The Distributed Self:

Virtual Worlds and the Future of Human Identity

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This theoretical work develops two central premises. The first is that human identity (defined as a person's conception and expression of his or her individuality) is not fixed and immutable, but changes in response to revolutionary developments in culture and technology. The second premise is that we are currently in the early phases of one of these profound techno-cultural transitions: The rise of 3D virtual worlds and the formation of a ubiquitous, photorealistic, seamlessly integrated (interoperable), and massively scaled Metaverse (Dionisio, Burns, & Gilbert, 2011) that will dramatically reshape our conception and experience of the self.

I. Conceptions of Human Identity: A Brief History

Psychologists, historians, and philosophers of mind generally divide the history of human identity into three stages: The "Pre-Modern Stage," the "Modern Stage," and the "Post-Modern Stage." During the Pre-Modern Stage, a person's identity (The Social Self) was based upon his or her roles and standing in the social order rather than on a unique organization of behavior and internal experience. In this era, a person was a peasant, merchant, landed gentry, or a lord; he was a farmer, a blacksmith, a soldier, or a knight – not merely someone who happened to occupy one of these occupations and social statuses. Moreover, this defined place in the structuralized whole was fixed and unquestioned. As depicted in Figure 1, the socially embedded self is described, not by a unique and distinctive pattern of feelings and thoughts, but by a set of status identifiers that reflect the person's roles or position within the social order including his or her birth order, child or parental status, generational group, and function or service within the community.

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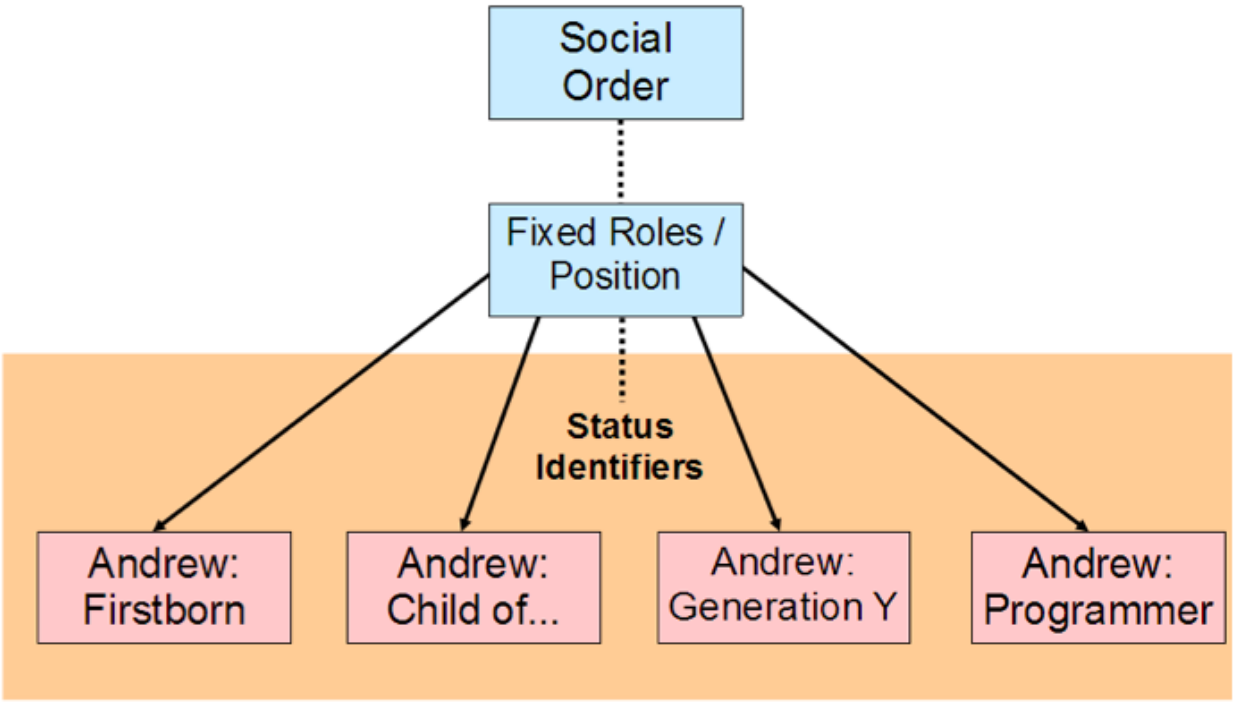

Figure 1: The Pre-Modern Social Self

The Pre-Modern conception of identity as external (outside of the individual) and contextual (rooted in the individual's place in the social order) gave way to a "Modernist" view of identity as personal, unique, and internal (The Psychological Self) following major historical developments that occurred in the 17th through 19th centuries. These included the Enlightenment (with its emphasis on internal processes of reason and cognition) and the rise of Industrial Capitalism (with its emphasis on private property, individual rights, and its fluid social and occupational system that enabled greater personal change relative to the old feudal order).

