Grasping the untouchable: the externalization of virtually created entities

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This paper explores the convergence of the diagnostic imaging method of computed axial tomography with the additive manufacturing method of rapid prototyping. This occurs through the common use of the layer as an incremental slice through a spatial entity. Both technologies have key functions of relevance in the extension, augmentation and replacement of organs of the human body. Both have unlimited potential within the creative sphere of art and design. By locating these technologies within the subject of virtual reality I will demonstrate how their interrelated use generates a feedback loop from actual to virtual and from virtual back to actual. This feedback has a value in the understanding of how humans interact with virtual space and in determining what can be gained by this interaction.

Both of these technologies are isomorphic in that their functions are predicated on a progressive layer-based system. In the case of tomography, scans are made through a body or object, in a sequence of slices, which are then digitally assembled to form a virtual entity. In the case of rapid prototyping, a virtual entity may be translated into a physical object through the fixing of granular material in a sequence of layers. The isomorphic nature of the analytic and synthetic functions of these two technologies enables the potential for a flow of information from actual to virtual and vice versa. This flow is an agent in the symbiotic convergence of reality with virtual reality and is fundamental to the concept of the post-human.

The rapid prototype originates in a digital construct, which is re-interpreted as a sequence of slices of data. This data is transferred from the computer to the rapid prototype printer. The printer is a mechanical plotter which acts upon a powdered material by printing an adhesive onto it. [1] The layers of information are systematically printed across the x and y-axis and progressively extended into the z-axis. The accretion of powder layers results in the coalescence of a physical entity. This entity

[1] There are several different rapid prototype processes. For the purpose of this paper I describe powder binder printing.

is a simulation, bearing all of the detail of the digital construct, re-defined in a physical form. Virtual reality is a translation of the real into virtual. With the development of rapid prototyping we are now able to translate the virtual into the real.

Tomographic imaging enables the selective seeing through, or seeing into heterogeneous matter. It results from an axial analysis of material which separates slices of information into processible data. This data is ultimately transferred into the virtual computer environment where it may be re-assembled as a holistic virtual entity.

Both systems function respectively through layer based analysis and layer based synthesis, enabling the virtual de-materialization and the actual materialization of matter. Both are mediated, interpreted and prescribed digitally. Through their layer based isomorphism they provide an interface between virtual reality and reality. They provide a progressive and structured two-way translation between real and virtual space. The distinction between manufacturing from a virtual entity and visualizing the internal structure of matter is one of a flow in opposite directions. The origin of the one process is the culmination of the other. Both are facilitated through a flow of digital, algorithmic commands.

When in 1968, Douglas Engelbart enabled the display of computer images through the introduction of bitmapping, and enabled the user to directly manipulate the data space with the development of the mouse, he established the interactive potential of the computer as an extension of the human body (Paul 2003: 10). The Graphic User Interface (instigated by Engelbart and developed by Macintosh computers in the early 80's) effectively provided skin and bones to mathematical constructs and enabled the human comprehension of digital structure. Programming was no longer a blind activity. Encouraged by this interface, individuals were able to interact with and manipulate an 'end user product' without the need to engage with the mathematical and geometrical formulas that enabled the entire process to occur. Michael Heim claimed in *The Metaphysics of Virtual Reality* that 'Computer technology is so flexible and adaptable to our thought processes that we soon consider it less an external tool and more a second skin or mental prosthesis. Once acclimated to the technology, we play it much as a musician plays an instrument, identifying with it, and becoming one with it' (Heim 1993: 64).

Virtual reality is a programmed space derived from our understanding of reality. We

experience reality through sensory perception. Through our understanding of physical space we construct an analogical virtual space modelled on reality. We understand this space as one that we enter into, where we leave our bodies behind and somehow float freely outside of the material world. Yet our understanding of virtual space is not as ethereal as it is sometimes presented. We are very conscious of the body in virtual space, even though we are somehow supposed to have left it behind. In this case our sense of proprioception is key to the mind's continual engagement with the body. Vivian Sobchack describes proprioception as 'that sixth and grounding sense we have of ourselves as positioned and embodied in worldly space' (Sobchack 2004: 192). It is the coordination of nerves within the entire body devoted to maintaining track of our limbs from a purely internal perspective. A form of internal gyroscope, it locks our senses into coordination. It is the mind's sense of proprioception derived from its attachment to a responsive organism that facilitates our engagement with reality. This engagement is of equal importance when we enter virtual reality. Despite the immateriality of virtual space, our comprehension of it is aided by simulation. Virtual Reality is thus experienced within the mind, and is the result of an agent acting on the mind, facilitated by the computer and standard VR apparatus of head mounted display. The computer as mediator provides an interface between the mind and body and allows for an articulated separation. The mind is not freed of its proprioceptive function, indeed it must rely to a greater extent on its understanding of the body in order to function within a virtual environment. John Perry Barlow's description of virtual reality was that of a sense of disembodiment - on donning the headset he exclaimed - 'my everything has been amputated' (Rheingold 1992). While this experience is far from usual, it serves as a suitable descriptor for a perceived loss of humanism. Rather than experiencing the painful separation of mind from body, Barlow was in a trance like state in which his body accompanied him in its totality. His experience was, that the flow of visual information to which he was accustomed, had been interrupted and exchanged for another, a processed version of reality.

