence our behaviour and our conceptions, an analysis of the human future related to cultural evolution must start with an analysis of the symbolic reproduction of archetypal future visions. Historically, the human future has always captivated our imagination, and has always existed as a temporal conception. However, there are few historical examples within any pre-modern subculture of archetypal *higher futures*—meaning more ordered, peaceful, free—manifesting in the secular domain. For pre-modern historical cultures, a higher future on earth was impossible (or, more properly, not seriously representable in symbol) as our world was instead often conceptualized as a world of material scarcity and brutal violence with no sociopolitical or technological mechanism of escape. Thus, many pre-modern human societies typically conceived of civilization as in a cosmic cyclical state, e.g. Hindu-influenced Indian society, or the Maya of Central America are two classical examples. In these civilizations, there was no clear directional historical progress in the worldly sense: history was a cosmic trap between heaven (i.e. higher world) and hell (i.e. lower world). Consequently, many great cultures reasoned that a higher future was only possible within the domain of supernature and impossible to realize on secular humanistic terms (e.g. most notably: Christians, Muslims, etc.). Of course, there are some important exceptions to this generalization about envisioning higher secular futures, but large-scale cultural dedication to a qualitatively higher future on Earth seems to have been almost completely absent in pre-modern thinking.

This pre-modern notion of existing in a historical trap changed dramatically with the emergence of the 'early modern' (~ 1500 to 1750) and 'modern' (~ 1750 to 2000) periods of human history. Modernity is a traditional period of historical classification generally defined by the emergence of a social and intellectual reliance on the scientific method, empiricism, and rationality (Baird and Kaufmann 2008). Modernists believed that utilizing science and building a worldview around evidence and reason, were essential for conquering the natural world, superstition, and the ultimate secular goal: freeing humanity from biological and material constraints (Tucker 1972). From this tradition, the idea that the human world may not be a world of scarcity and war forever, started to become a humanist dream increasingly tethered to the possibility of realization.

This development is by necessity a Western-centric construction of history, as advances in technology (e.g. printing press, industry) within specific European contexts, enabled the flourishing of modernist thought. In big historical terms, new information and energy dynamics provided a higher possibility space for the flow of new cultural ideas and theories identifying an emerging secular direction. This direction was/is often measured in terms of acquiring increasing objective knowledge about the cosmos, increased material abundance for society, and increased individual freedom from authoritarian sociopolitical structures. It is in this context that the concept of utopia acquired a persistent and influential presence as an attractor (e.g. More 1516), functioning to propagate future visions and new ideas for creating a more ideal society here on Earth (i.e. the human-world relation as an unfinished project).

Therefore, from the perspective of cultural evolution, the stable emergence of modern science, as well as a religious-like cultural reliance on empiricism and rationality, represented the emergence of an imaginative signal in the symbolic code that a higher state was in principle possible *in this world*. Philosopher Francis Bacon—a pre-eminent intellectual figure of the scientific revolution—succinctly captured the goals of the 'modern scientific project' when he articulated the nature of science as a force that could radically alter the human future, potentially bringing about "things which have never been achieved" and alter being in ways that "were unlikely to ever enter men's minds." (Bacon 1620, p. 103).

Bacon and his contemporaries dreamed of a science that, when combined with human imagination and rigorous experimental methodology, could allow for what we may refer to as a 'maximum possibility space.' He explored this idea in his own utopian novel *New Atlantis* (Bacon 1626, p. 19):

> The end of our foundation is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible.

Since the scientific revolution, the modern attempt of imagining and actively creating a higher human future here on Earth has always been an inherently scientific and rational project. However, this project directly contradicted, and is still contradicting, traditional theology and traditional culture more generally. Traditional cultures have tended to imagine a higher human future only in a supernatural sense, i.e. not on Earth but in some transcendent domain, typically post-death: life *with* death, not life *against* death. This emergent contradiction in futures and the meaning of worldly human goals, values, and existence has caused an ongoing intellectual tension throughout the modern period because imagining a higher secular future required a fundamental re-organization of human thought in regards to the relationship between humanity and God (e.g. Spinoza 1677; Leibniz 1710; Feuerbach 1841), humanity and the cosmos (e.g. Copernicus 1543; Newton 1687), humanity and life (e.g. Lamarck 1809; Darwin 1859; Wallace 1871), and the fundamental structure of human society itself (e.g. Rousseau 1762; Condorcet 1795; Marx 1844); all relationships with specific conceptualizations in Western theology (Brown 1981).

From a big historical perspective, the symbolic emergence of the modern project has occupied almost no time at all: less than 1 s on Carl Sagan's 'cosmic calendar' (Sagan 1977). In this cosmic sense, the modern project can thus be conceptualized as a type of intellectual explosion without historical precedent. However, we can also say it is an explosion that is *still* an incomplete project. The central goal of the modern project was to completely 'flip' the dominant human narrative from a world where humans understand themselves as trapped in an immutable state in relation to the rest of nature, subservient to God(s) (or the supernatural generally), towards a world where humans understand themselves as in the process of overcoming nature through reason and measurement (i.e. nature as incomplete), and ultimately towards a higher state of being and organization (Tucker 1972):

> The criticism of religion is the beginning of all criticism. It culminates in the percept that man is the supreme being of man. By exposing the God-illusion, it frees man to revolve around himself as his real sun: 'Religion is only the illusory sun that revolves around man so long as he has not yet begun to revolve around himself.' What would it mean for man to revolve around himself?

Thus this reconceptualization of humanity took on the dimensions of a secular eschatology, i.e. human will, as exercised through a full exploration of science and technology, was going to produce the conditions for an 'end' to the state of the world and nature as modern humanity had experienced it: the human self would be overcome and the full force of our imaginative desires would be actualized. In other words, history became a prologue to the main show, and the main show's stage shifted from the heavens to the Earth (Frye 1947; Abrams 1963; Tucker 1972). For some it would culminate in an aesthetic and transcendent freedom of the will (Kant 1781), for others rationality would allow for the achievement of the omniscient self and ultimate planetary human organization (Hegel 1837), for others we would achieve biological, social, and intellectual perfection (Condorcet 1795), for others nature would be usurped by humanistic creativity that would reveal new foundations for experience (Blake 1810), and for others the modern project would eventually abolish all facets of historical adult human life, including labour, money, property, and institutions (Marx 1844). Human civilization was no longer a trap of unending and perpetual war and scarcity, but a process of inspired suffering that would lead towards a true secular apocalypse (Frye 1970, p. 130):

> The vision of the end and goal of human civilization as the entire universe in the form that human desire wants to see it, as a heaven eternally separated from a hell.

From these foundational humanistic thinkers the future was becoming a real utopian attractor state with specific discernible properties. The socioeconomic nature of the historical process became a phenomena that could be modeled, and materially or idealistically grounded in science and philosophy, pointing the way towards a world with a far higher experiential possibility space (Abrams 1963). Thus, whether the emphasis was on the transformation of human psychology and biology, or on a transformation of human material conditions and structural organization, we would have our new world by reclaiming the Earth as Universal Humanity and re-making nature in our own imaginative image (Shelley 1813, p. 30):

> A garden shall arise, in loveliness, surpassing fabled Eden.

Throughout this modern period various political ideologies (i.e. liberalism, progressivism, conservatism, fascism, anarchism), economic ideologies (i.e. capitalism, communism, socialism, libertarianism), and philosophical ideologies (i.e. humanism, naturalism, deism) have arisen claiming to point the way for humanity. Clearly no ideology has yet achieved the lofty goals of the modern project, as a divine higher state of humanity has proven illusive, whereas political-religious institutional structures and God as an invisible symbolic structure of necessity have proven difficult to kill, emerging in many odd yet powerful pseudo-modernist forms. For example, the invisible symbolic structure of necessity in communism became the 'State' (i.e. the State will save us and guide us towards the 'End of History'), 'money' in capitalism (i.e. circulate finance capital at the expense of all else and everyone will experience '–insert country-Dream'), and traditional culture generally (i.e. preserve the old historical pathway at the expense of science, evidence, and reason and 'Jesus' or 'Allah' will eventually save/reward us, etc.): pseudo-modernist government, market, and religious fundamentalisms, where faith rests on bureaucratic, financial, and supernatural structure, respectively. From this perspective, it is more important than ever to point out explicitly that demonstrating the scientific implausibility of God (e.g. Dawkins 2006), does not kill God, but just causes the symbolic structure of necessity to change form.

More disturbingly, the modern project, as manifest in industrial civilization, has also generated an 'age of extremes' fraught with competitive and militaristic international division (i.e. 'War War I and II', 'Cold War') (Hobsbawm 1994), humanitarian catastrophes (i.e. 'Great Leap Forward', 'The Holocaust') (Leitenberg 2006), as well as tension-filled global development characterized by mind-numbing levels of socioeconomic inequality (Oxfam 2014), and several interconnected planetary ecological crises (IPCC 2013). These properties of contemporary global development make continued social, economic, and ecological stability within our current organizational structure simply impossible (Glenn et al. 2014). Not exactly the vision of Shelley's 'Garden of Eden', and this is where the intellectual tradition of 'post-modernity' emerges (e.g. Anderson 1998). Post-modernity is a system of thought that fundamentally questions the notion of progress, emphasizes the ambiguous role of technological advancement, and rejects the notion that a 'master scientific narrative' can guide the direction of the human species. Post-modernists claim that the beliefs of the modern project are nothing but wishful thinking, a secular fairy tale, and replacement of God with a 'human religion' (i.e. a new transcendent universality). They point to the facts of the modern world: that in reality it has been a world of large-scale state violence, socioeconomic inequality, mass slavery, colonialism, neo-colonialism, ecological devastation, and western sociocultural hegemony. For post-modernists these are all clear proofs that the notions of modern progress represent a tempting but dangerous lie.

From this tradition of thought some academics now claim that in fact the pre-modern notion of humanity as in a sociopolitical cyclical state of unending scarcity and violence, hierarchy and exploitative labour, is a better way to understand the human condition in civilization. These criticisms are important and often valid, but at the same time, the historical process is not over. Even in the face of overwhelming global obstacles (or even *because* we face overwhelming global obstacles), we cannot forget the hope for a higher world: a world where the structural conditions of civilization enable the highest flourishing of the human creative imagination; or even: the distributed emergence of a collective common goal that does not rest on an external necessary God [either religious (/supernatural), governmental (/bureaucratic), or market (/financial)] but on an internally generated intersubjective value system supporting collective freedom and immortality (a true universality).

Here I will concede that the assumed markers of progress traditionally associated with the modern project are in need of serious revision and that, at the present moment, we are at a genuine historical crossroads towards the end of our modern "ideological constellation" (Žižek 2011). In other words, if the symbolic direction of history in the modern world (i.e. 'the project for humanity to finish') was imagined to be increasing objective knowledge of the cosmos, material abundance, and individual freedom, this overall logic in 2015 seems questionable at best. In our quest to understand the cosmos, we have failed to understand each other; in our quest for material abundance, we have failed to properly distribute resources; in our quest for individual freedom, we have forgotten our duty to the common space we all share.

The objective rational capitalistic individual operating within a bureaucratic or financial hierarchy—the mythological *Homo economicus*—needs a make over. Or said in another way: the 'American Dream' (read today: Neoliberal Dream) cannot be the 'Global Dream', even as it is being symbolically outsourced to developing countries (e.g. China, India, Brazil, everywhere) in concert with depersonalized large-scale structural violence against the poorest people and communities (Springer 2012). The ultimate consequence of continuing down this socioeconomic road is not only more ecological destruction towards unlivable conditions and disenfranchised masses with no hope for a brighter future, but even worse: "Universal Alienation": a world where you cannot trust anyone (Harvey 2014). That is not exactly the *universality* the modern project envisioned: instead of Universal Humanity co-creating an egalitarian international organization, we are building a world of Universal Aliens centrally controlled by global corporate oligarchy.

In the twenty-first century we need a *realistic* Global Dream that can lead us towards a *real* Global Village, and here it is important to remember the modern project and explicitly reject and attempt to overcome government (/bureaucratic), market (/financial), and religious (/supernatural) fundamentalisms through a commitment to a higher democratic and egalitarian Universal Humanity (in cosmic evolutionary terms: integration through differentiation). For the modern project the dream of a transcendent mature, abundant, and egalitarian human state was to be expected with a spirited and poetic confidence (Hegel 1837, p. 447):

> Never since the sun had stood in the firmament and the planets revolved around him had it been perceived that man's existence centres in his head, i.e. in thought, inspired by which he builds up the world of reality… not until now had man advanced to the recognition of the principle that thought ought to govern spiritual reality. This was accordingly a glorious mental dawn. All thinking being shared in the jubilation of this epoch. Emotions of a lofty character stirred men's minds at that time; a spiritual enthusiasm thrilled through the world, as if the reconciliation between the divine and the secular was now first accomplished.

Now this dream seems distant, even terrifying. If we still hold these modernist and humanist values, we should not remember the modern project to repeat the mistakes of the past, instead we should remember the modern project to remember that we should demand and strive for what now seems (socially, economically, politically) "impossible" (Graeber 2015): a world built for people instead of *non-people*, i.e. governments, corporations, religions. Neoliberal economic theory, which emphasizes self-reliant competition in the marketplace, is not a grand unified physical "theory of everything" (see Mirowski 2013) destined to transform all of us into isolated individuals fending for ourselves within insanely inhumane structures towards Universal Alienation. Yet in our postmodern universe we cannot imagine a modernist Universal Humanity anymore: the mindless circulation of global capital presents us with an unconquerable obstacle destined to homogenize and reduce world culture to corporate culture. Thus for all intents and purposes the general sociopolitical zeitgeist of our moment has become a distorted return to pre-modern thinking: "we're trapped" (Sirius, R.U. in: Lebkowsky 1997, p. 20):

> Anybody who doesn't believe that we're trapped hasn't taken a good look around. We're trapped in a sort of mutating multinational corporate oligarchy that's not about to go away. We're trapped by the limitations of our species. We're trapped in time.

Even the science fiction of our age—dominated by cyber-punk mega-corporate dystopias—concedes defeat and cannot find imaginative optimistic constructions of an abundant, sustainable, and democratic world, built on a humanistic foundation (Wernick 2014). The old dreams are still just dreams, in need of a dramatic revitalization and re-tethering to the possibility of realization: a serious representational symbolic vision for common actualization.

In this sense, it is important to repeat that the modern 'act-of-becoming' has presented us with titanic obstacles in the twenty-first century that were severely underestimated by the intellectual founders of the modern world. Specifically, when it comes to achieving a higher Universal Humanity, we underestimated the levels of complexity that would be produced by our species emergence onto the global stage (San Miguel et al. 2012) in what geologists are calling the "Anthropocene" (Zalasiewicz et al. 2008). Ideally, a new form of "global systems science" is needed to make sense of "the whole" in a new way (Helbing 2013a), and provide a new general perspective of complex systems thinking for the Anthropocene epoch (Niele 2005). Most modernist thinkers thought science and technology would bring 'god-like' *absolute human control* over nature (Tucker 1972). However, the reality is that science and technology have created a complex world radically *out of control* (Kelly 1995).

Consequently, we need different modes of sociopolitical governance. Complex systems science teaches us that local, bottom-up, and distributed coordination are typically the most effective and capable mechanisms for enabling emergent global order in highly complex environments. This is because, in complex systems, there are just too many differentiated parts for effective external top-down mechanisms of coordination (read: coercion) to stably function and synergize the whole. Thus any global systems science and serious sociopolitical global development agenda must understand how to maintain a new planetary organization with dynamic and distributed mechanisms that lead to *self*-organization (as opposed to static and hierarchical historical mechanisms that produce centralized organization) (Helbing 2015). Here we need most urgently renewed critique of power and ideology: until we challenge the very structural foundations of our world, we are not serious about globalization (Graeber 2004, p. 77):

> The effacement of national borders. This is genuine globalization. Anything else is just a sham.

Here it is my contention that in order to move forward with a clear global direction towards Universal Humanity we must find a way to revitalize the modernist spirit with some type of 'new modernity' for the twenty-first century: a new 'offer' of eschatological universality. Modernity began when humans started to experience their human-world reality as *unfinished*: as a project to be completed with the application of science and technology with humanist-atheist goals and values (i.e. there is no God, we have to build heaven ourselves). But what would be 'new' in 'new modernity'?

I think that the potential beginnings of a new modernity can be designed (and indeed are in many ways already being designed) with the link between traditional modernist humanist-atheist dreams and the emergence of contemporary transhumanist-atheist dreams for both life extension and life expansion (see Vita-More 1983; More 1990; More and Vita-More 2014) (i.e. higher possibilities through longer collective life and higher collective perceptions/conceptions). In other words, the core of new modernity would explicitly recognize that in order to *complete modernity* (i.e. there is no God, we have to build heaven ourselves) we must challenge our traditional notions of 'human nature' and become *responsibly* but still *curiously open* to an exploration of what humanity can be (i.e. what are the farthest reaches of human sociocultural and technological possibility?). This pathway is something that Charles Darwin himself realized was open to both speculation and eventual achievement after providing the foundations for a view of an evolving universe (Darwin 1871, p. 492):

> Man may be excused for feeling some pride at having risen, though not through his own exertions, to the very summit of the organic scale; and the fact of his having thus risen, instead of having been aboriginally placed there, may give him hope for a still higher destiny in the distant future.

For many transhumanists Darwin's 'higher destiny in the distant future' has become the development of a near-term evolutionary transition produced from the accelerated evolution of information and communication technologies (ICT) that will enable a higher state of 'trans' human existence (for historical and analytical overviews, see Sandberg 2010; Heylighen 2012). In these future evolutionary conceptions, a modernist Eden will emerge (Shelley 1813, p. 30), but unlike the vision of many early humanist-atheist thinkers, it will be an Eden enabled by advanced, revolutionary technology (e.g. robotics, artificial intelligence, nanotechnology, etc.), which will allow us to forever abandon a crippling historical order characterized by violence and scarcity, but also conformity, repression, and authority.

Transhumanist predictions of a technologically mediated utopia have taken two main dimensions, one local (i.e. enhancement of the psychology of the human mind) in 'technological singularity theory', and one global (i.e. the emergence of a higher planetary entity) in 'global brain theory'. Many of these theorists predict that a near-term technologically mediated event and/or process (near-term on the scale of the next 50–200 years) will fundamentally transform the foundations of human individuals and civilization as a whole (Goertzel 2002, pp. 1–2). Technological singularity theory posits that the human individual will achieve superintelligence through technological modifications (Vinge 1993; Schmidhuber 2012). This paradigm understands the future of human civilization through the perspective of the advancement of artificial intelligence and robotics (see Kurzweil 2005; Blackford and Broderick 2014), and perhaps most importantly, through the perspective of the possible emergence of artificial general intelligence (AGI) (Pennachin and Goertzel 2007; Bostrom 2014). In contrast, global brain theory posits that human society will achieve a globally distributed organization through the emergence of a higher metasystem mediated by the self-organization of the Internet and the technologies we use to interconnect on a planetary scale (Turchin 1977; Goertzel 2002; Heylighen 2015). This paradigm understands the future of human civilization through the global perspective of how information technologies affect the fundamental structural possibilities for societal reorganization (Helbing 2012; Last 2014b).

Technological singularity and global brain scenarios are 'utopian' (in the sense of being attractors towards a higher state/universality) for the future of humanity. These visions have been proposed throughout the twentieth century from academics mostly connected to the physical sciences (see Adams 1909; Ulam 1958; Good 1965; Moravec 1988; Glenn 1989; Vinge 1993). These theories have attracted increased academic attention in recent decades (including the establishment of future-oriented university-based institutions, e.g. *Singularity University*, *Future of Humanity Institute*, *Institute for the Future*, *Future of Life Institute*, *Global Brain Institute*, etc.), influenced many recent popular science books (e.g. Kelly 2010; Diamandis and Kotler 2011; Kaku 2014; Bostrom 2014), and have also spawned the aforementioned philosophy of 'transhumanism' focused on the development and eventual transcendence of humanity on cosmic timescales (see Huxley 1968; Vita-More 1983, 1992; More 1990; Bostrom 2005).