In the modernist conception, identity is viewed to be:

- internally located
- unique
- divided between conscious and unconscious awareness
- largely continuous but subject to change
- consistent with developmental experience
- unitary or singular in its organization
- physically embodied

The classic theories of personality all reflect these modernist assumptions regarding the nature of identity and the self. Each assumes that developmental experiences interact with inborn tendencies to create a relatively stable internal organization that is unique to the individual and subject to accurate description. Where they differ is in their specification of the nature and timing of the formative developmental experiences and especially the type of internal byproduct that is the psychological legacy of these experiences. For example, Freud (1962) believed that the primary internal consequence of external experience was a set of resolutions of conflicts between biologically-based longings and the demands of culture (e.g. the Oedipal-Electra conflict), whereas Erikson (1950) focused on unconscious ratios of competing attitudes about the self and the world (e.g., Trust vs. Mistrust; Autonomy vs. Shame and Doubt, etc.) and theorists working within Object Relations and Self-Psychology such as Bowlby (1982); Mahler, Pine, & Bergman (1975); and Kohut (1977) emphasized the formation of internal models of self, other, and "self-in-relation-to-other," as the essential byproducts of development. Outside of the psychodynamic tradition, the more empirically oriented models of trait theory (Allport, 1961; Eysenck, 1991) and cognitive social learning theory (Bandura, 1986) proposed that the primary internal consequences of social experience involved either a collection of stable psychological attributes or traits, cognitive schema about the self and the world, or entrenched patterns of behavior.

The foundational logic of modernist conceptions of psychological identity is closely aligned with the natural science fields of geology and archeology. An individual's developmental experiences are presumed to leave unconscious byproducts (however they are conceived) in the interior of the person, analogous to fossils deposited within layers of sedimentary rock. Later on, through the painstaking work of psychotherapy, it is assumed that these hidden elements can be brought to light and the history and organization of the personality can be objectively described, much in the way an archeologist works to unearth fossils in order to reconstruct the history and development of a physical region. Perhaps, owing to this analogy, Freud, the author of the original modernist conception of human identity, considered himself to be an archeologist of the mind. This close relationship between developments in geology and archeology and modernist conceptions of a stratified mind containing imprints of the past raises a point that is relevant to all perspectives on human identity: Psychological conceptions of the self are strongly influenced by, and often directly modeled from, prevailing perspectives in the natural sciences and the operation of dominant forms of technology. Figure 2 below depicts the modernist conception of human identity.