The visual passage through solid matter is enabled with the aid of the diagnostic scanning techniques of computed axial tomography which can effortlessly penetrate a solid body, entering into and passing through tissue, leaving no trace of passage. Computed tomography (CT) uses a fine point rotating x-ray, which identifies and renders separately the different densities of heterogeneous material in a three-dimensional field of shadow like forms. This information once interpreted by computer software may then be navigated as an interactive virtual space. Although

designed with observation as its primary function, data acquired by CT may be translated to a virtual structure that is fully mutable and will allow for intervention and modification. Once the point cloud of digital data has been reconfigured, its parameters can be altered. The demarcation of solids of various densities enables their isolation and treatment individually or as linked components within the whole entity. The precisely mapped surfaces are rendered as an array of nodes, each with the potential for universal repositioning. The interchangeable potential of these nodes, introduces mutability and the concept of evolution as a digital construct. The principal of predictive evolution now becomes feasible. Once change is mapped in sequence, blocks of information may be added or deleted, altering natural pathways of development. The process of change may consequently be accelerated or slowed down. Katherine Hayles in her book *How we became Posthuman* describes how information lost its body, how it came to be conceptualized as an entity, separate from the material forms in which it is thought to be embedded (Hayles 1999: 2). CT scan captures information from the body and transposes it to a space where it can form a separate entity. Suspended as an integral whole, information of this nature becomes a virtual cloning of the body. The animation of this cloned entity as a simulated human form, or avatar, is a logical step for which all of the technology is freely available. Michael Heim claims, 'both law and morality recognize the physical body as something of a fence, an absolute boundary, establishing and protecting our privacy' (Heim 1993: 100). In its virtual form the body (or surrogate) body becomes fully permeable, electronically portable, and ultimately unpossessable. It becomes freed from what William Gibson describes in his novel *Neuromancer* as 'the prison of flesh′ (Gibson 1995: 51).

The value of diagnostic imaging to medical science is limitless, but what of its value as an ontological tool? When data is acquired in this form it joins with the world of computer simulation where it can freely meld with other scanned or generated data. It joins the ever-expanding field of cyberspace and virtual reality. Elizabeth Grosz in the *Prosthetic Impulse* describes how 'culture can be understood as an extension, a protraction, and a projection of the interior of the body itself' (Groz 2003: 192). It is through culture that the body gives something back to the living world on which it feeds. The tomographic scan discloses the interior and presents it as an accessible space. It is through this access that the worlds of the real and virtual converge and become interchangeable.

Virtual modelling is a prerequisite for virtual reality. The structural delineations of void and solid, object and space must be defined parametrically within the virtual environment. Virtual modelling output through rapid prototyping is that 're-entry' moment, where what is developed in the outer space of virtual reality is enabled a return to within a real physical space. Within weightless and frictionless virtual space a platform is prepared for the development of new principals of geometric structure. Forms made under these circumstances will inevitably bear the characteristics of their free-form virtual genesis. However, structure without material is a new language, which despite its rapid development, immediacy and accessibility, is predicated on an existing understanding of physical structure. For as long as we spend most of our waking hours in reality, we will continue to translate our understanding of the physical world into the virtual world. The language of digital modelling will only emerge and develop a true cadence after the feed-back loop of virtual to actual and back to virtual, is well established. This loop is effectively completed with the introduction of rapid prototyping. Since the development of additive manufacture we may now encounter virtually constructed entities and interact with them physically. Objects, which contain the unique code of a virtual genesis, may be perceived and received in physical form. This encounter may be described as a haptic experience, as the non-physical and almost purely intellectual creation of form is paradigmatically translated into material.[2]

With the continual development of the full range of rapid prototype possibilities comes the potential for direct manufacture. However, in the case of a virtual to actual translation, the prototype fulfills its original function of providing a tangible product, a formal study for a design concept and an instantaneous manifestation of a digital construct. This manifestation has implications far beyond that of providing an interim understanding of a product designed for mass production.

Removed from the bounds of the material world, the generation of the object within virtual space frees the creative process from all physical constraints. Form is dictated purely by mathematical formula. Virtual software is programmed to provide all of the qualities of ductility and malleability that we understand from our physical interactions with material, with the addition of a fixable, elastic reality. In virtual space things literally stay where you put them – no matter where you put them. An essential aspect to virtual modelling is that conventional principals of structure are put on hold.

[2] Haptics is the science of applying tactile sensation to human interaction with computers. Webopedia.com

The qualities of gravity and resistance are temporally removed from the equation. The parametric co-ordinates of the digital model originate within *intensive* spatial qualities - properties that do not depend on the presence of matter, and are subsequently rendered in the *extensive* properties of weight, mass and volume (De Landa 2005: 24). Rapid prototyping provides extensive qualities to the intensive world of virtual reality. A paradigmatic shift takes place in the translation from virtual to actual. Rapid prototyping enables the unconditional externalization of these fluid forms, faithfully replacing the rendered digital construct with solid matter. Computed space, as a mathematical construct, provides a framework for both a virtual reality and the material replacement of this virtual reality. Points of light as seen on a computer screen, may now be systematically deposited as grains of material.

A key function of rapid prototyping is in providing a haptic understanding of the virtual entity. William Gibson coined the phrase 'data made flesh' (Gibson 1995: 26). Rapid prototyping converts data into material and enables the flesh to encounter data in its material form. The virtual entity is a genetic code in which the chain of component parts provides a language for translating a virtual entity into an actual one. The expression of this language is through the prototype printer acting on a substrate – resulting in the materialization of the entity. Each printed layer has a specific code or reference position within the printed object. Although cemented into a concrete whole, the object contains the codification of its making. It differs from the homogenaeity of moulded clay, cast metal or injected plastic in that its form is derived from a clearly deliniated and mapped interior organisation of layers. This codification puts virtual space back within our grasp and immediately feeds the cycle of haptic understanding. It is through the fabrication of the virtual entity and our encounters with this solidified code that we may become full acquainted with the creative potential of virtual space and we may finally grasp the untouchable.

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