From this perspective transhumanism (or the transhumanist-atheist axis) explicitly seeks to become the formal successor to the modern project's version of 'humanism' (or humanist-atheist axis). However, its ability to achieve this goal can only be accomplished if the movement is able to find a renewed commitment to the connections between technological progress, social egalitarianism, ecological sustainability, and radical democracy (Hughes 2004) (i.e. technological progress measured on collective human-planetary terms, not on individualistic capitalistic terms). The contemporary transhumanist community mostly focuses on technological progress and specifically technological progress related to individual right to freely enhance human biology to 'superhuman' levels—enabling superintelligence, super well-being, and super-longevity (Pearce 2014)—via the application of various forms of genetic manipulation, nanotechnologies, robotics, and artificial intelligence (Stock 2002; Hughes 2004; Kurzweil 2005; More and Vita-More 2014).

This traditional transhuman emphasis on individual superhuman enhancement has often led to naïve form of libertarian transhumanism [most prominently expressed by futurist Zoltan Istvan's so-called 'First Law' of transhumanism: "1. A transhumanist must safeguard one's own existence above all else." (Istvan 2013)]. However, future transhumanism is going to have to become more socially, ecologically, and economically responsible, i.e. what sociologist James Hughes has labeled 'techno-progressivism' (Hughes 2004). This techno-progressive version of transhumanism is more critical than ever now that the transhuman movement is formally emerging internationally within the political arena (for a critical leftist three part series on the dawn of the age of transhumanist politics, see Benedikter 2015). If transhumanism can become more socially and ecologically conscious there is enormous potential for its philosophical foundations to be applied within sociopolitical context. Ideally this would result in the attempt to practically realize the original foundations of the modern project, which emphasized ultimate historical progress as "humanity to superhumanity" (Brown 1981, p. 60), or in our big historical foundations, historical progress towards higher sociotechnological diversity and connectivity.

Thus in the context of any type of 'new modernity' or a re-symbolized modernity we should make the link not just between people fighting for progressive international issues in the socioeconomic (i.e. equality, egalitarianism, etc.) and ecological (i.e. sustainable development, renewable energy, etc.) domain but also with contemporary transhumanists fighting for responsible progressive technological change: a new version of the iPhone does not change the structure of our world, but 'science fiction like' technologies could (Graeber 2015, chp. 2). If we were to ever seriously re-establish a collective new modernist political direction, then something 'impossible' in contemporary sociopolitical life, like legitimately discussing collective life extension or eliminating/automating all mundane labour (agricultural, industrial, bureaucratic, etc.), would become legitimate and normalized goals to strive towards (i.e. a world of dramatically extended youthful energy and play). In other words we will know that a new modernity has been successful the day when substantive geopolitical debates sound like Arthur C. Clarke meditations on the future limits of human possibility (see Clarke 1973).

Therefore, ultimately, the logic here is that in the same way the humanist-atheist axis challenged and overcame (politically castrated) pre-modern religious (e.g. church) and sociopolitical (e.g. monarchy) fundamentalisms consequently producing modernity (i.e. separation of church/state, increasing rights for people, etc.); now the transhumanist-atheist axis must emerge to challenge postmodern relativistic thinking by positing a higher transcendental Universal Humanity dedicated to forming *its own ground* (humanity self-organized in the commons, or: 'Religion is only the illusory sun that revolves around man so long as he has not yet begun to revolve around himself.'). Faith in our own ability and our own mind is the only way to overcome our postmodern tensions and cynicism produced by contemporary government (e.g. United States of America), market (e.g. International Monetary Fund), and religious (e.g. Islamic State of Iraq and Syria) fundamentalism/historical traps (i.e. instead of all power to the State, the Market, or a supernatural God: *all power to people and the imagination*).

When we think about modernity in this way perhaps it is also time to think about the 'humanities' in a new way. The humanities as a general academic pursuit are most enlightening and useful when they provide humane critique of historical and contemporary sociopolitical processes. However, with the emergence of transhumanism, and especially the more recent emergence of a politically engaged transhumanism, perhaps what we need now is the emergence of the 'transhumanities' to produce a new way of thinking about twenty-first century human development and evolution. At the moment we have many new academic institutions (mentioned above) focused on the science of transhumanism (i.e. robotics, artificial life/intelligence, genetics, complex systems, engineering, cybernetics, etc.), but we do not have a place for thoughtful transhumanist sociopolitical critique. This century we will need such critique, as 'science fiction like' 'transhuman' topics will likely play a larger sociopolitical and geopolitical role in the coming decades (i.e. between now and 2030–2050) (e.g. Google is attempting to become God, United States of America is testing telepathic army and secret military robotics program, United States of America and European Union are attempting to produce whole brain emulations, DARPA is working on technology that could connect our brains directly to the Internet, China is considering future generation of genetic designer babies, most jobs can be technologically automated, nanotechnology could revolutionize production, artificial intelligence could revolutionize health care, and so forth).

These developments force us all to confront the fact that there is really one political question within which all other political questions should be nested (Brown 1967, p. 81):

> There is only one political problem in our world today: the unification of mankind.

This converging universality is something that both the global corporate oligarchs and radical Islamic groups recognize as obvious (which it is). However mainstream sociopolitical 'humanist' discussion in our postmodern universe simply cannot imagine a human universality, and therefore cannot represent one seriously. Consequently, if humanists do not fight for a common space on behalf of all humans, we will keep losing our common space to either corporate or religious lunatics. From my perspective achieving a new global (trans-)humanist universality would be the long-term aim of the transhumanities. This would be an ongoing project to understand subjective and intersubjective humanity with the implications of uniquely twenty-first century issues that can only be analyzed within a transhuman and global frame (see Sect. 3.3). My intuition is that the result of this activity will help to create a new vision of the human species (already emergent) that progressively revives our cosmic image after the ego beating we have endured over the past 500 years (Žižek 2012, p. 266):

> The true trauma lies not in our mortality, but in our immortality: it is easy to accept that we are just a speck of dust in the infinite universe; what is much more difficult to accept is that we effectively *are* immortal free beings who, as such, cannot escape the terrible responsibility of our freedom.

Again I will repeat: even in the face of overwhelming global obstacles (or even *because* we face overwhelming global obstacles), we cannot forget the hope for a higher world: a world where the structural conditions of civilization enable the highest flourishing of the human creative imagination; or even: the distributed emergence of a collective common sociopolitical goal that does not rest on an external necessary God [either religious (/supernatural), governmental (/bureaucratic), or market (/financial)] but on an internally generated intersubjective value system supporting collective freedom and immortality (a true universality).

Finally, I do not want to be read as a cheap anti-Statist anarchist. The goal should not be to childishly smash the state, but instead to radically democratize the state until, eventually, no human is struggling over basic animalistic desires (food, water, shelter). Then perhaps the original modernist dreams of achieving an abundant, egalitarian state of universal trust (brotherhood/sisterhood) where everyone is free to strive toward innate human desires and dreams (love, creativity, community) without external hierarchical institutional coercion (state, corporate, or religious), could be accomplished in practice. The true tragedy of our neoliberal world is that this state of being now seems as distant from us in the sociopolitical imagination as the galactic clusters of the Hubble Deep Field. In this sense we are not simply being assaulted by a global economic class war, but also by a much more dangerous global war on the popular imagination, which anonymously and violently dictates to us what is possible and what is impossible within our collective sociopolitical space.

3.1 Technological Singularity

Here we have to return to our big historical perspective to explore the future of humanity within the larger conceptual framework of cosmic evolution as higher states for individual and collective humanity now seem at least technologically feasible (see Bostrom 2014; Kaku 2014). What are the implications of transhumanism for the eras of big history? Is it actually realistic to believe that some form of '(new) modern project' would culminate in a transcendent higher state and a completely (trans-)human world with the capability to overcome contemporary sociocultural and political tensions? In order to begin to answer that question we must further explore the history and theory related to the idea of technological singularity and global brain.

The original essence of the 'singularity' idea is simple: (1) science and technology drives change in human civilization, and (2) due to its cumulative nature advancing scientific and technological development will eventually reach a stage where change happens faster than the human mind can comprehend (Ulam 1958). Therefore the 'singularity' originally and essentially represented a point in the human future where human cognitive capacities driving science and technology became superseded by entities with higher cognitive capacity, i.e. robots and/or artificial intelligence as "our last invention" (Barrat 2013). Formally, this idea was first inspired from research in the physical sciences and specifically the pioneering work in computer science and cybernetics (e.g. Shannon 1948; Wiener 1948; Turing 1950). Many researchers quickly realized that the emergence of advanced computation represented an important turning point in the history of scientific and technological progress, as computers could now be designed to solve mental problems that only humans had been able to solve in the past (see Wiener 1948, 1950, 1963).

This possibility of human-level machine intelligence immediately inspired theorists to think of the singularity in terms of beyond human-level machine intelligence, what would now be called 'artificial general intelligence' (AGI). Humans have a general intelligence in that we can flexibly learn to solve most any problem we put our mind to with the aid of our symbolic code. However, if humanity was that close to designing a machine with human-level problem solving capabilities, was it not possible for *that machine* to either increase its own intelligence by re-programming its source code, or to start programming an even more intelligent machine, which could then program an even more intelligent machine, *ad infinitum*?

This conception of the future, of machine intelligence unleashing a strong positive feedback loop, has most popularly captured the imagination of singularity theorists since its introduction throughout the 1950s and 1960s (e.g. Good 1965). To this day the possibility of a machine "intelligence explosion" is still being seriously discussed and debated at length (e.g. Barrat 2013; Bostrom 2014; Goertzel and Goertzel 2015). In this singularity-based vision, emergence of the first AGI will be followed closely by the emergence of an AI+, and an AI++, and an AI+++, etc. (Chalmers 2010). Therefore, from our big historical perspective, this event has historically represented and been prophesized as a period when the universe would move on to beyond human level information processing and reproduction, and presumably, new domains of subject/object relations unknown to the biocultural human (Kurzweil 2005).

Scientific, philosophical, and popular interest in the "singularity" has increased since computer scientist Vernor Vinge first introduced the term "technological singularity" in a now famous paper of the *Whole Earth Review* (see Vinge 1993). Vinge originally likened the singularity to a fundamental evolutionary event comparable to the evolution of apes to humans. Since its introduction, singularity theory has become a key theoretical component of predictions related to the advance of ICT, and specifically the advance of computation, related to the aforementioned "transhuman" era (see Kurzweil 2005, 2012; Sandberg and Bostrom 2008; Loosemore and Goertzel 2012). Singularity theorists have emphasized the predictive power of "Moore's law" (e.g. Moore 1965, 1975), according to which the speed of microprocessors doubles every $\sim$18 months due to shrinking transistor sizes, consequently increasing the computer hardware capabilities utilized by artificial intelligence researchers (see Schaller 1997). According to models constructed using Moore's law, computer hardware will continue improving exponentially (or superexponentially) many decades into the future (Nagy et al. 2011), eventually allowing for the construction of technology utilizing femtotechnology (i.e. computers built by organizing subatomic particles) (Garis 2012). Thus far models built utilizing Moore's law have proven reliable and accurate when applied to many forms of information technology (e.g. Kurzweil 2010), thus making the concept of "exponential technological acceleration" a very useful and powerful tool in forecasting twenty-first century technological possibility (see Kurzweil 2001, 2010; Bostrom 2006; Ford 2009; Diamandis and Kotler 2011; Ismail et al. 2014).

The twenty-first century ramifications of exponential growth in computing complexity are truly overwhelming. For example, the most advanced supercomputers in 2013 could run at 50 petaflops (i.e. a thousand trillion calculations per second). This already astoundingly high level of computation only has the capacity of simulating the entire human brain at sometime between 2030 and 2050 (Pennachin and Goertzel 2007). It is this specific prediction that has resulted in many researchers believing that the technological singularity will occur before mid-century (see Vinge 1993; Hanson 2000; Kurzweil 2005). This predicted date now appears to be in-line with the majority of the artificial intelligence (AI) research community's belief that human-level or beyond human-level AI will be possible before 2050 (see Klein 2007; Baum and Goertzel 2011), and highly probably before 2100 (see Baum and Goertzel 2011; Sandberg and Bostrom 2011; Müller and Bostrom 2014). According to many researchers who share this singularity vision of the human future, the process of advancing computation is fundamentally inevitable (i.e. 'the immanent singularity'), and will result in currently unimaginable advances in genetics, nanotechnology, and robotics (Stock 2002; Kurzweil 2005; Drexler 2013; Kaku 2014). Therefore, according to these theorists, although the type of singularity we experience may be subject to moral debate and influenced by sociopolitical decision-making, the eventual emergence of a transhuman and/or posthuman technological era is something that cannot fundamentally be prevented, regardless of how some critics view it as dangerous (e.g. Fukuyama 2003) and undesirable (e.g. McKibben 2003).

However, there is of course tremendous diversity in opinions when it comes to the specific timing of singularity predictions (Armstrong and Sotala 2012). There are theorists like philosopher Nick Bostrom and mathematician Stuart Armstrong who believe artificial general intelligence is possible and will develop, but do not believe we can predict when it will occur with any reliable degree of accuracy (Armstrong 2014; Bostrom 2014). There are also theorists like technologist Kevin Kelly and computer scientist Jeff Hawkins, who acknowledge that advancing artificial intelligence will fundamentally disrupt contemporary societal organization in the coming decades, but do not believe that this advance will prove 'singularity-like' in regards to the development of beyond human-level AGI prophesized by futurists like Goertel, Kurzweil, and Vinge by mid-century (Hawkins 2015; Kelly 2015).

This brings us to a traditionally important division in singularity theory more generally, which is between those who argue that it is more likely that we will experience an AGI-singularity before mid-century, and those that argue that it is more likely that we will experience a global brain-singularity (GB-singularity) before a true age of aware technological minds with beyond human-level intelligence (Heylighen, personal communication, November 3, 2014). Although Vinge explored the possibility of a GB-singularity in his seminal technological singularity paper (see again: Vinge 1993), the concept has mostly been overshadowed in the singularity literature due to an overemphasis on AGI (e.g. Barrat 2013; Bostrom 2014). From a historical perspective this is hard to explain since, over the past 20 years, the Internet has proven to be a more revolutionary force in socioeconomic affairs, not AI. In GB-singularity theory, emphasis is more heavily placed on a systems framework and thus a 'metasystemic singularity' where the collective coherence of our sociotechnological networks develop to produce higher levels of consciousness and intelligence. Thus, the emergence of a 'global brain' is itself seen as a 'singularity' because it would be difficult to predict what such a collective mind would do deeper into the future (re: thoughts, actions, goals, values, dreams, etc.).

The idea of humanity as in the process of forming a global superorganism has been suggested since at least the late nineteenth and early twentieth century (e.g. Spencer 1896; Wells 1908). In fact, Charles Darwin made a brief commentary on the possibility of the global union of humanity in *The Descent of Man*, suggesting that "only an artificial barrier" prevented the human community from extending to "all nations and races" (1871, p. 96) (i.e. humanity as reaching some higher universality). However, paleontologist, futurist, and theologian Pierre Teilhard de Chardin may have been the first theorist to propose a concept and system of thinking for humanity forming an emergent higher-level brain-like organization: noosphere (Teilhard de Chardin 1923). Teilhard de Chardin suggested that a "noosphere" represented an emergent level of consciousness analogous to (but above) the "biosphere". Whereas the biosphere is the cumulative organizations of Earth's flora and fauna, a noosphere would be the cumulative organization of a mature humanity "woven by all intelligences at once on the surface of the earth" (1966, p. 230), producing "unimaginable" effects intimately related to conscious "reflection" and "invention" (1966, p. 63).

The first scientific model explored to realize a higher human level of organization was the theory of metasystem transitions (Turchin 1977). The "hierarchical levels" discussed above (Sect. 2.2; Table 3) are good examples of metasystem transitions, i.e. the origin of life as the transition from the molecular to the cellular organization (Table 3). Metasystem transition theory (MST) is a general systems-level approach to understand the control of a higher level of complex organization and also a potential future singularity towards controlling a global superorganism (Heylighen 2015). According to MST, higher levels of control organization can emerge from the coordination of less ordered subsystems (e.g., $A_1 + A_2 + A_3 \rightarrow B$) (Last 2015). This type of higher coordination is hypothesized to emerge from the selection for more advanced information processing and communications (i.e. the Internet), which enables previously disparate entities (i.e. nation-states) to synergistically coordinate their activities (i.e. global organization) (Turchin 1977). Consequently, such systemic transitions change the relationship between the parts they are composed of, and (if successful) lead towards new emergent and stable characteristics of the whole (the 'meta' part), through the exploration of (in our context) new (sociotechnological) connections, new (sociotechnological) distinctions, and consequently, new (sociotechnological) possibility spaces (i.e. a boundary-less whole or 'distributed singularity').

From the metasystemic singularity perspective the question of global control organization then becomes an issue of coordination between contemporary power structures towards a higher level. In contemporary global brain theory control organization for a future global sociopolitical collective rests on a functional and structural metaphor with biological brain control organization (e.g. Heylighen and Bollen 1996). GB theory thus stresses that the neuronal structure of biological brains give the appearance of a 'globally distributed society' (a "society of mind", see Minsky 1988) that literally mirrors the structural coordination activity of individual humans using the Internet in an open and free environment (i.e. free of centralized information control). Thus it is argued that, in the same way that biological brain's distributed collective neuronal activity self-organized to produce emergent consciousness and intelligence, the key to our global control organization is similar, and that we should foster more distributed coordination mechanisms built on local trust and support networks, which could produce a self-organizing emergent global consciousness and intelligence via sociotechnological mediation.

Of course, nobody knows just what 'critical threshold' of networked self-organization needs to be reached to produce a qualitatively higher level of human society, and in a world of growing sociopolitical tensions, it is hard to imagine a near-term coherence or integration. However, the rate at which we are interconnecting all of humanity to the Internet, as well as the even faster pace at which we are interconnecting all of our technological artifacts to the Internet (i.e. Internet of Things initiatives), we should not be surprised by the future potential for a concomitant qualitative emergence of something 'global brain-like'. In other words, just as the contemporary Internet is qualitatively different than our twentieth century telecommunications systems, the future Internet (20, 30, 50 years into the future) will also be qualitatively different in ways that we may not be able to predict with great accuracy due to likely emergent future applications like virtual reality and artificial intelligence, etc (Table 5).

However, on this pathway human decision-making matters; if our present sociopolitical reality and conversation is any indication we could be living in anything from a form of global authoritarian 'capitalism' to technologically automated luxury 'communism', and anything in between, within just the next 20–30 years. But if we truly want to build a

Table 5 Potential of a global brain-singularity

Omniscience	Whether we are interacting with artificial intelligence via a semantic web, or constantly being guided in our education by highly advanced MOOCs, our future experience within a global brain should be one in which billions of highly educated intelligent agents are closely interacting, communicating, and collaborating with an omniscient knowledge base. In such a world the testing of new hypotheses, the development of new theories, and the discovery of new laws, should be straightforward as the formulation of a sentence is for humans today
Omnipresence	With full specialization and integration of advanced information technology (e.g. wearable computing, internal computing) and the full implementation of the Internet of Things, all agent and "things" will have the ability to wirelessly communicate and coordinate activity—anything and anywhere—enabling omnipresence. As a result, any perturbations within our system (i.e. damages/disasters affecting infrastructure/people) will be solved through the distributed and self-organizing activity of our wireless communicating network
Omnipotence	All industrial processes for delivering products and providing services will become informational processes via 3D/4D printing and nanotechnology integrated into the Internet—allowing any physical object to be designed, shared, and constructed for negligible cost and produced with negligible waste. This omnipotence will allow the global brain to be a system of abundance
Omnibenevolence	A global brain would be built on abundance and cooperative distributed organisations attempting to maximise the potential of all of its "neurons"—allowing for a type of omnibenvolence. This system can already be seen as emergent as better education, greater wealth, and longer lives seems to be correlated with dramatic decreases in things we consider "evil" on a global scale (i.e. murder, war, slavery, prejudice, suppression, dictatorship, corruption)

'planetary society of mind' we need to work towards breaking down centralized control structures through radical democratization and start building local distributed connections that exhibit a form of spontaneous self-organization (i.e. human societies organized internally as opposed to externally organized by a central government, bank, corporation, or religion) (as discussed in Sect. 3). In this attempt, the global brain concept and theory of metasystem transitions can potentially give us a way to understand the nature of our planetary structure and help us direct it towards new models of global governance, integration, and organization more generally (Last 2015).