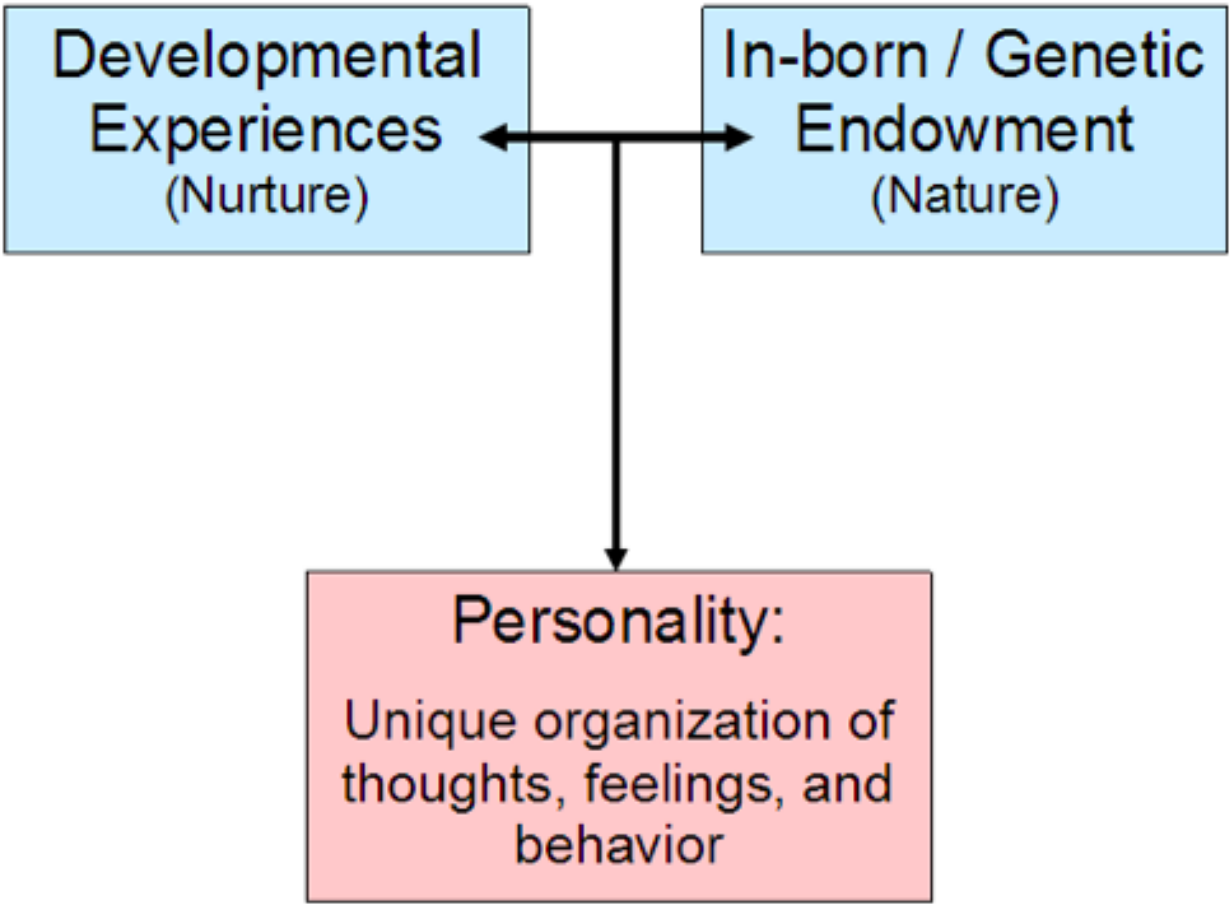

Figure 2: The Modernist Conception of Identity

In the latter half of the 20th century dramatic advances in transportation and telecommunications turned the world into a global village where individuals were constantly exposed to new and different perspectives, narratives, styles, and psychological realities. The sheer volume and diversity of these voices and perspectives challenged the very notion of objective truth. How could one believe in the truth of any position, including propositions regarding human identity, when a range of counter-positions was constantly available? In this broad context of intellectual doubt and uncertainty, modernist conceptions of an essential, singular, objectively describable self came under attack by post-modern theorists who argued that there is no stable, consistent, coherent individual identity (Gergen, 1991; Lifton, 1993). Instead they maintained that human identity is fragmented, multiple, and constantly shifting (The Multiple Self), no less than the chaotic and contradictory mix of voices that reverberate through the external world. In essence the multiple self represents a qualitative shift in how human identity is viewed because unlike prior conceptions it does not assume the existence of any structure that constrains the range of self-expression – either an external structure like the fixed social order of pre-modernity, or an internal, psychological

structure at the heart of modern conceptions of personality.

Just as modernist conceptions of the self are closely aligned with the fields of geology and archeology, the post-modern, multiple self can be understood with reference to developments in the area of computer science (Turkle, 1995). Like a windowed computer operating system that serves as the executive controller for many functionally different applications (only one of which is active and displayed on the screen at any time, while many others are available but in an inactive or latent position), the self is conceived as an entity capable of "maximizing" or "minimizing" multiple aspects of identity according to personal desires and the demands of a particular context without regard to whether they form a consistent, coherent, structure. Figure 3 depicts the Multiple Self as an operating system managing a shifting collection of active and waiting processes.

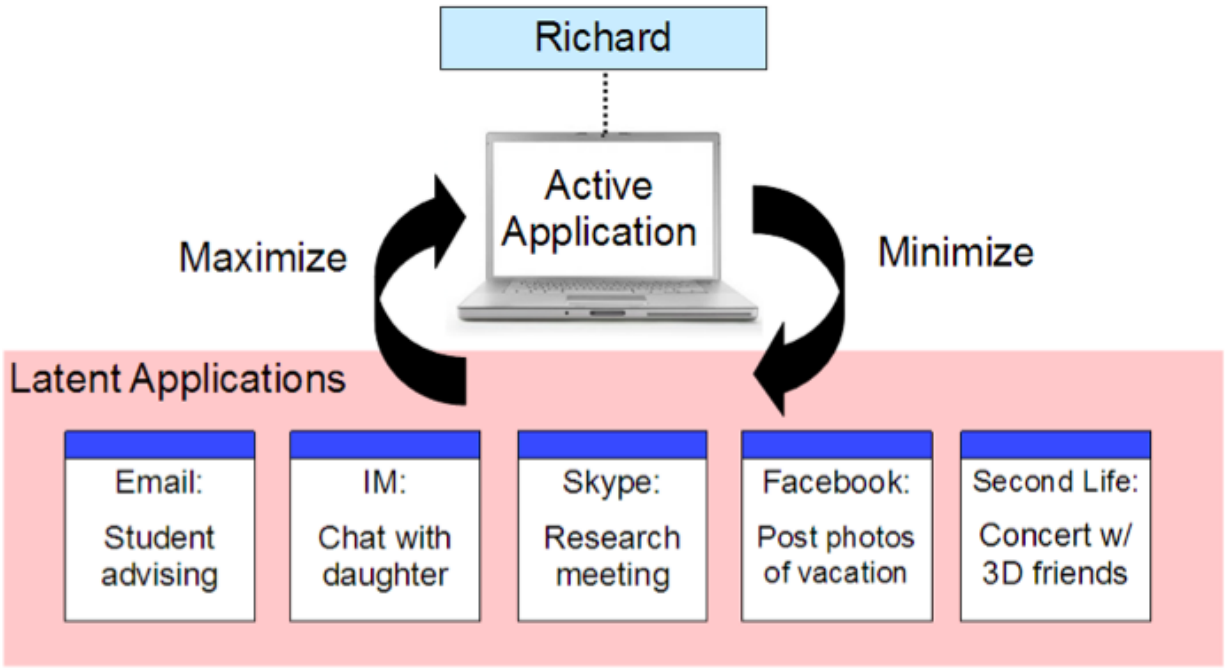

Figure 3: The Post-Modern Multiple Self

II. Virtual Worlds and the Future of Human Identity

A. The Distributed Self: An Overview

The rise of 3D virtual worlds and the introduction of avatar-mediated forms of expression and interaction has the potential to once again reshape humanity's conception and experience of the self and usher in a fourth stage of identity, one which can be termed "The Distributed Self" (Gilbert, Foss, & Murphy, in press). In this conception, consciousness and aspects of the self will be increasingly externalized and distributed into 3-dimensional digital forms (i.e. avatars) reflecting any number of combinations of age, gender, body type, race, ethnicity, style, personality, and physical health. Several studies have shown, for instance, that participants in 3D virtual environments such as Second Life often create avatars that, relative to their physical self, are younger, have a better body or physical appearance, and are ascribed a more positive or idealized personality (Au, 2007; Bessiere, Seay, & Kiesler, 2007; Gilbert, Foss, & Murphy, in press). Less frequently, they choose avatars with a different gender, ethnicity, or skin color (Wallace & Marryott, 2009, Duchenaut, Wen, Yee, & Wadley. 2009). Moreover, Gilbert, Foss, & Murphy (in press) estimate that among the overall user base of Second Life, 18% have a single "alt" (i.e. a secondary or alternative avatar) in addition to their primary avatar; 32% operate two or more alts; and that in approximately 70% of these cases one function of the alt or alts is to experiment with different aspects of identity or personality.

Taken as a whole these data indicate that about a half of active users of Second Life are coordinating a multiple personality system consisting of a physical self plus two virtual identities (a primary avatar and one alt) and about a third are coordinating an identity system involving 4 or more components (a physical self and three or more virtual identities). As depicted in Figure 4, when the allocation of consciousness to non-immersive digital forms such as email, Facebook, Twitter, or Linked In is added to the physical and 3D virtual components of the overall identity system, the structure of the self becomes more like an organizational flowchart rather than the singular entity in modernist conceptions, or the diverse, but device constrained, model of post-modernism.

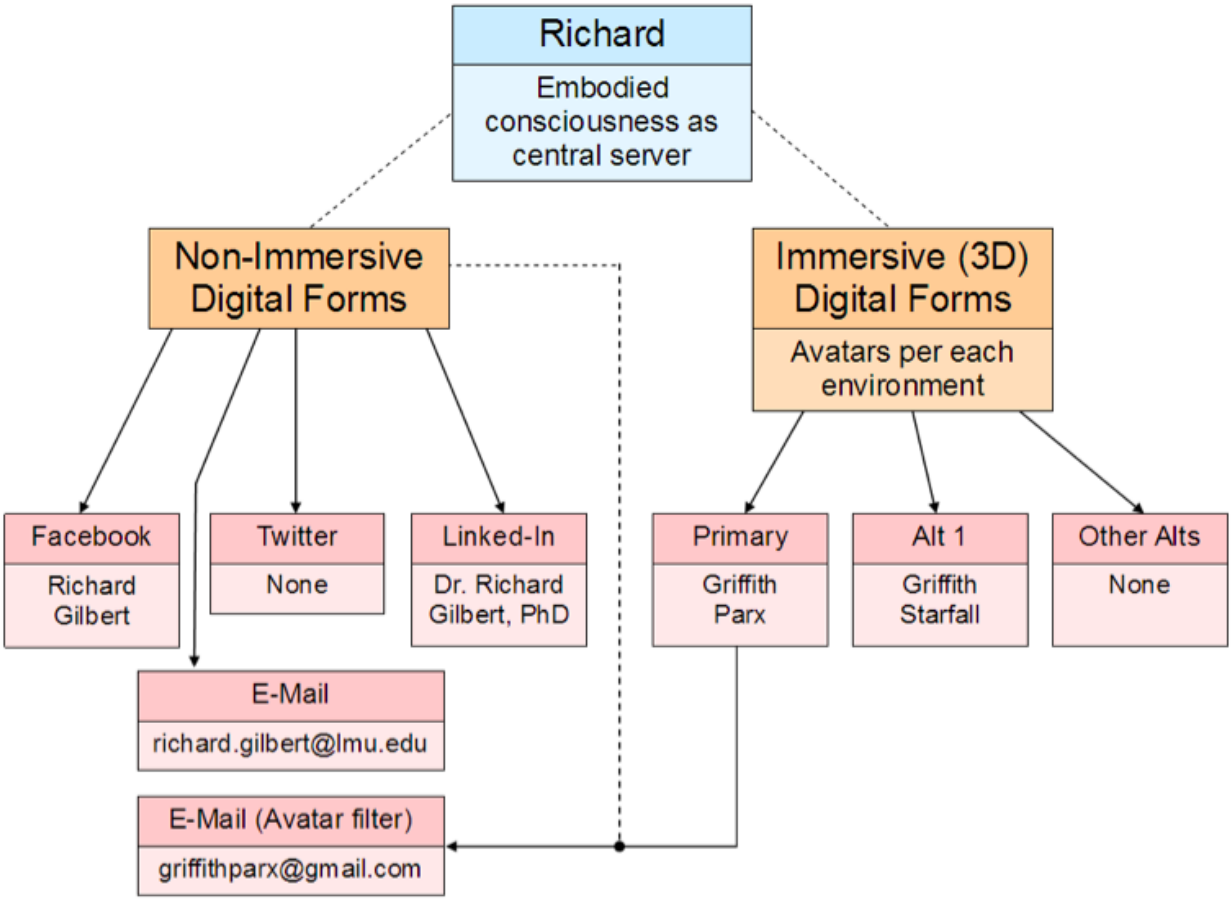

Figure 4: The Distributed Self

Whereas the windowed operating system serves as the technological analog to the post-modern conception of The Multiple Self, the rise of "cloud computing" (i.e., the virtualization of computational resources on the Internet so that they can be allocated, replicated, or distributed on demand across multiple platforms and devices) forms the technical basis for the new, distributed conception of identity and self. Within this new model, the source of consciousness remains internal and embodied (in the "cloud" of consciousness), but the expression or enactment of this consciousness becomes increasingly external, disembodied, and distributed on demand to multiple digital forms. Reflecting on this trend and growth projections for 3D virtual worlds, Gilbert, Foss, & Murphy (in press) note:

> "As 3D virtual worlds and the global population of avatars continue to grow, creating and coordinating a system composed of a physical self and a diverse set of online identities will increasingly become a normative process in human development. Individuals will manage their multiple personality orders in a manner akin to a choreographer managing a company of dancers or a conductor leading an orchestra and the operation of personality

will take on a quality of performance art."