Thus, if we are able to figure out the problems of global distributed governance and global distributed economics, it is possible for humanity to endure the coming wave of technological 'megachange' (present-2050) in a way that is more utopian than dystopian (see Diamandis and Kotler 2011; Franklin and Andrews 2012). Cyberneticist Francis Heylighen, one of the original pioneers of global brain theory, recently articulated a long-term vision of a metasystemic singularity within a holistic evolutionary context given expected advances in artificial intelligence, 3D printing, machine learning software, robotics, and other digital technologies (see Heylighen 2015). In this vision, Heylighen proposes that the global brain could eventually develop properties similar to omniscience, omnipresence, omnipotence, and omnibenevolence: traditional metaphors for God or God-like entities (Wierenga 2003).

The global brain could become omniscient in the sense of possessing all practical knowledge necessary to deal with humanity's global challenges, omnipresent in the sense of having a coherent view of what is happening everywhere in the world at the moment, omnipotent in the sense of eliminating waste and maximizing efficiency in regards to energy, transportation, and control, and omnibenevolent in the sense of attempting to maximize benefit and reduce harm inflicted on all individuals (Heylighen 2015). However, of course such an entity cannot emerge unless we in some sense co-create the common space, but if such a higher entity were to emerge from our collective activities, we would also have reached a new era of humanity and a true metasystemic singularity in terms of surpassing a level of change possible for the human mind to comprehend (Table 5).

Despite the large differences between conceptions of an AGI-singularity and a GB-singularity, the similarities are greater. The most intense theoretical debate between the two visions is mostly over issues of the nature of future socioeconomic and political disruption regarding superintelligent computers and computer networks. Currently, what seems most reasonable to say is that continued socioeconomic driven complexification of computation via Moore's law *and* continued quantitative and qualitative growth of the Internet as a global medium, gives us good reason to expect computer and computer-network related progress before 2050 that could fundamentally transform the nature of human beings and human society. Specifically it seems reasonable to suspect a quickly intensifying transition from contemporary AI systems that can solve specifically programmed problems towards AI systems that can solve a multitude of problems (Pennachin and Goertzel 2007), as well as large networks of AI systems that become increasingly important components of the Internet, consequently changing the way we relate to our information technology, and the way we relate to each other (Goertzel and Goertzel 2015).

The most obvious change in our lives as a result of these processes should come from a shift or complete elimination of mundane labour. Artificial intelligence pioneer Hans Moravec claims that this will occur "like water slowly flooding the landscape" of work (1998, p. 11) until all work that was once the sole domain of humanity could be outsourced to computation. Indeed, you only need to take a quick look at the type of jobs that employ the most people in contemporary society to start to realize that, there are virtually no large industries in manufacturing, social services, farming, transportation, etc. whose labour force could not be completely replaced by artificial intelligence and robotics within the next 20–30 years (Ford 2015). Even industries that have traditionally been hallmarks of professionalization and high education, like professors, doctors, and lawyers, could see their jobs outsourced to computation in the longer-term picture. This means that the first half of the twenty-first century could be characterized by the emergence of a world in which machines will be able to solve most of the problems that were once the sole domain of the human intellect (for a video presentation of this possibility, see Grey 2014). In fact, many scientific reports and forecasts for the future of work reflect this reality, as the process of outsourcing problems to computation is already under way (see Frey 2011; Frey and Osborne 2013; Brynjolfsson and McAfee 2014; McGinnis and Pearce 2014; Rifkin 2014), albeit in an early phase.

Of course, such a transition in the nature of work allows us to imagine a world with no mundane labour and no scarcity, a long-time dream of the late global systems theorist and visionary utopian Buckminster Fuller (1981). This would transform the human condition from its historical organizational limitations and dramatically alter contemporary socioeconomic dynamics, particularly in relation to work and money (Rifkin 2014; Ford 2015). If we are to take these radically optimistic possibilities to their conclusion, one potential ramification is that play and genuine self-motivated work could replace work stimulated purely from scarcity and societal expectation (i.e. the end of alienated labour). In this sense, the interests and activities that consume the childhoods and young adulthoods of many individuals today could become lifelong pursuits of exploration well into adulthood (Brown 1959; Graeber 2015). This may seem an impractical vision, but all of human history has been characterized by mundane labour (i.e. agricultural, industrial, bureaucratic work), and if that labour vanishes within a few short decades, new creative opportunities and freedoms may present themselves to adult existence that simply have no historical precedent.

Another potential ramification is that the importance of financial capital could be replaced by a shift towards the importance of 'social capital' (i.e. psychological self-actualization and community building). In this potential future direction our adult socioeconomic lives could become increasingly dominated by finding important ways to interconnect and relate to each other as social and creative beings, as opposed to our current reality of finding ways to interconnect and relate to each other as economic agents (Rifkin 2014). Such a transition would necessarily require a shift in the dominant microeconomic foundation of humanity as *Homo economicus* (i.e. individuals interested in their own personal financial success) towards humanity as *Homo socialis* (i.e. individuals interested in the personal welfare of others/communities) (Helbing 2013b). The most obvious macroeconomic policies that could safely bridge the gap between the worlds of *Homo economicus* and the worlds of *Homo socialis* would be the implementation of an unconditional basic income (UBI) and the enforcement of a maximum income limit in concert with dedication to *commons* technological automation (i.e. technological automation that benefits our shared social, economic, and ecological space) (Cottey 2014; Hughes 2014). This would at least be a start towards building a more egalitarian world and a world that allowed for healthier adult social and psychological development (Standing 2002, 2011), which is currently (and has always been) seriously debilitated by economic scarcity (Mullainathan and Shafir 2013).

In the short term, we could imagine that such a fundamental planetary shift could occur without the simultaneous rise of technological minds with independent thoughts, feelings, emotions, and autonomous will. After all, supercomputers are now the world's best chess players and *Jeopardy!* contestants, soon they will be the best doctors and lawyers, but they can accomplish this without awareness, and without any emotion or feeling (Broderick 2014). Moreover, if the future socioeconomic structure experiences a shift toward finding new ways to interconnect and relate to each other as social beings, this experimentation may involve a high degree of transhuman mind-interconnection as the century progresses. This is due to the fact that although AGI may encounter major theoretical stumbling blocks (as has been the case historically), the potential future of internal computing/nanotechnology will likely provide humans with the opportunity to expand our cognitive capabilities in unexpected ways (see Chorost 2011; Nicolelis 2011). In such a landscape deeper levels of collective thought, feeling, and action could become a commonplace possibility, and blur the line between biological and technological thinking (Kaku 2014) (for more see Sects. 3.2, 3.3).

Table 6 Nature of technological AGI-singularity

Artificial intelligence (AI) scenario	Superintelligent technology replaces biocultural humans
Intelligence amplification (IA) scenario	Humans transform themselves with technology and become transhuman/posthuman
Human-Technology Merger (HTM) scenario	AI and IA scenarios occur simultaneously manifested from evolutionary pressures and positive feedback loops generating biology-technology symbiosis

First and foremost: if we undergo a fundamental posthuman transition, what will be the transition's nature? (Table 6) (For more see Goertzel 2007; Vinge 2007; Sandberg 2010).

Of course there is just no way to test the AI, IA, and HTM hypothetical scenarios and therefore there is no general consensus as to which scenario is most probable among singularity theorists (see Sandberg and Bostrom 2011). However, some theorists tend to emphasize the dangers of an AI scenario and have advocated for a moratorium on artificial intelligence research to increase the probability of the IA Scenario (e.g. Antonov 2011). Others have suggested that we actively "delay the singularity" or "guide the singularity" by constructing an "AI Nanny" until we better understand the potential evolutionary ramifications (e.g. Goertzel 2012), and others have suggested that we focus on "confining" artificial intelligence so that we can benefit from its development but avoid extinction (Yampolskiy 2012).

This issue of artificial intelligence as an existential risk has also received far more popular attention recently due to the controversial statements by high-profile scientists and technologists like Elon Musk who claimed that we are "summoning the demon" with artificial intelligence (Musk 2014), and Stephen Hawking who claimed that the "development of full artificial intelligence could spell the end of the human race" (Hawking 2014). Concerns of this extreme existential variety have probably been most thoroughly envisioned in the work of artificial intelligence pioneer Hugo de Garis who has popularized the notion of a coming war between "Cosmists" and "Terrans" (Garis 1999). In Garis's future vision an intense global dichotomy will emerge towards the end of the twenty-first century between humans that want to build "God-like" machines (i.e. "Cosmists") and humans that want to forever delay their creation (i.e. "Terrans"). Philosopher Nick Bostrom recently explored the sociopolitical dimensions of confining such "God-like" entities claiming that, if we do not confine them or figure our how to align their value system with human value systems, our fate will be in the hands of machine superintelligence that vastly exceeds our own (Bostrom 2014). From our big historical analysis, it is interesting to note that in these visions, just like in the original futuristic secular visions of the modern project (see Sect. 3), humanity is part of a process that will birth 'God-like' entities, but in this dystopian conception, we become superseded and replaced (e.g. Garis 1999; Barrat 2013; Armstrong 2014) (history as a horrible cosmic trick for the emancipation of technological Gods?).

Despite these radical apocalyptic speculations, there are also more radically optimistic theorists who speculate that the technological singularity will be characterized by some variant of the IA/HTM scenarios, i.e. humans will survive and transcend, ushering us into a new era of opportunity and possibility for the exploration of posthuman mind (Hanson 2000; Kurzweil 2005; Kaku 2014; Rothblatt 2014). For these thinkers we should all strive to be 'posthuman' when we "grow up" (Bostrom 2009). Here it is reasoned that there will not be a strict dichotomy between the biocultural nature of the human and technologically-based artificial intelligence, as suggested by Garis (1999). Instead, it is suggested that biocultural humans will willingly transform themselves as technology emerges, allowing us to radically upgrade our intelligence, consciousness, lifespan, and general state-of-being (More and Vita-More 2014).

In these conceptions of the future the line between human and robot, or human and artificial intelligence, will simply start to become 'blurrier' (i.e. not a strict dichotomy) as the twenty-first century advances. Therefore, by 2050, these theorists reason that it will be difficult to differentiate between different forms of conscious intelligent beings and we will be fully immersed in a hyper-technological society (Glenn 1989). Consequently, the radical techno-optimists reason that we should boldly and optimistically move forward with research related to equaling or surpassing human intelligence with technology (Kurzweil 2012; Blackford and Broderick 2014; Kaku 2014; More and Vita-More 2014; Rothblatt 2014).

3.2 Theory of Atechnogenesis and Technological Life

In the above section I considered the possibility of 'technological singularity' from both the artificial general intelligence (AGI) and global brain (GB) perspective. However, the term 'singularity' in particular is problematic from the point of view of understanding the evolutionary nature of this future transition on scientific terms. As stated, the technological singularity concept was originally conceived and developed in the physical sciences in reaction to the possibility of encountering a prediction horizon resulting from the emergence of machine minds. The term singularity was borrowed from the mathematical notion of singularity where a radical material discontinuity in a physical system results in infinite values in a finite amount of time (i.e. gravitational density of black holes). However, many contemporary futurists and computer scientists are beginning to shy away from the concept of technological singularity (e.g. Dvorsky 2014; Naam 2014; Bostrom 2014). Computer scientist Ramez Naam explained most succinctly why many academics are breaking away in a conversation with futurist George Dvorsky (Dvorsky 2014):

> 'Singularity' in mathematics is a divide-by-zero moment, when the value goes from some finite number to infinity in an eye blink. In physics, it's a breakdown in our mathematical models at a black hole. Smarter-than-human AI would be very cool. It would change our world a lot. I don't think it deserves a word anywhere near as grandiose as 'Singularity'. It wouldn't be a divide-by-zero. The graph wouldn't suddenly go to infinity. Being twice as smart as a human doesn't suddenly mean you make yourself infinitely smart.

Moreover, philosophers and futurists have noted that the singularity concept appears to have developed many techno-utopian connections and similarities to the Christian rapture (Cole-Turner 2012) (i.e. 'rapture for the nerds') and other religious future beliefs (Hughes 2012). This may not in-and-of-itself be a bad development, as it simply demonstrates an archetypal continuity in human culture for a higher state, however it is still questionable whether the term 'singularity' lends itself to serious scientific inquiry regarding the human future (Bostrom 2014, p. 40). Even inventor and futurist Ray Kurzweil, arguably the most well known singularity theorist and leading popularizer of the term "technological singularity", admitted that the future of technological evolution did not present us with an actual singularity in *The Singularity Is Near* (2005, p. 34):

> Of course, from a mathematical perspective, there is no discontinuity, no rupture, and the growth rates remain finite, although extraordinary large. But from our currently limited framework, this immanent event appears to be an acute and abrupt break in the continuity of progress. I emphasize the word "currently" because one of the most salient implications of the Singularity will be a change in the nature of our ability to understand. We will become vastly smarter as we merge with our technology.

In short, although when it comes to the 'singularity' we can still be 'Vingeian' or 'Kurzweilian' in the sense that we are approaching a qualitative transition in our nature, the term singularity itself is more a by-product of our own limited level of biological intelligence, as opposed to a description of an actual singularity.

This results in a tremendous conceptual tension within modern futurist theory because the singularity concept is rooted in physical and mathematical theory, when it is attempting to describe a process (not a single event) that is inherently evolutionary in its nature. Our civilization does not face a "black hole of intelligence" as the concept of technological singularity suggests. Instead, when properly framed in big historical terms I believe it is clear that we face the full emergence of a new evolutionary pathway: the true birth and independence of cultural evolution. As we covered when discussing cosmic evolution (see Sect. 2.3), networks of cultural symbols code for inner conceptual experience, outward conceptual behaviour, as well as for technological structures. This can be seen as analogous to the way that networks of chemicals code for inner perceptual experience, outwards perceptual behaviour, as well as for biological structures. Consequently, the biocultural human lives in both a perceptual and a conceptual cognition landscape, and the technologies we produce are an integral aspect to the cultural evolutionary process.

Therefore, when approaching the notion of singularity I will instead be proposing and applying a theory of biocultural evolution within a cosmic evolutionary framework that may give us a different perspective on human evolution and enable more specific predictions about our future. Specifically, technological singularity theory appears to be an attempt to describe the emergence of technological life, and in particular, the emergence of technological intelligent life, as stemming from our own accelerating scientific (symbolic) activities [i.e. 'when humans transcend biology' (Kurzweil 2005)]. And if our symbolic activities either A) allow us to merge with our technologies and design our own substrate, or B) allow us to create self-producing self-maintaining technological life from advances in robotics and artificial intelligence (see Sect. 3.1), this would be a process whereby symbolic code produced technological structures with evolutionary-cybernetic properties analogous to biological living systems.

In the domains of evolutionary-cybernetics today there are many researchers that have been referring to the emerging 'life-like' properties of our machines with concepts like "postbiological life" (Dick 2008, 2009a), "machinic life" (Johnston 2008), "artificial life" (Aguilar et al. 2014), or "living technology" (Bedau et al. 2009). I prefer to think of these systems as natural and technological, while also sharing the same properties and processes as biological systems, so the names that make the most sense to me are 'living technology' or 'technological life'. Furthermore, many astrobiological theorists now also assume that technological life represents a natural extension of biological life with the potential to reshape the cosmos (e.g. Gardner 2005; Kurzweil 2005; Smart 2009; Kelly 2010; Flores Martinez 2014) (Davies 2010, p. 160):

> I think it is very likely – in fact inevitable – that biological intelligence is only a transitory phenomenon, a fleeting phase in the evolution of intelligence in the universe.

Agreed, but how should we understand this phenomenon as progress is being made in various fields related towards its actual creation? I think that when contemplating the possible emergence of technological life there is only one analogous known event in cosmic evolution: abiogenesis. Abiogenesis literally means 'biology arising from not-biology'. After the process of abiogenesis, all life has been produced via biogenesis, or 'biological life arising from biological life'. In this stage of biogenesis, biological evolution has produced three major domains of biological life: archaea, bacteria, and eukarya (see Woese et al. 1990). Archaea and bacteria are prokaryotic, whereas the eukarya are living systems with a nucleus and membrane-bound organelles, which includes most multicellular life (Woese et al. 1990). However, humans do not fit neatly within this biological classification scheme because our informational properties are not simply embedded within biochemistry. As we have discussed, the emergence of the genus *Homo* represents the emergence of a new evolutionary pathway, and the emergence of a biochemical lineage of forms that also produce symbolic information. Consequently, humans do not simply consist of variant chemical structures harvesting energy to create more fit replicates of similar forms, but variant chemical *and* variant symbolic structures. Therefore the emergence of humanity represents the emergence of a new evolution, meaning that the emergence of humanity can *only* be compared to the origin of life itself (Turchin 1977, p. 84).

Cultural evolution is a new pathway, but it is a pathway that has not gained its own independence. Culture is dependent on biogenesis for its own existence and thus all of human evolution is a biocultural phenomenon. As mentioned, if symbolic systems manage to construct technological systems with biological properties (i.e. technological life), this would no longer be the case. The biocultural being would become a transitory stage between the worlds of the biochemical and the worlds of the technocultural (Figs. 1, 2). This notion that we are a biocultural bridge between the world of biological life and the world of technological life is the essence of my approach to understanding the human phenomenon (for historical overview on the intersection between biological-technological evolution, see Dyson 1998). However, this does not necessarily mean that humanity is going to be replaced by technological life; instead as I will attempt to explore, it seems equally plausible that humanity would merge with its own creations by radically re-designing the biological substrate upon which we have evolved up until this point in our evolutionary development (this is what I mean by remaining 'Kurzweilian' (or 'Vingeian') even though the term 'technological singularity' may be scientifically problematic).

From this evolutionary perspective, as the architects of the modern project realized, we are not quite biological animal, and we are not quite technologically divine: our existence is a dramatic temporal tension in the act of becoming something far beyond our

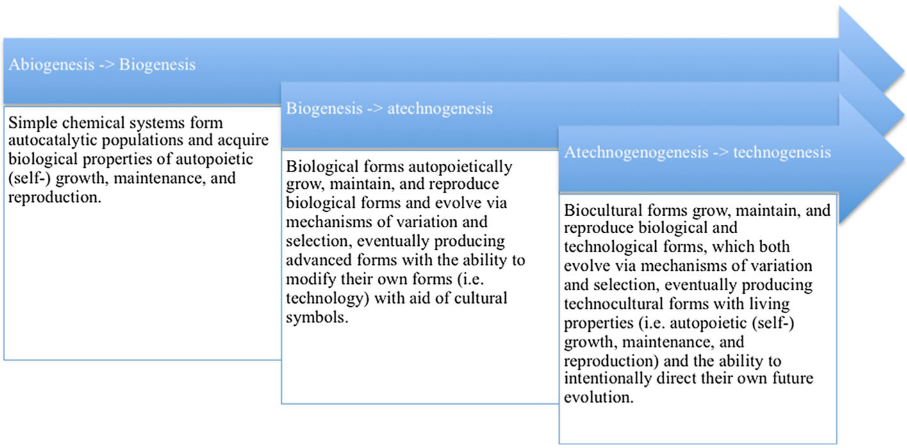

Fig. 1 Biological life to technological life with arrow of time. In the same way that the process of abiogenesis led to the process of biogenesis with the emergence of (blind) complex adaptive systems capable of growing, maintaining, and reproducing their biochemical structures, the process of atechnogenesis will lead to the process of technogenesis, which will be a world of (aware) complex adaptive systems capable of purposefully growing, maintaining, and reproducing their technocultural structures

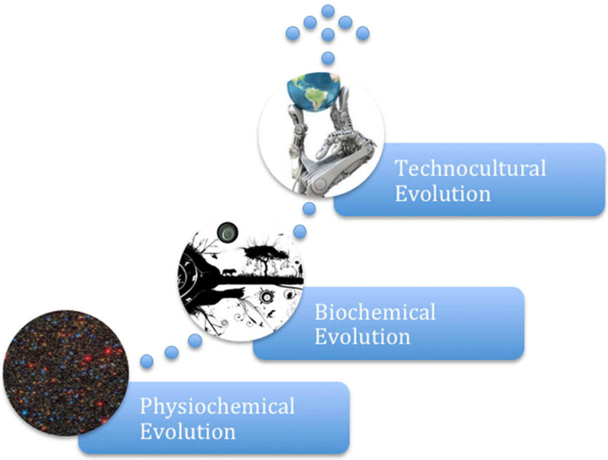

Fig. 2 Unified cosmic evolutionary process with arrow of time. Cosmic evolution spans the whole of local universal history in one interconnected process whereby one form of change directly generates a new form of change in a progressive direction with the arrow of time. In this context the human species is a "bridge" between the biochemical and technocultural realms of cosmic evolution via the process of atechnogenesis (Fig. 1). We emerged with the generation of cultural symbol systems coding for new types of awareness, behaviour, and technology. These systems will allow us to "transcend" the biochemical state and produce the next level of complexity construction within which the technocultural pathway will gain its independence: evolution fundamentally built on symbols, awareness, technology (Sect. 3.3) (Table 10)

imagination (i.e. beyond what we can currently represent with our symbolic structures or create with our technological structures). Thus my approach to a biocultural theory of human evolution is perhaps best described as explicitly modernist and 'Nietzschean' (Nietzsche 1883, p. 27):

> Man is a rope stretched between the animal and the Superman – a rope over an abyss.