B. "Expressive" Distribution

Thus far in discussing the distributed self, all of the digital forms that make up the disparate identity system are merely *expressions* or *reflections* of the embodied consciousness. That is, every act, comment, or gesture that emanates from any of the constituent identities must originate and be under the direct control of the authoring consciousness in real time. Without the initiative and guidance of the central consciousness, the component identities are devitalized and, like actors stripped of a script, are unable to engage in action or communication. Thus, the function of the divergent digital forms as currently presented is solely to express aspects of the authoring consciousness across a variety of domains or realms and is therefore referred to as "Expressive Distribution."

C. From Expressive Distribution to Distributed Intelligence: Integrating Artificial Intelligence into the Poly-form Identity System

A qualitative advance from a purely expressive distribution of consciousness would require aspects of consciousness to be transferred to one or more avatars that make up the immersive portion of the online identity system in a way that enables them to act in the absence of direct and immediate control by the embodied mind. That is, avatars would need to be equipped with at least a basic level of artificial intelligence that allows them to independently carry out functions prescribed by the authoring consciousness. Norbert Weiner and the Cybernetics group at MIT (Weiner, 1948) provided the theoretical underpinnings for this possibility by advancing the position that human consciousness and identity is best viewed as a pattern of information unrelated to a biological or any particular material substrate. In Weiner's famous phrase that captured the Cybernetic viewpoint: "Information is information, not matter or energy" (p.132). Thus, from a cybernetic perspective, patterns of information could theoretically move between different substrates without a loss of meaning.

Decades after Weiner's foundational work, Hans Moravec, in a 1988 volume entitled Mind Child: The Future of Robot and Human Intelligence, became the first scientist to specifically suggest that, because human mentality is essentially an informational pattern, it could be moved from carbon-based organic components and instantiated in silicon-based electronic components without a loss of functionality. Later, in a comprehensive treatise on "post-humanism," Hayles (1999) reasserted the cybernetic conception of identity as informational patterns independent of the material substrate in which they are housed. According to post-humanism, the embodiment of human thought in a biological substrate is

a vestige of history rather than an inevitability of life, and the body is viewed as the original prosthesis of the mind that can be extended or replaced with other prostheses. They believe that human consciousness can be seamlessly integrated with intelligent machines and that there is no essential or absolute demarcation between bodily-housed consciousness and intelligent computer simulation. From the post-human perspective, the insistence that consciousness must be permanently and solely housed in a fixed physical body that is highly limited, requires continuous feeding and cleaning, experiences pain, and eventually withers and dies, represents fear of change, imaginative limitations, or a form of prejudice that could be labeled "bioism" or "carbonism." Finally, the legendary futurist, Raymond Kurzweil, characteristically pursued the possibility of distributed intelligence to its logical extreme by asserting that the entire human brain could be transferred or simulated in a computational substrate. As the brain is a massive computational system, he specifically proposed that 10^{16} cps or Hertz of computation and 10^{13} bits of memory would be required to emulate human levels of intelligence, while 10^{19} cps and 10^{18} bits would be needed to capture the salient details of each of our approximately 10^{11} neurons and 10^{14} inter-neuronal connections (Kurzwil, 2005)

The distribution of information and action patterns from a human driver to an avatar is not just a conceptual possibility. It is currently taking place, albeit in a highly simplified form far removed from the ambitious scenarios just discussed. In Second Life, "bots" (intelligent agents that are visually indistinguishable from avatars directly controlled by a human driver) are being programmed to perform simple functions that previously had to be done by an avatar operated by a human intelligence in real time (e.g., greeting customers at a virtual store or club, answering basic questions about the location or use of inventory, taking messages, contacting the owner of the virtual environment, etc.) However, as discussed by Burden (2008; 2009) and the Daden Limited (2010) report on the Future of Virtual Worlds, it is widely speculated that next generation bots with human-equivalent artificial intelligence (AI) components may be able to pass a virtual Turing Test whereby they cannot be recognized as an intelligent agent by a majority of human-controlled avatars after five to ten minutes of interaction within the virtual world.[2]

Looking further over the horizon, it is anticipated that intelligent agents with ever more sophisticated AI components will be able to serve as effective virtual assistants for their affiliated human intellects by meeting other avatars and attending events when the human driver is unavailable and reporting back on these activities to the human intelligence. Eventually, it is assumed that the level and sophistication of the transferred intellect (i.e., information and behavioral patterning) will reach a point that, in conjunction with photorealistic graphics, it will be difficult to distinguish the bot from the person it is

[2]See Turing (1950) for a discussion of the original, non-3D, description of this classic test of AI.