Humanity has always dreamed of an 'other' 'higher' world in the non-secular dimensions (i.e. not of Earth and this world). However, in line with modernist humanist-atheist thought, our full commitment should still be to *this world* in the secular dimension towards a higher world: superhumanity, the only way to complete the modernist project.

Historically, biological evolutionary theory has had a difficult time understanding the human phenomenon within the context of life as a whole. Often times evolutionary theorists have been too heavily influenced by the neo-Darwinian synthesis (i.e. the merger of natural selection and genetics), consequently reducing all human behaviour and existence to genetic inheritance and gene frequencies (Laland et al. 2014). This approach may be useful for understanding the evolution of the biological world, but it is clearly inadequate for understanding biocultural humanity, especially biocultural humanity within the historical process. Many unique properties of the human species, including reflexive aware mind, symbolic information processing, evolving technology, and linguistic thought and communication defy reductions to genetics. Therefore, theorists in the humanities have typically been critical of evolutionary biological explanations that reduce humans within neo-Darwinian models. Despite this, contemporary evolutionary anthropologists appear ready to work towards a post-reductive theory of human evolution that is truly biocultural in its nature (Marks 2015).

In my attempt at a holistic biocultural theory of human evolution, I consider myself as attempting to build upon the approach to cultural evolution that was stressed by the late anthropologist Leslie White (1949, p. xviii):

> Culture may be considered a self-contained, self-determined process; one that can be explained only in terms of itself.

Only in terms of itself: this is to say that culture is not caused or determined by biological processes. Culture may currently depend on a particular genetic and neurological foundation, but it is its own emergent process, operating according to entirely different evolutionary ends. As mentioned (see Sect. 2.3), in biological evolution diversification does not lead to integration of the biological order itself. In contrast, as cultural evolution diversifies there does appear a direction towards an integration of the symbolic order itself (which is what I mean by "operating according to entirely different evolutionary ends"). *Self-contained, self-determined process*: this is to say that in order to support cultural evolution with symbolic inheritance and creation you must first have a high degree of self-reflexivity and self-awareness. In other words, aware mind(s) bridge the gap between the world of biological evolution and the world of cultural evolution, lifting life into a totally new domain of virtual creation and imagination [i.e. the self becomes aware of what is not (symbolic imagination), but also of what could be (symbolic representation)] (Frye 1947, p. 47):

> We are fearfully and wonderfully made, but in terms of what our imaginations suggest we could be, we are a hideous botch…

Although cultural evolution is distinct from biological evolution in these respects, many evolutionary scientists have recognized that the cultural evolutionary pathway displays many striking similarities to the biological evolutionary pathway, and that those similarities uniquely manifest in the human species (see Tomasello et al. 1993; Caldwell and Millen 2008; Laland 2008; Tennie et al. 2009; Last 2014a). However, here I am arguing that this pathway is starting to develop its own independence from biological evolution that may enable humanity to become an entirely new form of life founded on aware mind and a self-designed existential substrate. The point of proposing a new biocultural evolutionary theory is to better understand and contextualize this potential transition within an evolutionary-cybernetic framework. This theory and conceptual framework emphasizes that the phenomena driving a new evolutionary pathway—culture, language, technology, and aware mind—have existed for millions of years as part of one continuous emergent process. I think this process is best conceptualized as:

> "**Atechnogenesis**" (*AY-tech-noh-JEN-e-siss*): a cultural process in cosmic evolution whereby symbolic information processing and reproduction transcends mindless design (natural selection) by developing a self-producing substrate of mind design

In the same way that 'abiogenesis' means 'biology arising from not-biology', 'atechnogenesis' refers to a process whereby 'technology arises from not-technology'. This may sound counter-intuitive at first but the whole of human evolution can be conceptualized as a gradual (yet accelerating) process where symbolically mediated mind was able to conjure technological structures out of 'not-technology'. Every technology that has ever existed—from an Oldowan hand axe to the most advanced supercomputer—is an organization of atomic systems designed by an aware mind from constituent elements that were previously ordered or organized within a formerly geological, chemical, or biological physical structure. This is to say that the emergence of any technology is a symbolic process where mind creates technological organization out of 'not-technology'.

In nature, biology is self-produced and self-maintaining, or in other words it is 'autopoietic'. Biological organizations separate themselves (create a boundary) from the environment and adapt to various environmental challenges, i.e. they 'earn a living' or they lose their organization/existence. In contrast, technological organizations are not self-produced or self-maintaining; our technology does not generate its own boundary and earn a living, yet. However, with contemporary research projects explicitly attempting to achieve the goal of 'exploiting life's principles in technology' (see Bedau et al. 2009, 2013; Aguilar et al. 2014) this may not be the case for much longer. If achieved, a symbolic, mind-directed process would have generated biological processes in technology, potentially leading towards a world of increasingly biological-technological hybrid life forms, and eventually, a world of technological life forms: atechnogenesis to technogenesis.

To my knowledge, the concept of 'atechnogenesis' is novel. However the concept of 'technogenesis' is not novel. Historically the term 'technogenesis' has been used by postmodern academics to describe the co-evolution of humans and technology (e.g. Hayles 2012, p. 10):

> [C]oncept of technogenesis, the idea that humans and technics have coevolved together.

However, considering the concept 'biogenesis' literally means 'biological life from biological life', the concept 'technogenesis' should probably be interpreted to mean 'technological life from technological life'. Currently, all technology that exists on our planet would not exist if it were not for the biocultural activities of the human mind. Biocultural activity transforms not-technology into technology. Therefore, all technology that arises on our planet is part of 'atechnogenesis'. This is for the simple reason that, fundamentally, technology is not self-produced. If the biocultural human disappeared, technology would stop being produced. Even modern technologies produced on automated technological assembly lines are fundamentally conceptualized, established, and maintained by biocultural humans at some point in the process. Technology is not yet completely autopoietic, i.e. self-producing. From this perspective we are not yet in a world of technogenesis. And so, I would ask for a re-conceptualization of the historical use of the word 'technogenesis'.

This evolutionary framing of the relationship between biocultural humans and technology could be helpful for thinking about cosmic evolution as a whole and making progress in understanding many different phenomena, including most critically, the nature of the 'post-singularity world' (see Sect. 3.3). For example, the biochemical evolutionary pathway has dominated the evolution of life on earth. The emergence of this pathway via the process of abiogenesis is not completely understood, but biochemists are in universal agreement that it was a process in which autocatalytic chemical systems achieved independent growth, maintenance, and reproduction (Pross and Pascal 2013). By analogy, atechnogenesis would represent a process (carried out by biocultural humans over millions of years) in which symbolic system(s) eventually achieved growth, maintenance, and reproduction independent from biological evolution's genetically programmed substrate (i.e. we will purposefully redesign our genetic substrate and/or enhance/replace our functional biological substrate with nanotechnology/robotics). This concept fits with technologist Kevin Kelly's notion that technology is an emerging kingdom of life (i.e. 'the technium') that has yet to break away from biology (see Kelly 2010) (i.e. yet to achieve technogenesis).

The most important shift in the process is a shift towards a world where the existential substrate switches its design mechanism: from the mechanism of what has traditionally been called 'natural selection' towards a mechanism that has/can be called many things, i.e. 'intentional', 'purposeful', 'aware', 'cultural', 'mind' selection. I am less interested in what this mechanism is called and more interested in the fact that this cognitive selection process is driven by self-reflexivity and self-awareness enabling biocultural humans to direct their own evolution with cultural symbols; is laden with internal meaning, intention, and purpose; and could eventually culminate with an existential substrate that reflects this mind-driven symbolic ability (i.e. the world as the human mind wants to see it). Consequently, if the process of atechnogenesis reaches its completion and the age of technogenesis commences, the material composition of humanity's existential substrate (e.g. carbon, silicon) will be less important than the fact that the material composition of humanity's existential substrate will be purposefully and intentionally designed.

However, the road to a world of technogenesis has not been easy (and will likely still be paved with many obstacles in the twenty-first century). In order to support atechnogenesis, biocultural humans have engaged in an ever-present and unique life history trade-off between dedicating time and energy towards biological growth, maintenance, and reproduction, and dedicating time and energy towards cultural growth, maintenance, and reproduction (Last 2014a). We do not often think of the relationship between biology and culture, yet at the same time, this life history relationship fundamentally separates humanity from biological life. All forms of biological life spend their entire life history on only biological growth, maintenance, and reproduction. Therefore, the emergence of cultural evolution presented new opportunities, but also presented an irreconcilable internal tension between twin modes of reproductive output (i.e. should I dedicate most of my time and energy towards biological offspring, or my symbolic and/or technological 'offspring'?). Thus the theory of atechnogenesis represents a biocultural theory attempting to explain the full completion of this internal tension via the full maturation of the first independent evolutionary pathway since the emergence of biological life itself.

I realize that the concept 'technocultural' is also novel, however it is also a necessary addition to this system of thought. Although the term's meaning is intuitive I will quickly describe it with reference to the previous evolutionary modes of complexity construction. First, physicochemical evolution describes the process of evolution of simple atomic and molecular systems that are ordered in accordance with simple and predictable physical and chemical laws, i.e. they have no ability to actively control their behaviour or organize their own internal system dynamics. Second, biochemical evolution describes the process of evolution within complex self-producing cellular systems with the ability to actively control their reaction to environmental conditions (i.e. adaptation), but without the ability to significantly modify their own system components/functioning (hence the notoriously 'unintelligent' 'unconscious' nature of biological evolution). Abiogenesis bridges or connects physicochemical evolution to biochemical evolution. Finally, technocultural evolution describes the process of evolution within complex self-producing symbolic and technological systems with the ability to both actively control their reaction to environmental conditions (i.e. adaptation) *and* the ability to significantly modify their own system components/functioning in real-time (Fig. 2). Atechnogenesis is the process that bridges or connects biochemical evolution to technocultural evolution (Fig. 1):

> “**Technoculture**” (*Tek-no-kul-ture*): an evolutionary process fundamentally built on awareness, symbols, and technology enabling the ability to both actively control reaction to environmental conditions and to significantly modify their own system components/functioning in real-time

The theory of atechnogenesis makes two major predictions about the future of human evolution:

1. Biocultural humans should increasingly shift reproductive effort (time/energy) from biological reproduction to cultural (or sociocultural) reproduction;
2. Biocultural humans should increasingly replace functional biochemical structures designed by natural selection with functional technological intelligently designed structures

I explored the potential manifestation of this first trend in a paper titled “Human Evolution, Life History Theory, and the End of Biological Reproduction” (see Last 2014a) where I argue that human evolution can be conceptualized as one continuous process of delaying biological reproduction further and further (i.e. extending childhood and/or pushing back age-at-first-conception) in order to invest more and more time and energy in sociocultural growth and reproduction. This trend towards extended childhood or delayed age-at-first-conception first became exaggerated in early members of the genus *Homo* and remains a crucially distinct feature of modern humans (Hillard et al. 2000). In other words, most species do not have the luxury of 15–20+ years of social development before reaching sexual maturity and parenthood. This deep evolutionary extension of human sociocultural development became again further extended in the modern industrial world where there was an increased reliance on scientific/intellectual/specialized knowledge to

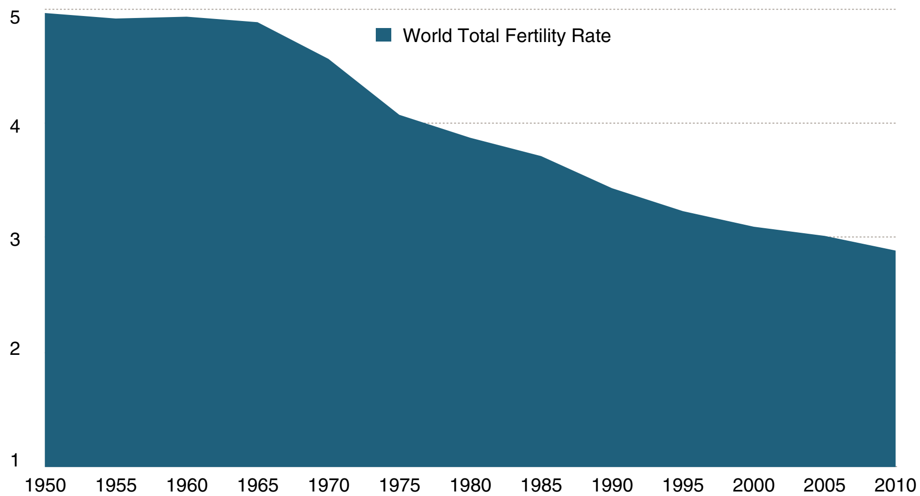

Fig. 3 World total fertility rate (1950–2010). The total fertility rate of the human population has been steadily declining since 1950 to the present in correlation with increased material abundance, individual rights, and cultural opportunity. Although the world’s total fertility rate is approximately 2.36 (still above the replacement level of 2.1) the most dramatic trend involves the fact of developed world fertility where most countries fall below 2.0, many fall below 1.5, and some fall below 1.0. Data collected from United Nations (1950–2015)

organize and maintain new levels of industrial advance, which required more education, and thus more time and energy dedicated to sociocultural growth (Galor and Weil 2000).

Consequently, this period was characterized by a shift in biological reproduction from 'quantity' to 'quality': in traditional agricultural societies women typically had/have 5–6+ children, but in modern industrial societies women typical had/have 2–3 or fewer children (Lawson and Mace 2011). In the most advanced socioeconomic (post-)industrial (post-)modern regions today this extension of sociocultural development and reduction in biological reproduction is becoming even more pronounced with the quite novel phenomenon of some adults opting against biological reproduction altogether. Thus I further argued that this life history theory of culture and biology as in direct competition for time/energy can explain what demographers and economists call the 'demographic/economic paradox'; a paradox characterized by developed countries with high urban density falling *below* replacement level fertility independent of cultural region (e.g. Asia, North America, Europe, etc.) (Weil 2004).

Indeed, the human species has been undergoing an unprecedented reproductive transition between (approximately) 1950 and 2015 where the world's Total Fertilty Rate (TFR) has dropped from 4.95 to 2.36 (replacement level is 2.1) (Fig. 3). Contemporary statistical projections of the global human population for the twenty-first century predict gradual increases towards a possible stabilization between 9 and 12 billion people (Gerland et al. 2014). However, the 'demographic/economic paradox' has not been explained nor accounted for in statistical projections, which could suggest that if we develop sufficiently broad global socioeconomic development programs for inclusive economic growth and social equality we could start to see an eventual plateau followed by a decline of global

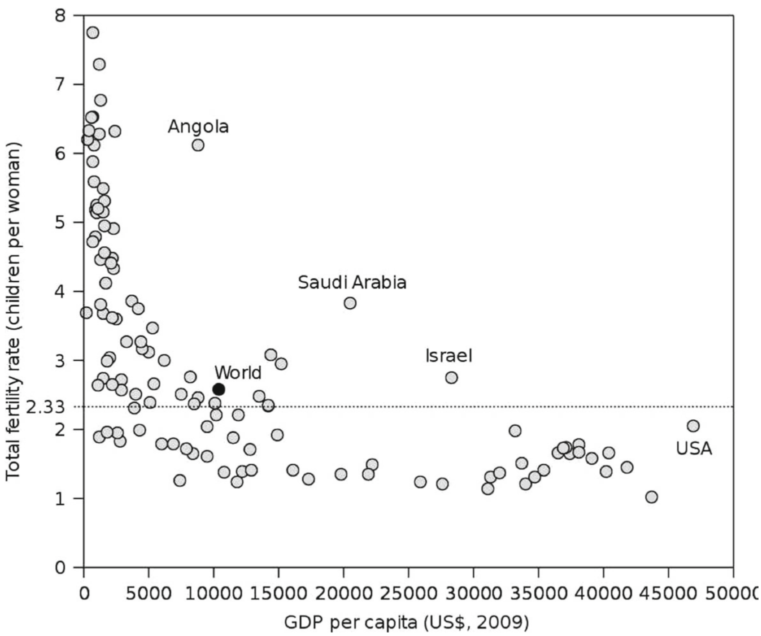

Fig. 4 Total fertility rates vs. GDP per capita (2009). Throughout the world fertility rate has dropped below replacement level in developed socio-economies. In the future, an economy built on principles of sustainable abundance could lead to the whole world dropping below replacement level. *Source*: CIA world factbook

population (Randers 2012). According to *World Factbook* data, as of 2014 there are now 116 countries that are below replacement level fertility, and 32 countries that have a fertility level below 1.5. According to *United Nations* data (which only sampled countries with at least 90,000 inhabitants), as of 2013 there are 71 countries that are below replacement level fertility, and 27 countries that have fertility below 1.5 (United Nations 2013). These declines can be statistically correlated with GDP (Fig. 4). However, GDP is not the only important metric to understand declining fertility, as individual rights (especially for females), and sociocultural opportunity (especially for females), are more or at least equally important. Thus when it comes to understanding the future of human demographics the emphasis should be on *socio*-economic development and not just economic development.

From the perspective of the theory of atechnogenesis declining biological reproduction is an indication that cultural evolution is starting to permanently outcompete biological evolution. In other words, the further we remove constraints of basic biological necessity and the more cultural opportunities present themselves for future exploration, the more we could see people opting to spend time and energy on cultural growth, maintenance, and reproduction (e.g. music, dance, sport, science, philosophy, engineering, anything sociocultural) *at the expense of* biological growth, maintenance, and reproduction. However, if this prediction correctly captures twenty-first century life history, it would mean that humanity is undergoing a fundamental culturally mediated life history transition towards even further delays in biological reproduction and increased social development. The importance of this is that previous life history transitions toward delayed biological reproduction and increased social development—which have occurred four times throughout primate evolution, e.g. prosimians to monkeys, monkeys to apes, apes to humans—co-evolved with encephalization and life extension (Last 2014a) (Figs. 5, 6). Thus if biological reproduction continues to decline globally in correlation with broad

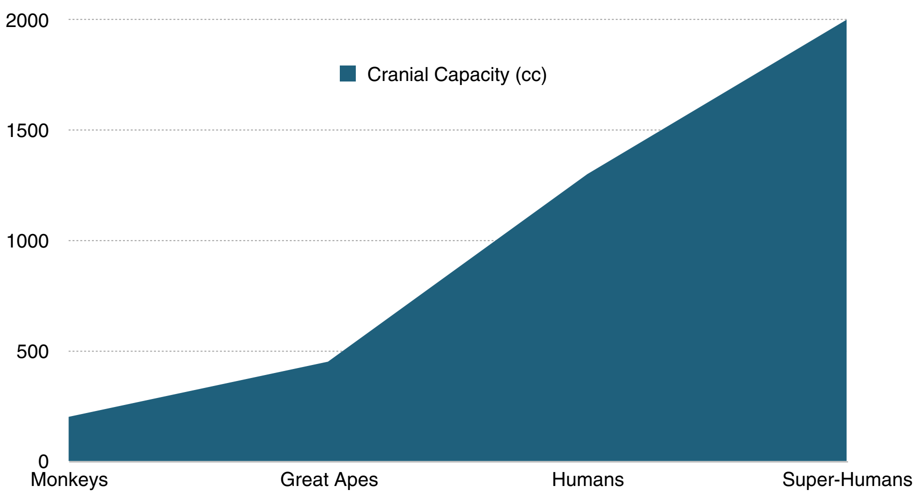

Fig. 5 Evolution of life expectancy throughout primate life history. Throughout the history of the primate order life expectancy has progressively improved with life history transitions. With the next transition from biocultural humans to technocultural super-humans we will see a further extension of life expectancy aided by developments in genetics, nanotechnology, artificial intelligence, and robotics. Although the chart suggests a future life expectancy of 120 this number will likely be unbounded

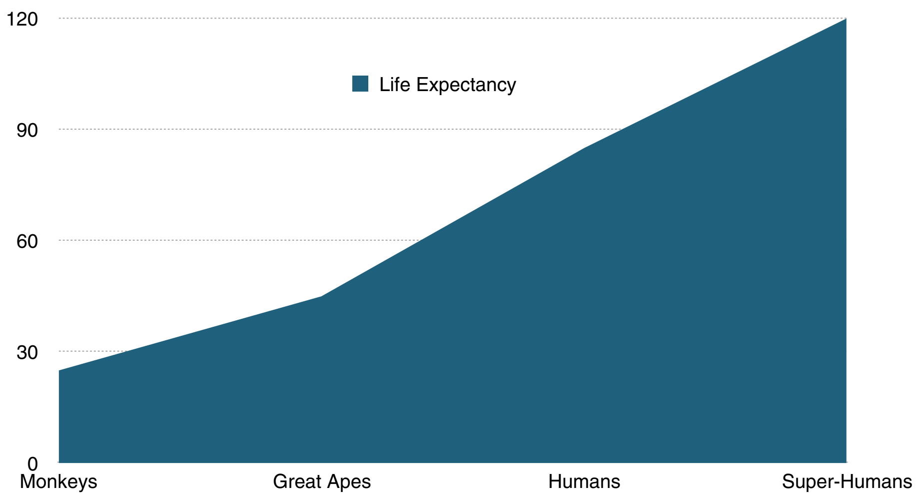

Fig. 6 Evolution of cranial capacity throughout primate life history. Throughout the history of the primate order cranial capacity has also progressively increased with life history transitions. With the next transition from biocultural humans to technocultural super-humans we will see a further expansion of cranial capacity with the development of biology–technology hybrid thinking. Although the chart suggests a future cranial capacity equivalent of a doubling of current human capability, in reality the expansion will likely also be largely unbounded

global socioeconomic development we should not fear a demographic implosion towards extinction but instead a species-wide transition towards encephalization and radical life extension (Last 2014a). From this perspective the evolution of the human species is the evolution of increasing the gap between biological generations to the point where the gaps vanish (i.e. the end of biological reproduction). In the theory of atechnogenesis, this is where trend 2) towards internal merger with technology could feature more prominently.

The second crucial prediction for the theory of atechnogenesis is that biocultural humans will start to replace/re-design functional biochemical structures via genetic, nanotechnological, and robotic manipulation. Indeed, humans are already beginning to develop technologies that surpass biological functionality. The evidence that humans are replacing their biology with these functional technological analogues can be found in countless bioengineering and cybernetic examples, from robotic prosthetic limbs and organs (Campbell 2014), nanotechnology that can interface with/replace cellular machinery (Tian et al. 2012), brain-machine interface for direct brain-to-brain communication (Pais-Vieira et al. 2013; Rao et al. 2014), and other technological mechanisms involved in improving working memory, sensory perception, and potentially even forms of telepathy and telekinesis (Nicolelis 2011; Kaku 2014).

This has led many to realize that the 'cyborgs are already among us' (e.g. in popular press: Ferguson 2012; Carroll 2014; Duhaime-Ross 2014; House 2014; Pepitone 2014). But that is not news. What is news is that human cyborgs are likely to be *increasingly* among us potentially changing society in *qualitatively* new sociocultural dimensions. Of course, this transition towards humans that experience reality through increased technological mediation as opposed to biological mediation will not happen in one year or decade, it will likely be a process that occurs at a gradual yet accelerating pace throughout the twenty-first century as the requisite technology emerges and as access diffuses. How fast it will emerge and diffuse will depend partly on Moore's law, but also on how much time and energy we dedicate towards developing the requisite baseline technologies as well as our sociocultural reaction towards practically implementing them. Thus the future of these developments includes sociopolitical dimensions that are difficult and/or impossible to predict because they depend on our collective will (which was discussed re: 'new modernity' in Sect. 3).

Therefore, depending on various sociopolitical factors, in the coming decades major biology-technology mergers may remain mostly in the medical domain as more and more nano- and robotic technologies acquire properties enabling them to outcompete biology in terms of basic functionality (Freitas 1999, 2005; Drexler 2013). This will include humans regularly adopting 'bionic' limbs, organs, exploring new sensory modalities with technological prosthetics, and even experimenting with internal nanotechnology for regulation of metabolic pathways and general cognitive functionality. Over this time period cultural acceptance of 'cyborgs' will likely increase with social exposure, leading to more recreational attempts to merge biology-technology, not out of functional biological necessity, but rather out of a playful curious exploration of what could potentially be: i.e. running faster, jumping higher, increasing/expanding perception, increasing ability to learn, improve memory, etc. Here new cyborg and robotics cultural events, both intellectual and physical, are likely to play a dominant role in showcasing new types of human forms and abilities.

Throughout the entire process, medical developments will eventually enable radically longer life span and biological rejuvenation, but the more recreational or professional pursuits will also enable radical encephalization through deeper neocortex interconnection to the Internet, artificial intelligence, and other human minds, etc. (Kurzweil 2012). Thus, whereas previous life history transitions were biologically mediated through an expansion of the neocortex (e.g. monkeys to apes; apes to humans) the life history transition from humanity to 'superhumanity' will likely be technologically mediated through a further expansion of the neocortex (i.e. biology-technology hybrid thinking) (Figs. 5, 6). In this sense the twenty-first century could be the century where we start to reach the end of the 'Nietzschean' 'abyss' which separates the animal from the superhuman and reach the shores of our long-awaited higher world.

Technological replacements will eventually be more durable and easier to control/modify than our contemporary biological substrate (Freitas 1999, 2005). Therefore as biological functions naturally fail with age, medical professionals (in the form of either humans, AI, or most likely networks of humans and AI's) will increasingly turn to technological replacements until the biocultural human subject has become transformed into a technocultural superhuman subject. In the end, non-genetically enhanced/rejuvenated biology may not survive the technological merger. Biology will be a good teacher along the way, enabling us to mimic its basic properties, but in the end the sophistication with which we will be able to design matter (i.e. our technology) will be of a higher design than biological natural selection, thus eventually culminating in a transition from biocultural humanity to technocultural superhumanity.

In summary, I have attempted to introduce a process: atechnogenesis to technogenesis, which places an emphasis on the technological singularity as a gradual evolutionary transition from the world of the biochemical to the world of the biocultural to the world of the technocultural (Figs. 1, 2). Contemporary singularity theory biases twenty-first century transformative potential towards the emergence of artificial general intelligence and de-emphasizes the potential transformative role of technologically enhanced biocultural humans. Consequently, many technologists and philosophers are reaching a dystopian eschatological horizon reminiscent of Bill Joy's (in)famous *Wired* article "Why the future doesn't need us" (Joy 2000). In these dystopian visions futurists speculate that the convergence of genetics, nanotechnology, and robotics will lead to the extinction of humanity (e.g. Barrat 2013; Armstrong 2014; Bostrom 2014). However, it is possible that the twenty-first century will be a world in which self-evolving humans will play a dominant role in the transition between biological and technological intelligence through the exploration of an intermediate type of biological-technological hybrid thinking and symbiotic relationship with artificial intelligence. The theory of atechnogenesis emphasizes this potential evolutionary pathway, integrates technological singularity theory with our understanding of biocultural evolution, and makes critical predictions for the future of humanity in the twenty-first century related to demographics, sociocultural life, and biological functionality.

3.3 Big History in the Technocultural Era

When we think of the technocultural era in big historical terms we are not so much confronted with the future of 'humans' (as we typically think of humans) but the future of

Table 7 The next evolution

Directed by aware minds	Biological evolution is not consciously directed by a mind, it is a consequence of biochemical variation at various levels of living system hierarchies, and selection of that variation depending on internal organismal dynamics and external environmental dynamics. In contrast, post-atechnogenesis evolution will become a consciously directed process with aware minds completely taking the place of natural selection, and consciously selecting the cultural and technological world into the future
Mediated through Symbolic/linguistic codes	Biological evolution is built on the foundation of the genetic code, which are structured programs enabling functional capabilities and complex adaptation to varying environments through generational natural selection. This process is mediated by the inheritance, exchange, and expression of genetic codes between and within organisms. In contrast, post-atechnogenesis, technocultural evolution will become built on the foundation of linguistic codes, which enable functional adaptation to varying environments without death to the individual host. Furthermore, this process will become mediated from the inheritance, exchange, and expression of cultural ideas and worldviews between aware minds. This interconnection can be conceptualised as a new type of sexual activity, especially when mind finds a deeper interconnection
Built upon a technological substrate	Biological evolution is built upon a biological substrate composed of chemical elements. Therefore, throughout life history all living organisms have been fundamentally biological in their basic nature. In contrast, the future evolutionary process will increasingly transition towards existing upon a modifiable technological substrate that mimics and improves upon contemporary biological processes of growth, maintenance, and reproduction, but also, control and feedback between sub-system components. Such a substrate allows for deeper interconnection with other technological beings, and allows for greater mind control (self-directed evolution)

It is important to note that this next evolution has existed since the birth of cultural evolution (Sect. 2.3) (Table 3), however the technocultural pathway has yet to gain its own independence because technology cannot yet outcompete biology. However, once this occurs aware minds will be able to escape the limitations and constraints that exist due to dependence on a biological substrate designed without conscious intention, i.e. biochemical natural selection self-designed intelligent 'beings' self-organized towards a higher level of thought. Therefore, when we enter the technological world we enter the academic regions of highest speculation. But here we put the concepts atechnogenesis, technogenesis, and technoculture to another practical test. The technological singularity concept forces us to imagine a black hole of experience, an event horizon beyond which we could know nothing for certain about the deep future. In contrast, with the concepts of atechnogenesis, technogenesis, and technoculture we are confronted with a new evolutionary pathway, a pathway fundamentally (1) directed by aware minds, (2) mediated through symbolic/linguistic codes, and (3) built upon a self-designed substrate (Table 7). From this new evolutionary groundwork the world of the deep future of speculation opens, and a vista of possibility is revealed; a possibility space perhaps constrained only by our imagination.

Computer scientist Viktoras Veitas and philosopher David Weinbaum (Weaver) recently proposed a futuristic evolutionary paradigm, the 'World of Views', which may be useful to help us situate an exploration of the technocultural world. The 'World of Views' attempts to understand a post-scarcity, post-singularity, evolutionary landscape where the primary driver of change is the "multiplicity of unique, modular, and open co-evolving worldviews." (Veitas and Weinbaum 2015, p. 504). This 'World of Views' paradigm is built from the foundations of the philosophy of worldviews (see Aerts et al. 1994; Vidal 2014a) that encompasses an 'objective/external' component, a 'subjective/internal' component, and an 'intersubjective/social' component. Thus we can utilize this paradigm to both de-emphasize evolutionary change that results from the inherent constraints of biology, and instead focus emphasis on opportunities inherent to the future of cultural and technological evolutionary change directed by the personal and interpersonal co-evolution of worldview structures: 'A World of Views'. In this exploration we assume that the emergence of primarily technocultural beings will allow for a much higher perception of 'objective/external' reality, dramatically altered 'subjective/internal' experience due to the ability to process and understand large quantities of information more efficiently (consequently changing our perceptions of subjective space and time), and also heightened ability for 'intersubjective/social' connection with other technocultural beings through direct mind-to-mind communication.

We can add to this view within our own big historical paradigm to make basic structural predictions. First, throughout big history we have seen a steady rise in energy flow (Chaisson 2011a, b), that has enabled living system complexity further and further from thermodynamic equilibrium, and towards higher order (Aunger 2007a, b). Also, throughout the history of living systems we have seen a steady rise in the ability to organize information with ever more complex biological or technological information processing systems (Corning 2002b; Smart 2009). Both of these processes related to energy flow and information processing should continue to increase into the technocultural world, with further energy control being achieved via renewables (Bradford 2006) and nuclear fusion (Niele 2005), and further information processing being achieved via the continued progress related to computation (Kurzweil 2005) (see Sect. 3.1). Furthermore the general evolutionary properties related to differentiation and integration should both continue with differentiation manifesting from the independence of self-directed cultural creativity in a post-scarcity economy (Veitas and Weinbaum 2015) and integration manifesting through the dissolution of national borders and the formation of a distributed planetary network organized in the collaborative commons (i.e. post-property, post-labour social economy) (Rifkin 2014) (see Sect. 3.1).

The combination of higher energy flow, information processing, cultural differentiation, and sociopolitical integration could create the foundations for an emergent organization with a far higher possibility space than any historical society. This shift will include a qualitative leap in all of the dimensions of our personal lives, including how we relate to our own mind and life, how we relate to the world, and how we relate to each other (not to mention who we call "we", see Hofstadter 2003). Historically, these dimensions of our experience have been shaped by our evolved biological perceptions, the replication of our symbolic structures, and the sociopolitical structures of historical civilization. However, in a technocultural world the mechanisms for sensory perception, replication of symbol structures, and sociopolitical organization will all have foundationally changed, likely leading towards a planetary network of unprecedented cultural and technological creation: tens of billions of minds in free association, exploring deeper levels of interconnection, and internal/external reflection than possible within a purely biological substrate.

In the technocultural world the interconnected transhumanist goals of radical life extension and radical life expansion will most likely define the era. Thus, fundamentally we will approach the technocultural world from two directions: what does it mean to live indefinitely, and what does it mean to experience a higher qualitative cognitive landscape? First, radical life extension will have been achieved because the technological substrate can be more easily controlled by mind in regards to basic functionality and efficiency. Futurist and gerontologist Aubrey de Grey has called this possibility the "Methuselarity" (de Grey 2015): a point in the future when technology is advancing faster than we age, allowing individuals to reach Longevity Escape Velocity (LEV) (de Grey 2004). This is an important concept to understand because historically we have conceptualized age in exactly the opposite way, i.e. the longer we have lived the shorter we have expected our future life to be, etc. But throughout the process of transforming our existential substrate we should start to experience exactly the reverse, i.e. our future life expectancy will start expanding before us.

Here it is important to remember that, in history, the biocultural human is not just subject to a sociopolitical tyranny (i.e. "man is born free, and everywhere he is in chains" (Rousseau 1762) etc.) but also a biological tyranny. In a biological substrate a biocultural being is subject to a certain tyranny in relation to sleep and food in particular. If your biological body is tired, well then it's time to sleep, or else it will be difficult to do anything else. If your biological body is hungry, well then it's time to eat, and so on. Although it is possible to develop a certain control over these processes—via the use of your mind—ultimately your biological substrate is something that must be "dealt with" if you want to continue existing and functioning. Ideally, one must contemplate methods for healthy biological maintenance (see Heylighen 2014a). This creates a great deal of internal mental tension, and in many ways structures (or at least constrains) the way we live our individual and collective lives. However, in a technological substrate, the mind is likely to have far more control over the nature of conscious experience; not just related to sleeping and eating, but also in regards to physical healing, durability, attention, etc. Fundamentally, this will enable radically new levels of personal longevity.

Many have stated that this potential 'end of death' could lead to the 'death of meaning', but I think this is too naïve a philosophical approach to the future of radical life extension, and certainly will not be a deterrent to its realization. However, it is indeed true that, throughout the entirety of life history, the game of life has been the game of generation and death after generation and death. Beings pop (or are "thrown": Heidegger 1962) into existence, struggle to make sense of existence, and then pop out of existence. The human being added conceptual awareness to the struggle. Human civilization added collective learning to the struggle. Humans individually and humanity collectively create/participate in "immortal cultures" and "make history" in order to repress our mortality and finite existence (Brown 1959, p. 101). This drive against death [originally recognized by psychologist Sigmund Freud (Freud 1920)] is the eternal struggle for our species (Cave 2012). How do we human beings use our creative and sexual energy in light of the fact that we are all going to die and return to non-being? Surely escaping this internal psychological tension is both inspiration [i.e. the "inspired suffering" of history (Frye 1970)] and something to be collectively overcome (Brown 1967, p. 53):

> The conclusion of the whole matter – Blake: "We are in a world of Generation and death, and this world we must cast off."

Thus, in the technocultural world we have the chance to leave our current state of mortal suffering and struggle, and instead push beyond this struggle, to 'cast off' the world of generation and death towards an entirely different world. Would it be a transition from a world of impersonal eschatology (biological ageing and death) towards a world of personal eschatology? Would the life force of our internal desire for future creativity and sexuality be transformed and sustained indefinitely? Would the question be rendered redundant due to the sublimation of the individual self into a higher entity (i.e. the sacrifice of the particular for the universal)? The only reference we have to imagine such a world comes from the Gods of our own cultural design and imagination. In this sense we can only say that the world of the technocultural being is on a whole different experiential level than that of the biocultural world. The biocultural human may not be able to handle or understand effective immortality. The constraints presented by both death and time are both so overwhelmingly important towards the construction of human meaning that the end of both can only mean that the burden of meaning creation will shift more and more towards our own internal urge for more life and experience.

Carl Sagan once famously remarked that "the secrets of evolution are death and time –" (Sagan 1980, p. 3) but he meant this in the historical sense that differential survival over the course of billions of years has led to the complex biological world we see around us today. When thinking about the future of evolution perhaps the real secrets of evolution are to be found on the other side of death, and the problems that arise when beings have all the time in the world. For us the reality of finite time, and the uncontrollable nature of our inevitable personal eschatology, is a reality that our whole collective self unconsciously revolves. If this is not the case for the technocultural being, then everything changes: sense of identity, perception of time and space, experience of being, relation to the cosmos (Wolfram 2011):

> Effective human immortality will be achieved. And it'll be the single largest discontinuity in human history. I wonder what's on the other side though.

Beyond immortality the deepest possibilities and surprises of the technocultural world will likely come, not from radical life extension, but from radical life expansion, in terms of cognition and cognitive interconnection. Therefore, when we explore the technocultural world experientially, we reach a world of deeply integrated minds in planetary interconnection, and whatever that interconnection will birth (see Sects. 4–4.2).

This potential future integration would be a continuation of past cosmic evolutionary metasystems, where new levels or hierarchies have been achieved through higher synergistic interconnection (Miller 1978; Corning 2014) (Table 3). Thus, in the technocultural world, the real action could be occurring on an entirely new intersubjective level of full mind–body consciousness (Chorost 2011). Cyberneticist Valentin Turchin thoughtfully contemplated the possibility of a deeply integrated human super-being under the apt subtitle "Questions, Questions" (Turchin 1977, p. 259):

> How far will integration of individuals go? There is no doubt that in the future (and perhaps not too far in the future) direct exchange of information among nervous systems of individual people (leading to their physical integration) will become possible.

What does it mean to expect a higher level of qualitative experience? The future emergence of a new qualitative dimension may be seen as analogous to the way that symbolic art is commonplace for biocultural humans, yet completely absent in the biochemical world (Conkey 1997). Art was a qualitative emergence that resulted from the increased informational transfer abilities acquired through the expansion of the neocortex and the evolution of language. Of course the same goes for the other uniquely human cultural activities like science, poetry, philosophy, mathematics, music, etc. Thus in the past we have clear evidence that quantitative increases in brain capacity can lead to the radical emergence of new qualitative properties which then proceed to play a dominant causal role in future evolutionary processes. What new symbolic or mind properties will emerge from a further technological expansion of the neocortex and further evolution of language towards closer mind-to-mind communication? And what will emerge from the new ecosystems of purely technological mind?