representing even by associates and friends in the physical world. It is important to note, however, that this achievement would represent a significant advance over current AI-equipped avatars and thus it is more likely to be a moderate versus near term development.[3]

D. Implications of Distributed Intelligence

The current and anticipated developments in distributed intelligence that have been discussed thus far have profound implications for human psychology and culture, including:

The Multiplication of the Self

When the information patterns of human mentality are successfully instantiated in a digital form, the potential arises to make a large (theoretically unlimited) number of copies of the autonomous agent. Each replica or simulated self will then be able to carry out functions that previously required the direct control of the embodied consciousness, thus creating a group or army of selves to multiply the impact and functionality of the authoring consciousness. In contemporary culture, the benefits and drawbacks of multitasking (i.e., dividing consciousness into more than one activity at the same time) is often discussed and debated. In an immersive world filled with AI equipped avatars, the self will have the unprecedented ability to simultaneously execute multiple tasks with each of its intelligent agents being able to fully focus on its assigned activity. Thus, the development of autonomous agents will help achieve the co-existence of multitasking and undivided attention.

The Virtualization of Time

One of the great achievements of the 20th century was the virtualization of space. The development of the radio, telephone, and digital communication technologies enabled individuals to instantaneously project their consciousness across vast physical distances. However, the embodied consciousness and its spatially distributed form (text, audio, video) both needed to operate at the same time. In contrast, when intelligent agents are capable of action outside of the direct and immediate control of its physically-housed consciousness, these digital “stand-ins” or “representatives” can simultaneously

[3]To view the current status of realistic, AI-equipped avatars, click on http://isnvirtualwords.com (select “Virtual Agents” in the left column menu, and watch the “Virtual World Assistant Demo.”) or http://www.existor.com/

operate in multiple time zones (e.g. while the embodied consciousness is sleeping, the distributed consciousness is rising; while the embodied consciousness is working, its intelligent agent is socializing, etc.), leading to the even more radical achievement of the virtualization of time. In a world teeming with intelligent agents, the self is not only capable of being in two (or many more) places of at once; it can also be simultaneously projected into multiple time zones from a single position in space.

A New Conception of Immortality

For most of history, the only way that human beings could respond to their fear of death and desire for life extension was to invoke metaphysical notions such as an afterlife or reincarnation. More recently, advances in genetics and micro-biology have introduced possibilities such as organ regeneration, cloning, and modifying cellular processes involved in aging and death as mechanisms for life extension (Hall, 2003). Now, with the rise of avatar-based distributed intelligence, another possibility has emerged other than invoking concepts of an eternal soul or extending the life of the physical body. This involves the immortal preservation of an individual's consciousness (Geddes, 2010), or at least his or her appearance and a large set of behaviors, attitudes, personality traits, and patterns of thought in a 3-dimensional digital form, an outcome that Blascovich & Bailenson (2011) have termed "virtual immortality."

Experience with Historical Figures

The preceding discussion of immortality pertained to the timeless preservation of the self. However, the self is not the only person whose identity could be endlessly maintained. The physical and psychological features of parents and grandparents could also be distributed to highly realistic avatars so that subsequent generations within a family would be able to interact with a persuasive 3D simulation of their ancestors in a manner that was far more powerful than non-immersive experiences such as viewing photographs or videos of their deceased relatives. In addition, the same mechanism could be applied to provide individuals with immersive experiences with simulated historical figures such as past presidents for educational purposes. For example, Project LifeLike, a collaboration between Avelino Gonzalez at the Intelligent Systems Laboratory (ISL) at the University of Central Florida and Jason Leigh at the Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago, has developed an avatar that has captured the appearance, gestures, speech idiosyncrasies, and personality characteristics of retired NSF program director, Dr. Alex Schwarzkopf, for historical preservation.[4]

[4] http://www.usnews.com/science/articles/2009/05/20/the-next-best-thing-to-you.

Reconsideration of a Mind-Body Dualism

For much of its history, the field of psychology has embraced monism (i.e., the belief that the mind is housed in the physical body and is part of a unified entity). Dualistic assertions that the mind is separate from the body have been disputed on a variety of grounds including: The problem of causal interaction (i.e., Having something totally nonphysical causing physical events such as neuronal firing violates the physical laws of the deterministic universe); the argument from brain injury (i.e., If the mind was completely separate from the brain, how could it be possible that every time the brain is significantly injured, the mind is also affected?); the argument from biological development (i.e., Human beings begin their existence as entirely physical or material entities and, since nothing outside of the domain of the physical is added later on in the course of development, then we must necessarily end up being fully developed material beings); and finally the argument based on simplicity (i.e., Why is it necessary to believe in the existence of two, ontologically distinct, entities of mind and brain when the same events and properties can be explained in terms of one?) If, however, patterns of thought are successfully distributed from an embodied consciousness to a 3-dimensional digital form, long held assumptions about the unity of mind and body will need to be revisited.

E. From Distributed Intelligence to Synthetic Evolution

The future scenarios that have been outlined thus far, as radical and consequential as they may be, are all limited in the sense that they involve transferring fixed elements of the embodied consciousness to a digital form. That is, after the process of transfer takes place, the avatar independently executes the distributed pattern of information in a manner that never changes, in a uniform or “static” manner over time. However, there are two extensions (i.e. extensions that add an element of change or variability to the process) that would be truly revolutionary.