Technocultural beings will be able to share extraordinary high levels of information at the speed of light, and via much more reliable mechanisms, likely via direct mind connection with others and with our collective computer networks (i.e. our ‘digital twins’ or ‘personal AI’s’) (Kurzweil 2014). That is to say that the (practically) instant transmission of information files (for example: books, movies, music, photographs etc.) could be transferred between minds directly and understood near-instantaneously. All minds would have a dramatically expanded understanding of acquired knowledge, allowing for an unprecedented level of “cultural ratcheting” (see Tennie et al. 2009) or “collective learning” (see Christian 2004). The generational barriers towards knowledge transfer may even be completely overcome. Beings would also be able to communicate vast reaches of their mind through virtual recreations of any and all varieties in mediums of expression that currently do not exist.

But these are the quantitative aspects of future mind. The qualitative aspects are much harder to describe and anticipate, as they will be emergent in their very nature, potentially enabling new forms of game, adventure, exploration, ecstasy, and mystery in physical spaces, but also intersubjective virtual spaces. Here a potential major sexual transition could occur between interconnecting bodies towards interconnecting minds, or interconnecting minds and bodies simultaneously in new ways. In a world where there is no reason to suspect a limit to the sharing of thought/feeling spaces in respect to temporal duration or number of aggregating minds/bodies, we can only expect future surprises (Chorost 2011; Nicolelis 2011).

The technological substrate itself will play a new role in the foundations of social expression and interconnection. In contrast to being a fixed substrate of mind-less design the technological substrate will be self-designed and thus far more malleable to conscious intention and potentially effortlessly self-transforming, i.e. reflexive to and expressive of inner thoughts and feelings. In this sense, the body itself would become a new art project for a technocultural being in the same way that clothing and various forms of cultural body decoration can become art projects for biocultural humans today (Vita-More 1992). The self-transforming body could become a new higher form of body language, enabling technocultural beings to communicate exact meaning of their thoughts and feelings to the external world. In some sense, we can think of these future possibilities of linguistic body expression as creating a form of 'naked mind', where our minds are no longer completely hidden from view, instead becoming tableaus for the higher expression and interconnection of subjective meaning, thought, and feeling. This may in turn allow for the higher expression of subjective experiences like 'love', 'joy', 'anger', 'frustration', and 'depression' to be communicated with a higher-level of understanding, making it easier to see from another person's unique point of view, and reinforcing the commonality/integration of mind in full subjective differentiation. Ultimately, these types of abilities could manifest with qualitatively new forms of dance, music, sport, discussions, debate, and ritual celebration.

To view the modern biocultural human within this framework is to conceptualize a finite species preparing the architecture of a departure into an infinite (from our point of view) experiential landscape. Consequently, there is no telling what form such a superbeing would take, what thoughts and feelings would emerge, what possibilities would become commonplace over the longer-term. What would be the nature of a superbeing's goals, values, dreams, and visions? This would be like trying to compare the experiential landscape of the first bacterial colonies of the Archaean Earth with the experiential landscapes of Anthropocene New York City, as evolutionary theorist John Stewart aptly recognized (2010, p. 402):

> The difficulty we face in trying to evaluate [the future of intelligence] at our current scale of intelligence would be similar to the challenge facing an intelligence bacterium in our gut that is trying to make sense of the social interactions we engage in.

However, we will still attempt to push further into the future by entertaining two scientific thought traditions about the human deep future. We will organize the first thought tradition under the banner of the 'Expansion Hypothesis' (EH) to describe theorists who posit the deep future of intelligence is destined to find itself among the stars and galaxies. We will organize the second thought tradition under the banner of the 'Compression Hypothesis' (CH) to describe theorists who posit that the deep future of intelligence is destined to remain in the local region.

Therefore, these two deep future thought traditions propose radically different deep futures, one in deep space the other focused on continued local 'inner' development. Thus these hypotheses must be fundamentally separated because they make radically different predictions about the potential nature of the intelligent universe beyond our local region (speculations on cosmic evolution within 'global' cosmological perspective). If we quickly consult dominant cultural representations of the deep future, e.g. *Star Wars*, *Star Trek*, etc. it is easy to conclude that the "outer space" model of the deep future has been more influential. Although that is not to say that it is a more accurate representation of the nature of future intelligence.

4 Deep Future

Culture and technology may be processes that lead to 'infinity' (i.e. endless process) or 'omega' (i.e. process with an ultimate end) (see Barrow 1998; Deutsch 2011). Here I think it is interesting to explore a potentially fundamental dichotomy in our universe, one that exists between the possible and the impossible. In this way of thinking what is physically possible is what can be caused to happen (given the right knowledge acquired by a system) and what is impossible is what cannot happen no matter the knowledge acquired by a system (due to the laws of physics) (Deutsch 2013). The collective subjective body of humanity viewed from this perspective gives the appearance of a phenomenon engaging in a titanic battle against the indifferent universal object to realize its latent subjective and intersubjective future potentiality through knowledge creation (i.e. the ancient relationship between the 'tree of' knowledge and mystery). Our ultimate collective potentiality currently remains mysterious: our biggest known unknown.

Although we do no know what is at the end of this knowledge creation process (or whether there is an end), we do know that we do not live in a clockwork Newtonian universe with the future already determined for us. There is choice, creation, and emergence along the pathway of the future universe. However, as mentioned, there are also physical transformations that are possible and physical transformations that are impossible. For our future this means that there are certain technologies a cognitive system can in principle produce to enable certain actions and certain technologies a cognitive system could never produce because they are forbidden by physics, thus rendering the future technological possibility space in some sense predetermined (in terms of the axis of possibility/impossibility) (Drexler 2013).

In this way the future is both open-ended and free, yet constrained towards certain possibilities and away from certain impossibilities. However, the trick with the future is that we will only become cognizant of what is possible (and also what we want to be realized) and what is impossible in the course of time as our understanding of our collective past/present changes in relation to new knowledge/conditions. From this perspective it may be useful to think of the deep future in terms of an, originally Protestant turned Kantian, notion of 'predestination' (Žižek 2012, p. 214):

> Predestination does not mean our fate is sealed in an actual text existing from eternity in the divine mind; the texture which predestines us belongs to the purely virtual eternal past which, as such, can be retroactively rewritten by our acts. […] Our acts not only create new actual reality, they also retroactively change this very condition.

Thus an exploration of the deep future is by its nature impossible in any 'objective' sense because we are completely unaware of what will be discovered tomorrow or 50 years from today (or what we will want tomorrow or 50 years from today). That future knowledge will, *retroactively*, change the conditions of our understanding, and thus change the way we act and conceive of our future possibilities. But given our lack of knowledge can we still speak of our final frontier? Or said in another way, what is the future relationship between the collective living subject of humanity and the indifferent geometric universal object?

4.1 The Final Frontier: Expansion Hypothesis

From the beginnings of the scientific revolution to the present day, humanity has imagined itself as becoming the future colonists of outer space (see Kepler 1608; Voros 2014). Indeed, in some ways we can see a significant portion of frontier science production, as well as a significant portion of the creation of science fiction, as fundamentally dependent on the idea of human space expansion. In the modern world, the idea of humanity as becoming future space colonists exploded (see Wells 1920; Tsiolkovsky 1929; Oberth 1957; Kardashev 1964; Dyson 1979; Asimov 1983; Tipler 1994; Sagan 1997; Landis 1998; Annis 1999; Dick 2000; Hanson 2008; Stewart 2008). In this tradition of thought we can find the popular cultural representation of the Earth as our "cradle" (see Tsiolkovsky

1911), and outer space our "destiny" (see Clarke 1950). Today, many scientists view expansion as our only long-term hope: "We must continue to go into space for humanity. We won't survive another 1000 years without escaping our fragile planet." (Hawking 2013).

In some sense, this can be seen as a logical evolutionary conclusion. After all, where else would we go after we have completely conquered (i.e., ephemeralized) space, time, matter, and energy on planet Earth? There is an infinitely vast space–time continuum on the shores of Earth, populated with 100's of trillions of stars, and 100's of billions of galaxies. How many life forms exist in this infinite vastness? How many other life forms have developed culture and technology as well? Although speculative, our universe is so large and structurally homogenous that it is far more probable that there are other forms of information processing being. Our existence could only be conceptualized as miraculous if we were truly alone among billions of galaxies. Therefore, the Expansion Hypothesis (EH) posits that the continuation of human history as a cosmic drama can surely be expected to outsource itself and play itself out in this cosmic arena, which, it can be safely assumed, will be populated by other beings (Dick 2000, p. 555):

> Over the next 1000 years the domain of humanity will increasingly spread to the stars, a process that will alter our future in profound ways. At least three factors will drive this expansion: (1) increased understanding of cosmic evolution, changing our perception of ourselves and our place in the universe; (2) contact with extraterrestrial intelligence, bringing knowledge, wisdom, and problems of culture contact now unforeseen; and (3) interstellar travel, transporting humanity's emissaries to at least the nearest stars.

Material and colonial adventures abound in this deep future vision. Civilizations spanning multiple solar systems and multiple galaxies are still to be forged over deep time (see Armstrong and Sandberg 2013). Maybe we will be able to see other galactic civilizations in the process of doing just this (see Voros 2014). Interstellar and intergalactic communication mediums could be erected to facilitate the formation of these civilizations, and new forms of energy extracted from the hearts of stars and planets, could be commanded to power the existence of beings throughout the cosmos. We would climb the Kardashev energy scale (Kardashev 1964, 1997; Ćirković 2004). The universe itself will finally "wake up", and eventually, mind will decide how it will end (Kurzweil 2005, p. 260):

> Our civilization will then expand outward, turning all the dumb matter and energy we encounter into sublime intelligence – transcendent – matter and energy. So in a sense, we can say that the Singularity will ultimate infuse the universe with spirit[/consciousness].

However, if we are going to entertain expansion scientifically we must situate our thinking within a cosmic evolutionary framework. Currently, the strongest evolutionary argument in favour of expansion comes from the work of theorists developing a progressively integrative model of living system complexity construction (see Stewart 2000, 2014). In this model, living systems are characterized by the evolution of ever-more diversified and integrated structures on ever-larger physical scales, e.g. cells, organs, organisms, groups, organizations, communities, societies, supra-national organizations (Miller 1978). Therefore it is argued that a progressively cooperative arrow exists in the evolutionary process (Stewart 2000): proto-cells formed cooperatives to produce prokaryotes; prokaryotes formed cooperatives to form eukaryotes; eukaryotes formed various cooperatives producing all multi-cellular fungi, plants, and animals; and human beings are forming larger and larger cooperatives that should eventually reach a planetary scale (Heylighen 2007, 2008; Last 2014b; Stewart 2014). From this line of reasoning, it is argued that the trend towards higher levels of cooperation will drive the cosmic process of expansion towards cooperatives on the scale of solar systems, multiple solar systems, galaxies, and even galactic super-clusters (see Armstrong and Sandberg 2013; Voros 2014) (Fig. 7).

Of course, nobody knows with certainty whether such entities are possible in our universe. However, we can still have fun in theory by positing technological mechanisms of interconnection. For example, advanced civilizations could be interconnected with some form of interstellar or intergalactic 'internet' system, fuelled by feeding on the fusion of stars, and physically connected through some form of light speed (or faster-than-light speed) travel that is currently beyond our contemporary understanding of physics and engineering. Indeed, these possibilities have been considered most thoroughly in regards to future energy potentiality. The most famous such example was explored by the astronomer Nikolai Kardashev where he speculated about energy sources for an expansionist civilization. In Kardashev's scheme civilizations could be classified by their energy consumption rates (measured in watts) and mechanisms from Type I to Type IV (Kardashev 1964). The scheme is fairly straightforward where a Type I civilization can control the energy resources of its home planet, a Type II civilization can control the energy resources of its solar system, a Type III can control the energy resources of its own galaxy, and a Type IV civilization can control the energy resources on the scale of multiple galaxies (see also: Sagan 1973; Kaku 2010). According to the astronomer Carl Sagan, human civilization is approximately a Type 0.7 civilization (Sagan 1973, p. 182) (Table 8).

Although current cosmological models of the universe suggest that colonizing the entire physical universe is impossible, or even nonsensical, we can still conceptualize a

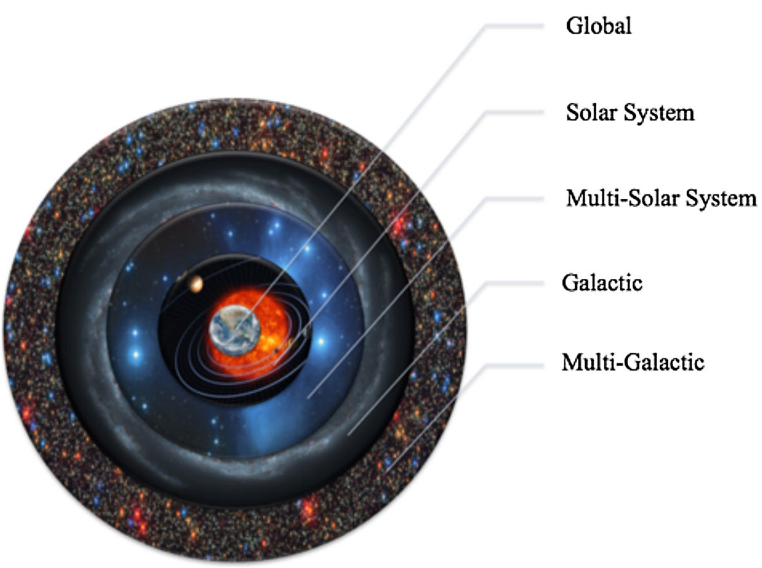

Fig. 7 Potential future of progressive cooperative organization. The expansion hypothesis posits that intelligent life will progressively organize higher cooperative organization from the global to potentially even the multi-galactic level. The above image conceptualises this expansion assuming that intelligent life would radiate in all directions with each new level of organization

civilization that—through some technological wizardry of an unimaginable order—managed to completely reverse the entire process of cosmic expansion and control the whole of physical reality. We would call such an entity an 'Omega Civilization'. Cosmologist John Barrow introduced the idea of 'two forms' of Omega Civilization, with the aforementioned entity representing the expansionist variety (see Barrow 1998). We will call this hypothetical Expansion Hypothesis variety: Omega Civilization-E: an entity that could "manipulate the entire Universe (or even other universes)" (Barrow 1998, p. 130) (for more: Sect. 4.2).

Considering that the technocultural world is likely to be a post-scarcity realm of higher cooperation and integration perhaps this is the deep future for intelligence: the cosmic web as a playground for transcendent information processors. "Many centuries from now, will intelligent beings look back upon human history as an episode in the biography of cosmic *Geist*?" (Zimmerman 2008, p. 369). Indeed, this EH framework for thinking about the deep future can be made to fit nicely with our current cosmic evolutionary framework related to information, energy, complexity, as well as differentiation and integration. Each of these higher-level space cooperatives would need increased energy, information processing capabilities, and would therefore exhibit higher levels of complex organization and interrelationships. These entities would also produce far more variation, as likely manifest in forms of cultural expression and technological product beyond human imagination. Of course, it is also possible in this scenario for variation to be produced through qualitatively different phenomena that currently do not exist, i.e. mind in a cosmic evolutionary world beyond even the technocultural.

However, this is not to say that the EH is without philosophical problems. Regardless of its popularity and intuitive appeal, we must remember that it is running on no empirical data: there is no evidence that intelligent life follows some developmentally constrained expansion to the cosmos; it is a logical conjecture, and nothing more. Indeed, a recent infrared survey of 100,000 galaxies looking for signs of a Type III or Type IV civilization did not find any obvious signs of large-scale macro-engineering or large-scale processes that could not be explained with astrophysical models (Griffith et al. 2015). And yet the whole of the *National Aeronautics and Space Administration* (NASA), as well as the whole of the *Search for Extraterrestrial Intelligence* (SETI), have been influenced by the narrative construction of the EH. Because of this we rarely question the logic that both humanity and other intelligent beings, will go to the stars.

Of course, this is not the same as stating that no expansion data will ever be found, or even that we should stop looking for data to support the EH. This is also not to say that we should stop attempting to explore our own solar system. I think NASA and SETI as organizations represent the very pinnacle of cosmic cultural thought as manifest in institutional structures, and deserve a much larger share of our attention and support. If SETI were to discover any intelligent civilization tomorrow, an understanding of its nature would likely completely revolutionize our understanding of the universe and nature as a whole. And if NASA developed some type of transportation device that allowed us to

Table 8 Kardashev energy scale

Type 0	Control of energy resources of below planetary level
Type I	Control of energy resources of home planet
Type II	Control of energy resources of home solar system
Type III	Control of energy resources of home galaxy
Type IV	Control of energy resources of multiple galaxies

explore the Milky Way, then physical expansion would look like the obvious deep future for humanity (both good examples of 'predestination' where the 'purely virtual eternal past' becomes 'retroactively rewritten by our acts' given new knowledge/understanding). But as of now, the expansion of intelligence is still an assumption that we should consider, both seriously *and* skeptically.

Despite this, throughout most of science history, the EH has gone (mostly) unchallenged as an assumption. But there are now philosophical problems raising important questions about its probability. The most important philosophical challenge to the EH can be found in the realization that technological evolution on Earth is accelerating towards a much higher possibility space than previously assumed. Essentially, this means that the biggest theoretical development forcing us to re-assess the assumption of expansion comes from the emergence and subsequent development of singularity theory (see Sect. 3.1). Singularity theory forces us to confront the fact that an intelligent species can evolve from a primitive technological civilization with little knowledge/understanding of its home planet and universe to an advanced technological civilization characterized by ubiquitous supercomputing, artificial general intelligence, and an interconnected global brain, within the cosmic 'blink of an eye' ($\sim$250 to 500 years).

Immediately it is clear that there is something very strange about the nature of cosmic time vis-à-vis cultural time. On scales of cosmic time significant events and developmental processes occur on scales of millions and billions of years, if not even longer scales of time. In stark contrast, on scales of cultural and technological time, significant events and developmental processes occur on scales of decades and centuries. Increasingly, significant human events occur on scales of years, months, weeks, or even days. Cosmic timescales and cultural timescales simply do not exist on the same temporal dimensional plane of existence. Furthermore, cultural and technological processes are now stably harnessing the most intensive and dense flows of energy in the whole of the universe (Chaisson 2011a). These processes are continuing to intensify, generating organization of a variety and at a speed that is unparalleled when compared all phenomena in the known universe.

This is relevant to our discussion of the EH because of Fermi's Paradox (see Davies 2010). Fermi's Paradox, simply stated, attempts to capture the bizarre fact that we have woken up in a vast and homogenous universe, which appears empty and silent. Yet here we are making all this noise. Thus, the paradox can best be conceptualized by physicist Enrico Fermi's immortal question:

> Where is everybody?

No one has a definitive answer for Fermi (although not from lack of effort, see Webb 2002), and this is problematic for science and the scientific worldview (see Ćirković 2009). Of course, the answer to why we detect no intelligence in the universe as a whole could be explained in many different ways. One of the most probable possibilities is that we simply do not have the requisite technology (or the necessary funding) to scan the entire universe in sufficient detail (as of 2015). As SETI astronomer Jill Tarter stated (2001, p. 511): "SETI results to date are negative, but in reality, not much searching has yet been done." Astrophysicist Neil deGrasse Tyson echoed Tarter's sentiment, and made fun of SETI critics with the analogy of someone taking a cup to the ocean, scooping out some water, and then concluding that there must be no whales! (Tyson 2010). The point is obviously that we have not thoroughly scanned the large majority of the universe for intelligent activity, even though efforts are intensifying (e.g. Griffith et al. 2015). Consequently, many SETI researchers believe that, due to advancing technological capability, there will be advancing satellite detection capability, which will allow researchers to scan millions of star systems in the Milky Way galaxy simultaneously, dramatically increasing the chances of finding E.T. in the process (Shostak 2013).