The first extension involves the *addition of dynamic attributes*. It occurs when agents equipped with distributed intelligence are able to learn from, and be changed by, their experiences in executing elements of the authoring consciousness. This capacity for experiential learning or adaptation would mean that, over time, there would be a growing discontinuity between the embodied consciousness and its digital representative because the two entities would increasingly be shaped by tangibly different histories. While the digital actor’s interactions with the environment could be predicted from their attributes at the time of construction, the uniqueness afforded by the actor’s divergent experiences would produce qualities and attributes that could never have been foreseen by the human architect/server. Under these conditions the only way to maintain the intelligent actor’s fidelity to the human user’s consciousness would be to

undertake the process of frequent, if not continuous, updates. Because this process of ongoing synchronization would almost certainly prove to be unwieldy, if not impossible, the more likely outcome would be that the intelligent agent begins to evolve in ways that are not direct or obvious reflections of the original, authoring consciousness. When this occurs, avatars equipped with distributed intelligence will become more like digital offspring of the initial, embodied consciousness rather than a direct expression of it. Moreover, because these entities exist in digital space mediated by contemporary processing power that far exceeds the human capacity, it is not difficult to imagine such electronic progeny being capable of development at a blinding pace, one that shatters the comparably snail-like pace of the biological human. On a philosophical level, at a certain level of discontinuity between the embodied and disembodied mentalities, fundamental questions can be raised about whether the evolving avatar intelligence has any connection to humanity as a whole (Is it human?) or the particular identity of the human who served as its architect (Is it me?) At advanced levels of discontinuity one could reasonably argue that the evolving avatar is no longer a component of the distributed identity of the authoring consciousness and has acquired a unique identity of its own.

The second extension involves the *addition of server capacity*. This means that avatars loaded with information patterns from the embodied consciousness acquire the capability to act as servers in their own right and transfer information patterns to a next level of avatars (i.e., avatars twice removed from the original, embodied mind.). In this way, the distributed self gains potentially infinite depth, with each created agent harboring the potential to project their own actors, who in turn may create their own offspring, ad infinitum. As shown in Figure 5 below, some avatars that have acquired server capacity (+SC) will execute their ability to transfer information patterns while others will not, with the latter designated as “non-proliferating” avatars.

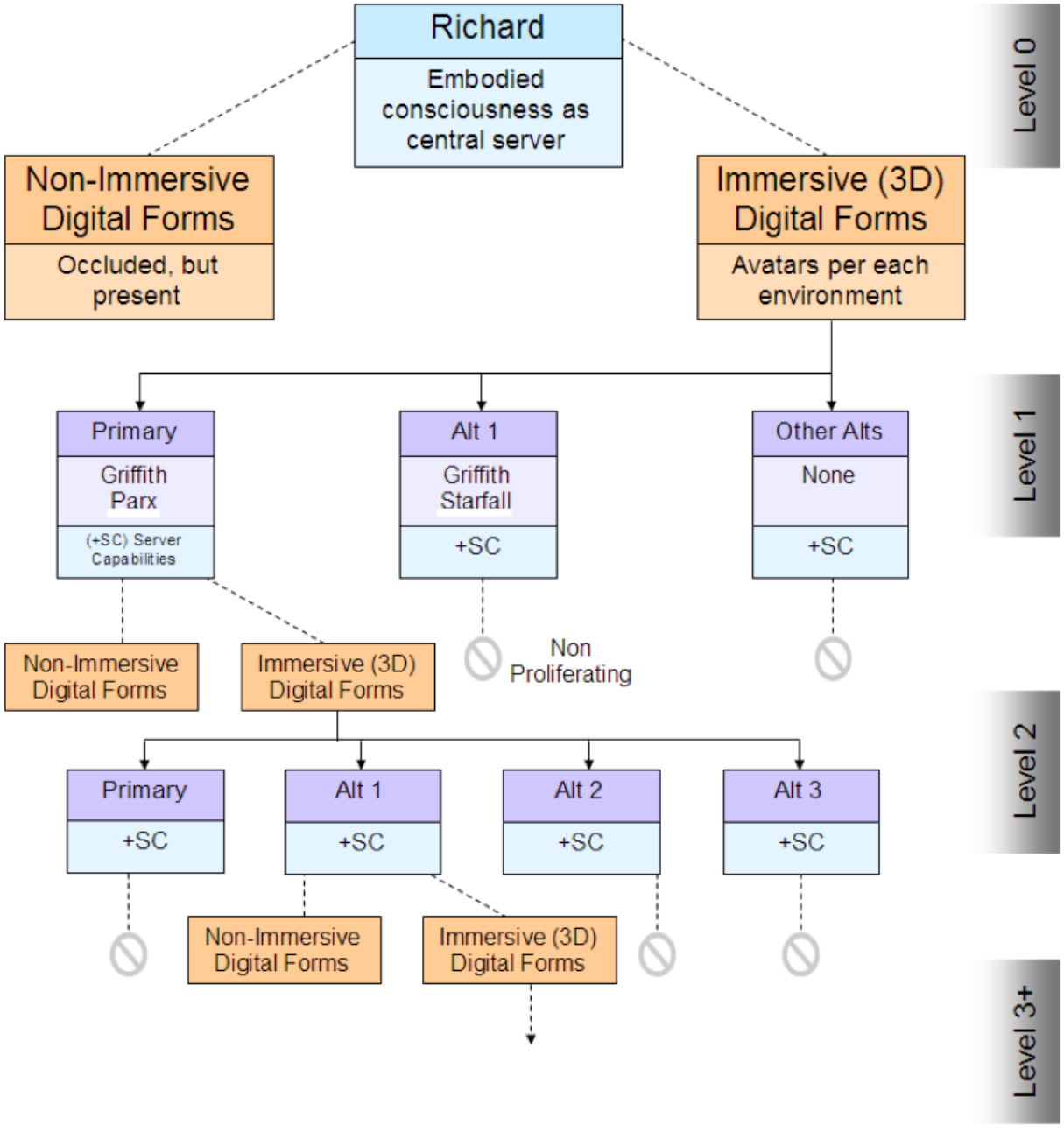

Figure 5: The Distributed Self (with dynamic attributes and multi-level server capability)

The implications of a dynamic, autonomously proliferating collection of digital selves tracing back to an initial, embodied consciousness (the virtual equivalent of a line of descent or genealogy) are difficult to grasp. However, when considered in concert with the laws of accelerated returns that accompany digital vs. biological development (Kurzweil, 2005), it is conceivable that a single, embodied consciousness could spawn an enormous community of actors whose development may proceed in a vast number of directions.

It is also possible that human beings would try to close Pandora's Box and seek to limit the transfer of information patterns across generations of avatars. This might be accomplished by requiring every avatar operating in the virtual world to be sponsored by a human being and tied to physical world data such as a bank or credit card account. This would ensure that the human consciousness was the ultimate determinant of the number of avatar levels in the distributed identity system and reassert human authority.

Another possibility, raised by evolutionary biologists, is that there are inherent barriers that will block the capacity for avatars to independently transfer information patterns to other avatars and create unlimited levels of distributed identity. From an evolutionary perspective, the ability for an avatar to undertake a process of transferring its mentality or information patterns to another avatar implies a level of consciousness or awareness on the part of the transferring agent that currently does not exist and may never be possible to develop. This is due to the assumption that consciousness and cognitive prowess is a latecomer to evolution that arose only after deeper layers of perception had been built over millions of years of biological progression. They argue that efforts to short-circuit this process by attempting to program advanced intelligence into a disembodied form are destined to fail, no less than one could hope to construct a roof without first building the house.

A logical answer to the objections of evolutionary biologists might be to note that the problem itself (transferring something closely tied to biology into a non-biological substrate) also suggests a solution: Assuming that the evolution of consciousness is the product of a long line of development, this time frame could be dramatically compressed due to exponential increases in the speed and power of computer processors. Cognitive evolution that may have taken millennia to produce in conventional, biological terms may occur in a micro fraction of time due to this accelerated state. At the same time it should be noted that exponential advances in computational power and speed alone might not be sufficient to simulate higher order human mentality. Regardless of the capacity of the hardware (even assuming near-infinite capacity) new computational methods or techniques (i.e., algorithms, paradigms, theories) will be required for synthetic agents to, for example, understand natural language the way a human being can. It is even possible that these complex cognitive capacities will prove to be "non-computable" for any device, regardless of capacity or speed, into the distant future.

It is impossible to know where on this continuum of possibilities the distribution of the self and human identity will ultimately fall. Due to challenges in AI and computational methods, will we merely see slow and incremental increases in the capacity to instill patterns of human mentality into non-biological entities that have a limited ability to perform simplified tasks in defined contexts within the virtual world? Or will distributed intelligence allow us to create more skilled and flexible agents that can serve as our personal representatives in more complex and varied immersive settings? In the extreme, will these digital

representatives eventually develop the dynamic ability to learn from experience or execute transfers of their informational patterns to other avatars and usher in a process of synthetic evolution? The future will answer these questions. However, given the exponential pace of technological development expressed in the laws of accelerated returns, including advances in miniaturization and nano-technology (the likes of which Kurzweil and others posit will be critical to the digitization of human mentality), it is likely that patterns of information that make up the self and human identity will be increasingly distributed beyond their embodied roots, and current assumptions of a unity of mind and body will be replaced by a resurgent dualism.

Table 1: Stages of Human Identity

Stage	The Social Self	The Psychological Self	The Multiple Self	The Distributed Self			
				Expressive Distribution	Intelligent Distribution	Intelligent Distribution with Dynamic Attributes	Dynamic Intelligence with Server Capabilities
Features	Contextual, embedded in fixed social order	Internal, embodied, stable, individual	Fragmented, embodied, unstable. Changes with context and personal desire	Embodied consciousness distributed to multiple digital platforms and selves	Distributions to entities capable of action without direct input from embodied consciousness	Distributions to entities capable of learning and being changed by experience	Distributions to entities with the ability to distribute their own informational patterns
Societal Context	Feudalism	Enlightenment; Industrial Capitalism	Globalization; Post-Industrialism / Age of Information	Post-Industrialism / Age of Information	→		
Technological Context	Agriculture	Geology; Archeology	Windowed Operating Systems	Cloud Computing; Immersive Virtual Worlds	Artificial Intelligence	Advanced Artificial Intelligence; Human-Machine Singularity	→

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