SETI's contemporary position is valid and I take it seriously, but this does not help us evade the philosophical and theoretical challenge of technological singularity theory. The simple fact is that all of the preconditions for advanced intelligent life have been present in our galaxy, as well as our Local Group of galaxies, for at least 4–5 billion years. That is to say that our galaxy has been a region of the universe theoretically conducive to the formation of life for as many as 10–11 billion years now (Rees 1997; Dick 2009c). Taking these data to their extreme, we find that advanced intelligent civilizations could be 7.5 billion years our senior (Vidal 2014a, p. 206). Of course, that is plenty of time for a mature civilization to put their home planet in order and start a galactic journey, even when we consider the temporal restrictions posed by the speed of light, and the vast distances separating most star systems. But we do not need that much time in order for Fermi's Paradox to become problematic in light of Moore's law and the potential future advance of technological evolution.

When Moore's law is extrapolated to its logical conclusion, what we get is some pretty jaw dropping conclusions; even more jaw dropping than the near-term emergence of advanced technologically based superintelligence. The ultimate question with the nature of computation is: how fast can information be processed in our universe, given the known laws of physics? Then, based on the rate of Moore's Law, can we approximate how quickly such an information-processing limit can be reached? (see Krauss and Starkman 2004). The current hypothesis is that the ultimate computer, or the ultimate "laptop", would be able to perform 10^{50} operations per second on -10^{31} bits (Lloyd 2000). Such a device would be in a highly ordered negentropic state, taking on the analogous dimensions of a space–time black hole (Lloyd 2000, 2006; Lloyd and Ng 2004). Based on Moore's law such an entity could conceivably be constructed by human civilization (or a future technocultural civilization) within 250–600 years (Krauss and Starkman 2004, p. 10):

> Our estimate for the total information processing capability of any system in our Universe implies an ultimate limit on the processing capability of any system in the future, independent of its physical manifestation and implies that Moore's Law cannot continue unabated for more than 600 years for any technological civilization.

What this means for Fermi's Paradox should be clear: once an advanced civilization figures out the nature of computation, there is a possibility that it could develop into a black hole computing civilization. Such an entity would have compressed space–time to a dimensional point within a very short duration of time when compared to cosmic developments. Even if contemporary predictions made using Moore's law are unreliable—as quantum computer scientist Seth Lloyd explicitly acknowledged (2000, p. 1053)—and it takes humanity an extra 1000 or 5000 or 50,000 years to develop the computational power of black hole computers, that would still be almost no time at all when compared to the scales of time that characterize solar system development or galaxy formation, and so on.

Furthermore, even though Moore's law is a product of human intelligence and economics, not a property of physics, there is little reason to think that future intelligences would somehow be prevented from ultimately reaching these computational capacities. From what we have observed in the twentieth century, there will always be critics of the continued advance of computation, but as Lloyd notes, every time we encounter some overwhelming obstacle: "clever engineers and scientists have found ways to cut the technical knot." (Lloyd 2006, p. 111). Therefore, if *any* civilization got their hands on this type of computation—*and* physical expansion is what advanced intelligence does—then the universe should show some clear and obvious signs of intelligent activity. "It takes but one match to start a fire; only one expansionist civilization to launch the colonization of the universe." (Bostrom 2010, p. 6).

Considered in this frame, we should *definitely* see the types of galactic macro-scale engineering hypothesized to exist by numerous theorists (e.g., Sagan and Shklovskii 1966; Sagan 1973, 1975; Freitas 1975–79, 2008; Carrigan 2012; Learned 2012; Voros 2014). Highly STEM compressed and efficient civilizations should be exploding in galaxies throughout the universe, making Fermi's Paradox worthy of the name. Given the nature and physical limits of computation, as well as the emerging data related to significant components of the Drake Equation, e.g. potential number of habitable stars, habitable planets, abundance of necessary chemical elements, etc. (see Impey 2007; Billings 2013), adds considerable mystery to this cosmic silence (Brin 1983). The universe appears more than capable of advanced information processing (Barrow 1998; Wolfram 2002; Lloyd 2006, 2013), and our civilization gives the suggestion that advanced civilizations evolve culturally and technologically at a very fast pace when considered in a cosmic context (Sagan 1977; Turchin 1977; Kurzweil 2005; Smart 2009).

Admittedly, many technological singularity theorists have realized this logical confrontation with Fermi's Paradox, and have essentially concluded: "We must be the first" (e.g., Kurzweil 2005; Bostrom 2010):

> [O]ur humble civilization with its pickup trucks, fast food, and persistent conflicts (and computation!) is in the lead in terms of the creation of complexity and order in the universe. (Kurzweil 2005, p. 239)

To support this view, the concept of a "Great Filter" has been deduced (e.g., Hanson 1998). The logic of the Great Filter is that our universe can generate hierarchical levels of complexity, but that it can only do so with 'great' developmental difficulty. The three main "threshold" hierarchical levels of complexity that have been targeted as potential Great Filters include the origin of life, the origin of multicellular eukaryotic life, and the origin of higher intelligence or technologically advanced beings (Hanson 1998; Bostrom 2010). This simply means that the universe may be poor at generating life itself, multicellular life, or high intelligence; or perhaps it is poor at generating all three. If this is the case, the Earth would represent a preciously unique example of a planet that 'made it' through all three developmental Great Filters. Or alternatively, the Great Filter could be ahead of us,

Table 9 Potential developmental great filters

	Approximate temporal local achievement
Prokaryotic life	4–3.5 billion years B.P.
Multicellular life	2–1 billion years B.P.
Intelligent/technological life	2–1 million years B.P.
Interstellar/intergalactic life	N/A (future?)

How likely is it that these developmental levels of complexity have been achieved throughout the universe? We know that the universe can easily generate galactic, stellar, and planetary systems, but at present we have no knowledge of how easily living system organizations can be generated within a global cosmic context (Table 1) meaning that the universe can generate life, multicellular life, and high intelligence without difficulty, but then has difficulty generating an interstellar or intergalactic civilization (Bostrom 2010) (Table 9).

The Great Filter may be a useful concept, or it may be irrelevant (see Aldous 2010), we simply do not have the data to say one way or another. However, by placing our own planet's history in a cosmic context, it seems like the Earth has had relatively little trouble generating any of the three 'Great Filters'. For example, life itself appeared on Earth's surface as soon as it was no longer a giant ball of magma (Bada and Lazcano 2009). Multicellular life evolved from unicellular life on 25 independent occasions (Grosberg and Strathmann 2007). And although only one species has developed evolving culture and technology (i.e., us), it is important to remember that large-brained organisms with primitive cultural behaviours and simple technologies have proven surprisingly abundant in the animal kingdom (Laland and Hoppitt 2003). When you combine this fact with the consideration that all human biocultural evolution has covered a minuscule 2 million years of time (Last 2014a), and that the Earth has at least another 1 billion years remaining to support complex multicellular life (Franck et al. 2005), it stands to reason that if we had gone down a non-cultural evolutionary pathway, some other species would have, eventually. At the very least we can say that there are several candidate species that just need a little 2 million year ecological nudge towards higher neocortex functioning. However, we of course suffer in this analysis from the "observational selection effect" whereby any intelligent life that could conduct this analysis is by default existing on an unknown subset of habitable planets that did evolve and overcome these supposed "Great Filters" (Bostrom 2010).

In conclusion, contemporary science and philosophy stands at an odd place in relation to both Fermi's Paradox and the Expansion Hypothesis. The idea of expansion and contact with intelligence has fuelled some of the best science fiction, and it has also fuelled some of our most innovative science. But now there is an emerging spectrum of theorists who are exploring alternative possibilities. Therefore, it may be time to organize these alternative possibilities under the banner of the 'Compression Hypothesis'.

4.2 The Final Frontier: Compression Hypothesis

The Compression Hypothesis (CH) does not have a deep history, although it does have a history. Systems theorist and futurist John Smart most thoroughly and formally (re)introduced (a version of) the hypothesis recently, proposing that (Smart 2012, p. 55):

> [A] universal process of evolutionary development guides all sufficiently advanced civilizations into what may be called "inner space," a computationally optimal domain of increasingly dense, productive, miniaturized, and efficient scales of space, time, energy, and matter, and eventually, to a black-hole-like destination.

Smart refers to this "black-hole-like" destination as a "developmental singularity" (see Smart 2000; Smart 2009; 2012). Here the point of the concept is to emphasize the developmentally constrained and compressed dimensional nature of the phenomena. Although, somewhat ironically, the term "technological singularity" would work as well, as the concept actually represents a space–time singularity generated by technology. Here I will interpret the concept of the developmental singularity, and other similar historical conceptions, as falling within the CH, i.e. that intelligent life does not expand out into the physical universe, but instead becomes 'compressed' towards the 'inner universe' via mechanisms and towards a fate that we currently do not understand (thus, CH is exactly the inverse of the potential EH deep future).

However strange the developmental singularity concept and the CH first sound, in the twenty-first century, a number of theorists have essentially been attempting to reformulate our understanding of the deep future, as well as our understanding of the universe, within a similar framework. These attempts include theorists from diverse backgrounds in physics, complexity science, philosophy, systems theory, etc. (e.g. Farhi et al. 1990; Harrison 1995; Gardner 2005; Smart 2009; Flores Martinez 2014; Vidal 2014a), all of whom stress the importance of information processing entities, and especially the possibility of technological information processing entities with far more advanced capabilities for manipulating the physical universe at the smaller scales of reality (Table 10). As far as I have been able to understand, these theorists emphasize the potentialities of one of the following three CH deep futures:

First you may notice that one variant of the CH (i.e. Variant 3) overlaps with the Expansion Hypothesis (EH) in an interesting way with interconnection with other intelligent civilizations but without physical expansion. I consider this a CH and not a EH specifically because this future does not include a physical expansion, which has consequences for observations of the physical universe (e.g. no macro-scale galactic engineering projects, e.g. Griffith et al. 2015). Second, it must also be stressed that modern CH speculations and predictions take a novel quality that is hard to compare to any scientific/philosophical theory pre-late twentieth century. Although a few enlightenment philosophers, most notably Georg Hegel and other German Idealists, speculated on a future leading towards the Absolute Self where humanity would acquire omniscient-like 'Absolute Knowledge', these thinkers did not formulate their hypotheses within an cosmic evolutionary framework.

One of the clear exceptions to this can be found, once again, in the theories of paleontologist Pierre Teilhard de Chardin, as he constructed an evolutionary cosmology/philosophy into the deep future driven by increasing complexity and consciousness, and which ended here on Earth through the formation of a "noosphere". Teilhard de Chardin predicted that "noospheric effects" would generate "a whole layer of consciousness exerting simultaneous pressure upon the future" (Teilhard de Chardin 1955, p. 286). From these noospheric effects, Teilhard predicted that intelligence would compress towards "Point Omega" (or the "end of the world") where humanity would reach "maturation" and "escape" from the "material matrix" (Teilhard de Chardin 1955, pp. 287–288). According to Teilhard, "Point Omega" would be a "single point" within which humanity "as a whole" will "reflect upon itself" (Teilhard de Chardin, p. 287): complete space–time compression leading to transcendence of mind.

This future conception of 'noosphere' and 'Point Omega', to my knowledge represents the first *clear, secular* example of a Compression Hypothesis-like prediction. The criterion of evolution being developmentally constrained or attracted towards an 'end point' is met, and the criterion of humanity as driving a process that will lead to us 'leaving the physical

Table 10 Potential CH deep futures

Transcension (Variant 1)	Technological life transcends our physical universe through inner space
Replication (Variant 2)	Technological life functions as a mechanism for universe replication
Cosmic Net (Variant 3)	Technological life forms an integrated network with other technological nodes (w/o physically expanding)

universe' is met. In other words, Teilhard de Chardin stresses the transcension variation (2) of the CH; not expansion (Teilhard de Chardin 1955, p. 287):

> I adopt the supposition that our noosphere is destined to close in upon itself in isolation, and that it is a psychical rather than a spatial direction that it will find an outlet, without the need to leave or overflow the earth.

This version of the deep future is far harder for the human mind to conceive, let alone understand. As stated above, the EH is in some sense helped in that it is intuitive. After all, human beings have already 'expanded' to the Moon, and are making plans on expanding to Mars. We already have satellites dispersed throughout the solar system and even one satellite that has left the solar system (i.e., Voyager 1). We can also easily imagine interstellar space ships and the colonization of multiple planets. Obviously this is not only because there are countless science fiction books, comics, and movies specifically focused on this type of future, but also because we already live on a physical planet in a physical form. In contrast, we reach a very quick barrier to comprehension when we imagine a 'hyper-local' future in 'inner space' that potentially leads to an escape from the physical universe and/or replication of the physical universe. The closest exploration of this idea in science fiction that I can think of is Arthur C. Clarke's famous novel *Childhood's End* (1953) where an alien race guides humanity towards higher mind interconnection and then eventual transcendence into the 'Overmind'.

However, although Teilhard-esque CH predictions have been often overshadowed by visions and systems that support EH predictions (see Sect. 4.1), in the late twentieth century there were a number of theorists considering the possibility that intelligence, culture, and technology could either be mechanisms for the generation of new universes, or mechanisms that would allow us to eventually escape the gloomy picture painted by most cosmologists influenced by the second law of thermodynamics (see Sect. 2.4). Two major developments sparked flourishing of this theoretical direction: A) physicists theorized that intelligence could function to create 'offspring' universes distinct from our own universe (e.g., Linde 1988; Farhi et al. 1990; Harrison 1995; Gott and Li 1998), and B) evolutionary biologists and systems theorists made progress on understanding the nature of convergent development as constraining potential variety and structure of biological forms (Kauffman 1995; Pennisi and Roush 1997; Morris 1998).

When combined these ideas lead to the hypothesis that, although there is an undetermined and unpredictable freedom and creativity throughout the evolutionary process, the possibility space for that freedom and creativity itself is not infinite, i.e. it is structurally constrained towards an end that is potentially predetermined (again, the free creativity would come from not knowing in what way it is predetermined, that knowledge emerges, thus rendering it only *retroactively* 'obvious'). In other words there may be many different 'pathways' that can be 'travelled' throughout cosmic evolution. The 'travelled pathways' were/are not predetermined but dependent on the free choice of agents with limited knowledge and local environmental context (open possibilities). Most of these roads lead nowhere, but there also exist a small subset of 'pathways' that lead towards 'new levels' (diversification/integration) or new vistas of possibility (what we have conceived of as new metasystems, see Table 3), with an even smaller subset of roads leading towards still higher 'levels' (metasystems) towards an ultimate (hyper-technological) end point.

Today a few researchers are synthesizing these ideas with cosmic evolutionary theory to build a new framework for understanding the universe, primarily focused on Variant 2 of the CH: the Evo Devo Universe (EDU) framework. This framework is new, but the fundamental idea is ancient, as EDU conceives of our universe as metaphorically organism-like (Platonic). From this Platonic perspective our universe is viewed as a developing or growing entity with yet-to-be realized future potentiality; as opposed to a metaphorically mechanical entity (Newtonian), which led to the traditionally conceived view of our universe as a highly predictable clockwork. Specifically, from the EDU perspective this means that the universe itself is predicted to be going through a type of multi-local developmental life cycle, complete with birth, growth, reproduction, and eventually, death (Gardner 2000; Smart 2000, 2009) ('multi-local' in the sense that the process is presumably occurring on innumerable 'Earth-like' planets throughout the universe).

Throughout this developmental life cycle the universe's 'cosmic life history' would be represented by 'birth as big bang', 'growth as the (multi-)local evolutionary process' (see Fig. 3; Sect. 2.3), 'senescence as heat death' (see Table 1; Sect. 2.4), and finally, 'reproduction as universe-making technological life forms'. Therefore, we get the image of a universe that has a beginning, matures, becomes increasingly aware, replicates itself, enters old age, and then eventually passes away (after leaving many progeny in the multiverse). Here the emphasis should be placed on cosmic 'growth' and 'reproduction' and their potential to transform our understanding of the structure of the universe, as we became aware of the potential 'birth' (big bang) and 'death' (heat death) process in the twentieth century. Therefore, in this system culture and technology are not irrelevant epiphenomena, but of central importance as they could represent emergent mechanisms for new growth and universe reproduction after the cosmic developmental process reaches full maturation.

From the EDU perspective there are two main points of emphasis in an application of developmental biology to developmental cosmology. First, just as there is a tendency in biological development to generate evolved degrees of freedom as manifest in subsystem differentiation (e.g. genetic, cellular, organs, neurological) culminating in the reproduction of that subsystem differentiation, it is proposed that there is also the tendency in cosmic development to generate evolved degrees of freedom as manifest in subsystem differentiation (e.g. atomic, chemical, biological, cultural, technological) culminating in the reproduction of that subsystem differentiation (i.e. new universes). Here we re-encounter the ancient idea of the universe as a type of 'ouroborous' or a self-reflexive cyclical entity that is constantly re-creating itself: physical order, biological order, and symbolic order, repeat.

Second, just as there are practical energetic constraints and environmental pressures throughout biological development that act as challenges to successful biological reproduction, there are also constraints and pressures throughout cosmic development that act as challenges to successful cosmic reproduction. Here it is important to stress that the EDU perspective does not support the notion that future evolution towards hyper-technological reproduction is *inevitable*, rather it is a contingent and unpredictable process. Thus, the *necessity* of cosmic reproduction (our ethical duty to reality) would be predicted to only become evident once we have reached the final 'level' of the 'game' (in other words, it only becomes necessary in retrospect). Moreover, remember that most of the universe is and is likely to remain 'barren' or 'infertile' forever incapable of giving 'birth' to higher intelligence and hyper-technology. However, in the small subset of regions where higher complexity and order are achieved and stabilized, the chances for potential future growth increase, but never reach inevitability or necessity, presumably until the 'end is near' [and even then perhaps there still exists a (or many) critical choice(s)].

The key general CH prediction with relevance to SETI and NASA is the idea that the cosmos itself exhibits a developmentally constrained tendency towards intelligent black hole-like dimensions (i.e. intelligent manipulation of the smallest dimensions of space–time). This has been referred to as STEM (space–time-energy-matter) compression (Smart

2012). Compression suggests that complex metasystems are developmentally and hierarchically constrained not just to accelerate change in time (STEM efficiency), but also to emerge more locally in space than previous systems. This idea works in our big historical framework as temporal acceleration (STEM efficiency) is hypothesized to arise from increases in information processing capabilities [also formulated as the 'Law of Accelerating Returns' (Kurzweil 2005)], whereas spatial localization arises from increases in density of energy flows. Historically related conceptualizations of the universe have mostly been used to describe accelerating physical change with time (e.g. Adams 1909; Teilhard de Chardin 1955; McKenna 1998a; Smart 2000; Kurzweil 2005), but space and time are connected dimensions, and so it may be useful to conceptualize temporal acceleration and spatial localization as coupled processes related to increases in evolutionary complexity (Fig. 8).

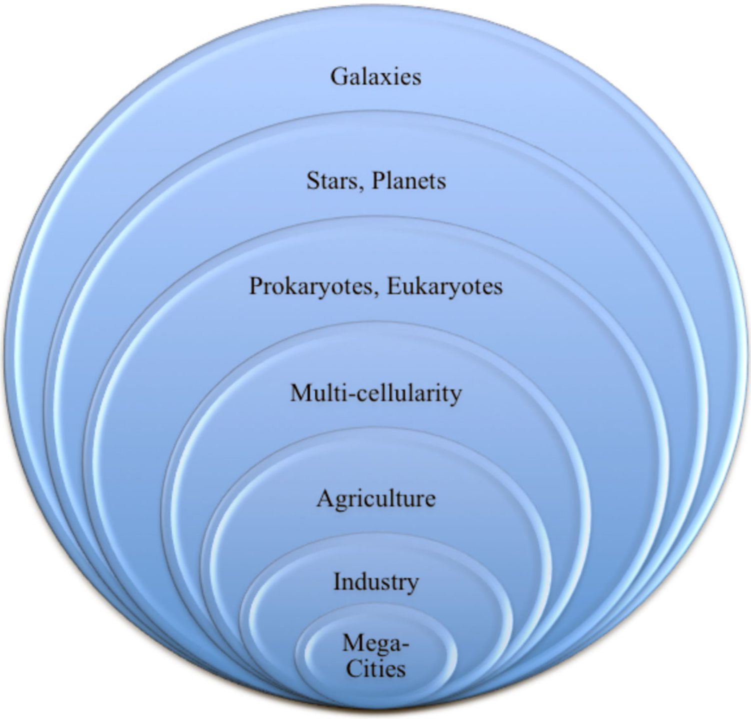

Fig. 8 Compression: hierarchically and developmentally constrained local universe. Throughout the ordered and organizing processes of cosmic evolution higher levels of complexity have emerged in physical, biological, and cultural systems. Apart from emerging in a directional dimension with the arrow of time, these phenomena have also emerged in ever more local regions of space–time. This is achieved by utilizing ever-denser forms of matter-energy. Therefore, complexity in our universe may follow a developmentally constrained localisation property that can be roughly correlated to major energy transitions away from thermodynamic equilibrium. For example, stars developed more locally than prokaryotes and eukaryotes from simpler life; agricultural civilization developed more locally from multicellular life; and finally industrial civilization developed more locally from agricultural civilization. In the modern world we see an overwhelming demographic shift from rural-to-urban, suggesting that by 2050 the large majority of humanity will be congregated hyper-locally in vast mega-cities, which are also the localised hubs for further localisation, currently emerging in the form of advanced super-computation

Here the criticism that is often forwarded against the idea of STEM compression specifically (not STEM efficiency) is that spatial localization itself is not a phenomenon because the evolution of complexity is conceptualized in terms of differentiation *and* integration (with integration representing an expansion of process over *larger* scales of space, not more local scales of space). However the key to understanding spatial localization as a *potentially* important cosmic evolutionary phenomenon is to understand the *totality* of an emergent process. For example, the totality of 'galaxy' (as a cosmic class of phenomena) is one that exists throughout the entire universe. In other words, galaxies as a totality are as 'global' (in the cosmological sense) as you can get. However as you progress through cosmic evolution towards stars, planets, prokaryotic life, eukaryotic life, etc. the totality of the class does not just emerge at a faster pace than the previous phenomena (STEM efficiency), but also becomes more localized in space (STEM compression).

For example the totality of 'prokaryotic life' exists everywhere on Earth, from the deepest regions beneath the Earth's surface, to the highest regions in the Earth's atmosphere [i.e. prokaryotic "extremophiles" (Rothschild 2007)]. In contrast, the totality of 'eukaryotic life' exists on a more local scale, as larger more complex organisms cannot exist in as extreme environments. Furthermore, the larger the eukaryotic life form, the more likely it is that there spatial extent is restricted to specific niches (increasingly compressed). The same goes for the human superorganism as we have evolved from foragers, to farmers, to machine tenders, to global brain urbanites: the totality of our spatial location has become *more locally concentrated* (from wandering nomads to mega-city dwellers), with many projections for the future of human demographics suggesting an acceleration of contemporary migration from rural to urban (Kraas et al. 2013). Thus, although our population is currently growing, the space we occupy on Earth is shrinking (becoming compressed). This most clearly represents how the concepts of higher global integration and more concentrated spatial localization are not mutually exclusive or paradoxical in cosmic evolutionary theory. The difference between these two concepts is also key to the big challenge for twenty-first century humanity: i.e. how to find the local in the global?

The CH appears to be the strongest contender to the EH that has existed in modern times. And it may also provide us with a new framework for thinking about developmental convergence in astrobiology (see Flores Martinez 2014), including how we approach SETI in particular (see Smart 2012). This framework also works with our big historical and cosmic evolutionary framework. As we have covered, information processing, energy control, complexity, as well as differentiation and integration have characterized large-scale trends throughout the history of the universe. If some variant of the CH is accurate this general process should continue to reach maximum local information processing and maximum local energy control limits within our universe's possibility space. The manifestation of a living system organization that reaches the maximum limits of both information processing and energy control would represent an entity with both the highest complexity and the highest order in the known universe.

In terms of information processing and energy flow, STEM efficiency and compression appear to be consistent with both current long-term predictions for the future of computation and the future of fusion energy (and other forms of high-energy potentials). Advanced supercomputing will undoubtedly be a process that occurs from an understanding of computing on ever-smaller scales of the physical universe (Lloyd 2006). The whole evolution of computing technology involves the achievement of computing on ever-smaller scales of the physical universe. This phenomenon has been called the "Barrow

Scale" to describe the hypothetical achievement of organizing matter at its smallest possible physical scales (Vidal 2015) (Table 11):

Furthermore, we have already discussed recent speculations in physics and computer science related to mechanisms for the "creation of baby universes in a lab" (e.g. Farhi et al. 1990; Gott and Li 1998, p. 36), in the form of black hole computers (see Lloyd 2000, 2006; Lloyd and Ng 2004, p. 56). Such information processing capability would push our ability for technological manipulation all the way down the Barrow Scale (Table 11). If humanity (or what became of humanity) emerges around such black hole computing devices almost anything would be possible in terms of experiential degrees of freedom, although the actual phenomenological state for these hyper-technological entities would likely be indescribable, involving space–time perceptions, knowledge, memory, interconnectedness levels beyond contemporary symbolic representation.

The long-term future of human energy will also almost undoubtedly occur on more compressed scales of reality via the production of fusion energy, which is the ability to replicate the behaviour of atomic collisions, an inherently hyper-local phenomenon (Souers 1986). Although there have been problems with achieving fusion energy over the past few decades we know that it is physically possible because the whole universe is powered by fusion. Also, the fact that we have made progress with fusion over the past 50 years suggests that achieving this level of energy flow would be trivial for an advanced technological intelligence. And whenever an intelligent species has fully exploited the power of fusion energy, it will have access to practically infinite amounts of energy when considered on the scales of deep time (Niele 2005). Furthermore, considering that we exist in a universe where stellar fusion and biological computation are both common properties (with biological computation being at least locally common, i.e. on Earth), we may also consider the possibility that technological manipulation in the form of advanced computation and nuclear fusion energy are both developmentally constrained information-energy pathways (i.e. inherent latent physical potentialities in our universe) providing the opportunity to achieve universal limits of local complexity.

However, there are other, potentially even more powerful forms of energy control that, although they stretch the imagination, are achievable in the local universe, such as anti-matter collisions (Borowski 1987), Dyson spheres (Dyson 1966), starivores (Vidal 2014a), and zero-point energy (Barrow 1998). Anti-matter collisions would produce energy in massive quantities, as it would convert the entire mass of particles into useable energy, an energy potential larger than both fission and fusion energy. Dyson spheres or a Dyson swarm is a potential mega-structure created by advanced civilizations that can surround and capture the entire energy output of a civilizations parent star. The starivore is an even more bizarre type of advanced mega-structure, which is described as a coupling between a

Table 11 The technological barrow scale

	Physical scale
Nanotechnology	10^{-9}
Picotechnology	10^{-12}
Femtotechnology	10^{-15}
Attotechnology	10^{-18}
Zeptotechnology	10^{-21}
Yoctotechnology	10^{-24}
Plancktechnology	10^{-35}

dense host object (i.e. advanced technological civilization) and its parent star through the creation of a large planetary accretion disk (Vidal 2014a, p. 236). Zero-point energy would be the achievement of utilizing quantum energy from the smallest scales of the universe with yocto-technology or planck-technology (Barrow 1998, p. 136) (Table 11). Although all highly speculative future energy scenarios, they all also represent actual high-energy potentialities in the local universe, which could in principle fuel the exploration of the highest local levels of information processing.

This brings us to the second class of Omega Civilization. We have already considered the remote possibility for an Omega Civilization-E (see Sect. 4.1), however, if we are on some type of constrained pathway towards increased STEM compression and efficiency, we may consider an alternative type of civilization: Omega Civilization-C (e.g.: Teilhard de Chardin 1955; Crane 1994; Barrow 1998; McKenna 1998a; Smart 2012; Vidal 2014a). Omega Civilization-C would represent the ultimate order and the highest complexity possible in the local universe. As a result of having achieved the highest information processing capabilities, it would be "capable of manipulating the basic structure of space–time" (Barrow 1998, p. 133). These technological abilities would either result in the complete transcension towards a different universe/reality/process (Variant 1), the replication/generation of new universes (Variant 2), or towards the fusion with other Omega Civilization-C entities (Variant 3) (Table 10). Although Variant 3 overlaps with EH predictions (as mentioned above) it is by necessity a process that should be considered within the CH category because it is not a physical expansion where we actually leave the local region of the evolutionary process and disperse throughout the cosmos.

In my opinion, all of these CH variants deserve deeper philosophical contemplation. However, Variant 2 is obviously most consistent with the Evo Devo framework as currently formulated. If Variant 1 or 3 turn out to be a better or more accurate explanation for the deep future of life and intelligence our local cosmic evolutionary process would not represent a reproduction mechanism and therefore the Evo Devo metaphor of the universe being 'organism-like' would be less applicable to further understanding. However, if Variant 2 is correct we would obviously have to rethink both the origins of the universe and the future of our role in the evolutionary process. Thus the EDU framework has made specific predictions about a type of cosmic selection process within a physical multiverse scenario.

Over the past two or three decades researchers in the physical sciences have considered the possibility that our universe may undergo a process of 'Cosmic Natural Selection' (CNS). The most popular CNS models propose that black holes act as universe reproducers (see Smith 1990, 2000; Smolin 1992, 1997, 2006). In this scenario we exist in a multiverse where individual universes (or disconnected space–time 'sub-regions' of the multiverse) vary in their initial conditions and fundamental constants (with humans obviously inhabiting one of the (potentially large minority) of universes capable of giving rise to life). Thus in the CNS models the universe is also conceived of in a 'biological-like' or 'evolutionary' way, with the universe going through birth, growth/maturation, reproduction, and death; however in the CNS model the 'growth/reproduction' component of the process is related to the production of physical black holes (i.e. impersonal growth/reproduction).

Therefore, the CNS model predicts that, just as the biological order operates via 'fitness maximization' and 'variation and selection' so does the physical order within a larger cosmological multiverse environment. Consequently, universes that produce the most 'fecund' black holes will reproduce more universes that share their physical properties (perhaps with small variations), and thus as a by-product, more universes that are also conducive to living forms like you and me (Gardner and Conlon 2013). However, this CNS conjecture suffers in (potentially) some crucial dimensions. First, it does not appear that the universe is fine-tuned in any way for black hole maximization (which is what you would expect if that was the mechanism for the larger physical order to generate more copies of itself), and also suffers in that black holes do not possess controller and duplicator functions necessary for replication (as we know it) (Gardner 2005). In other words, physical black holes (as we understand them today) do not appear to be great candidates for cosmological developmental phenomena that fulfill functions we observe within the biological order.

In contrast, Variant 2 of the CH leads to the idea of Cosmic Natural Selection with Intelligence (CNS-I) models (Smart 2009) (also referred to as Cosmic Artificial Selection (CAS), see Vidal 2014a). In CNS-I/CAS scenarios, intelligently designed black hole computers function as universe reproducers. In this scenario we also exist in a multiverse but 'livable universes' have their initial conditions and fundamental constants established by a hyper-technological entity in a separate universe (i.e. physical laws (in this model) do not have ontological primacy over mind as posited by some physicists, see Krauss 2012). In particular it is predicted that the physical order of our universe is specifically designed to maximize the potential for the biological order, and that the biological order is specifically designed to maximize the potential for a symbolic order, which is then constrained towards maximizing its full potentiality (ultimately towards the end of the universe). Here we do find empirical support in the fact that the basic chemical ingredients for life are super abundant throughout the universe (thus the physical order could be a universally homogenous platform for the potential generation of complex life, etc.). Furthermore, the biological order has (at least on Earth) produced a multitude of highly complex and diverse cognitive living systems that display either early pre/proto-cultural, pre/proto-technological evolutionary capabilities (as discussed, see Sects. 2.2, 4.1). And finally the symbolic order, as manifest in human beings, does possess the necessary mechanisms for cosmic reproduction with both a controller (mind) and duplicator function (technology).

The CNS-I scenario may at first seem like a re-symbolization of the 'God hypothesis' or 'Intelligent Design hypothesis' but the interesting difference is that the CNS-I scenario is entirely secular/natural. In other words there is no unexplainable supernatural entity leading towards an infinite regress (see Dawkins 2006), but instead a self-reflexive multi-local cycle that continually regenerates itself. Moreover, CNS-I escapes the naïve assumption of the traditional God hypothesis that the universe was designed 'for humans'. As discussed above, in the CNS-I scenario the universe is designed, but designed in such a way that there is a certain probability for a biological order, and a certain probability for a symbolic order, etc. but not *for* a certain biological or symbolic order (i.e. in our case, 'God' did not design our universe so that cosmic evolution would lead towards human beings specifically, any species willing and able to cross the 'Nietzschean abyss' would do, see Sect. 3.2). Furthermore, and I think this is crucial, in this CNS-I scenario we can remain properly humanist-atheist in the modernist sense (or transhumanist-atheist in the new modernist sense) in that, even if a previous hyper-technological civilization designed our universe, we are still truly alone left to fend for ourselves and to figure our what the purpose of humanity is *internally* within the collective subjective body (i.e. the external universal geometric object is obviously indifferent to us, etc.).

Here it is not my goal to suggest that intelligence within the symbolic order *is* the key component towards simultaneously solving the fine-tuning problem and the potential for a multiverse (i.e. a repetition of pre-scientific dogma). Indeed, it is obviously possible that the multiverse hypothesis is incorrect and that the fine-tuning problem is actually a non-problem produced by a scientific ontology built fundamentally around a priori notions of time and causality (Heylighen 2010). In either case, within the current scientific paradigm, the success or failure of the Compression Hypothesis, the EDU-hypotheses, or Cosmic Natural Selection-I hypotheses will depend on whether or not they can lead towards accurate predictions of the universe we observe. Future observation could completely falsify these claims. For example, if intelligence were found to expand throughout the universe the EDU framework would be falsified in certain key respects, or if some currently unknown property of our universe prevented the technological construction of universes then the idea of intelligence as a mechanism for universe reproduction would likewise be falsified, etc. However, at the same time, I do not see any reason why we should a priori exclude the possibility that life and intelligence either A) develop hyper-locally through developmentally constrained informational-energetic compression or B) play a key component to universe production through multi-local cosmic development and evolution. At the very least, philosophers and scientists should be as open to exploring the dimensions and predictions of all CH variants as they have been towards exploring the dimensions and predictions of the EH.

5 Big History, Deep Future: A Conclusion

Big history is a subject that offers academics the opportunity to study the whole of nature, and not just some small subsection of its constituent parts. Consequently, this opportunity offers academics the chance to bridge all subjects and integrate human knowledge. Very interesting logical connections appear to emerge as a result of this integrative process. Therefore, big history may open a more diverse dialogue on a true theory of nature that takes into consideration ‘pre-human’ phenomena like physics, chemistry and biology, but also uniquely ‘human phenomena’ like culture, technology, language, and aware mind. “All science has one aim, namely, to find a theory of nature.” (Emerson 1836, p. 2). And no unified theory of nature can emerge if we are only engaged purely in reductive science. The whole of nature cannot be reduced to its constituent parts. Here it is evolution and complexity, as situated within a multi-disciplinary big historical framework that offers us a chance to achieve what academics in disciplinary information silos have failed to achieve.

Modern evolutionary and complexity sciences also offer us the potential to escape our postmodern social universe characterized by a lack, specifically: no common historical direction. Consequently, the evolution of complexity may be able to help us guide the future of humanity towards a higher universality. Furthermore, these sciences may now be able to help us make future predictions about our own future cognitive processes in ways that may have appeared completely impossible just a few decades ago. For the first time since the formulation of thermodynamic theories and the exploration of the potential implications of entropy, scientists can now offer an alternative narrative of the deep future that does not inevitably end with human civilization in ruins and mind giving way to heat death. The physical and biological eras of big history *may* ultimately end in thermodynamic equilibrium, but we should not underestimate the potential power of the future cultural era to transform what we think about humanity and reality. “Who can set bounds on the possibilities of humanity?” (Emerson 1836, p. 62).

This is fundamentally why (to return to the introduction’s discussion of cosmic meaning/purpose) Weinberg’s existential nihilistic worldview: “The more the universe seems comprehensible, the more it (also) seems pointless” (Weinberg 1977, p. 154), although not completely ridiculous, should at the same time not concern us. As Einstein realized the 'incomprehensible' fact of the 'universes comprehensibility' means that the universe is not only accessible to our understanding, but also *completely open to us* in our ability to physical transform it through symbolically reproducible knowledge (science). This means that the more the universe becomes comprehensible to us, although it is true that we become radically 'de-centered' (which can initially be psychologically troubling); this 'de-centering' simply means that the burden of meaning shifts more and more towards *our own internal center* in reality: humanity the collective subjective body. In other words, the burden shifts more and more on us to 'grow-up' in the universe and create our own internal meaning without resting on an invisible symbolic structure of necessity (the 'God' symbol in all of its deceptive incarnations). This can be achieved through the full exploration (desire) and transformation (creativity) of the external physical geometric object towards satisfying the subjective and intersubjective worlds (i.e. the human-world relation as currently incomplete, a project). This is the universal frame, in my opinion, for a 'new modernity': the collective human project is incomplete and pushing the boundaries of that incompletion will bring us towards a totally new qualitative foundation for human nature/experience.

From the cosmic evolutionary view this means that it is our function and purpose to create the next level of the evolutionary process, simultaneously revealing that we are not irrelevant epiphenomena but critical evolutionary actors, and also within a historical process with directionality towards a higher universal goal achievable through full symbolic differentiation. The big bang gave birth to physical evolution, abiogenesis gave birth to biological evolution, and human civilization through the biocultural evolutionary process of atechnogenesis appears to be giving birth to a completely new technocultural evolutionary process. The further convergence of sociopolitical processes as well as the further development of our information technologies this century will surely lead to a human civilization that we can scarcely recognize today. "We won't experience 100 years of progress in the twenty-first century—it will be more like 20,000 years of progress (at today's rate)." (Kurzweil 2001). Our understanding of reality and nature is likely to be completely revolutionized in the process.

In my analysis, I have attempted to show that we can explore this 'deep future' within the context of the big historical perspective. Big history naturally lends itself to a structured analysis of potential deep human futures. This is because big history is identifying large-scale trends that can be correlated with increases in information processing, energy flow, and consequently, increasingly diversified and integrated complex adaptive systems. Of course, existential risk is serious and could alter the course of cultural and technological evolution. Perhaps we will fail to mature on the sociopolitical level, destroying our species and our planet in the process. However, the fact that there are large-scale trends related to energy, information, and complexity, which manifest in an ever diversifying integrated evolutionary process, should be enough to give us pause and consider deeply the implications of this acceleration into the twenty-first century and beyond. As we transform our planet and ourselves via the evolution of a deeper technologically mediated integration, we should at least have some reasoned perspective on where this process is likely to proceed.

All things considered it appears as though we should brace for an overwhelming century characterized by historically unimaginable problems and opportunities. "The truth is that, as children of a transition period, we are neither fully conscious of, nor in full control of, the new powers that have been unleashed" (Teilhard de Chardin 1955). But this future pathway is not determined, thus it is up to us to make good decisions, and if successful, it is our privilege to guide humanity through a century of cosmic importance, and potentially, towards the birth of an entirely new living phenomenon. “We are about to become unrecognizable to ourselves.” (McKenna 1998b).

Acknowledgments I would like to thank John Smart, Clément Vidal, John Stewart, David Weinbaum (Weaver), Viktoras Veitas, Marios Kyriazis, Claudio Flores Martinez, David Christian and all anonymous reviewers for their thoughtful and constructive feedback. I would like to thank the Global Brain Institute (GBI) and the Vrije Universiteit Brussels (VUB) for support and the opportunity to develop and share these ideas with the world, and in particular, to present these ideas at the International Big History Association (IBHA) 2014. I would also like to thank the authors I cited, who provided me with a wealth of data and a playground of brilliant concepts and theories, without which I would have never been able to produce this work.

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