46

Prosthetics

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Prosthetics fall within the broad category of assistive devices that people use to support what they want to do. Assistive devices, in general, enhance such capacities as mobility and agility, sensory apprehension, communication, and cognitive action. But the field of prosthetics, in particular, refers to those artificial body parts, devices, and materials that are integrated into the body's daily routines. Because "prosthetics," as a term, encompasses the way people select hardware, undergo procedures, and understand the results, there is no one immutable definition for it.

Prosthetics runs the range of detachable, wearable, implanted, or integrated body parts and may be functional, cosmetic, decorative, or hidden. It covers a wide range of components: from familiar designs such as peg legs, split-hook hands, and myoelectric limbs that yoke nerve signals from remaining muscles, to artificial skin, replaced hip joints, eyeglasses, hearing aids, strap-on penises, and reconstructed bones. Some prosthetics use sensory feedback, thought control, or neuronal elements to move limbs, process speech, or simulate vision. Implant engineering, by contrast, repairs the body from the inside out through integration of artificial tissue.

For most of history, prosthetics was a do-it-yourself enterprise and continues to be so in many parts of the world (Putti 1930). Because each human body and its prosthetic need are unique, each device is customized. The person takes possession of the device through alteration, decoration, daily use, and further fitting with accessories such as shoes, makeup, stump socks, gloves, and attachment methods. Society mobilizes to study the problem and provide solutions when historical events—most often wars, natural disasters, and the application of new technologies to human endeavors such as work, transportation, sports, and entertainment—create large numbers of people in need of prosthetics.

The object most commonly associated with the word in medical and popular literature is the lower limb prosthetic (Ott, Serlin, and Mihm 2002). The 1851 Great Exhibition, held in London's Hyde Park, brought attention to these objects as makers displayed the first modern prosthetics as consumer goods. During the U.S. Civil War, battlefield tactics and the weapons used produced injuries and infections that resulted in a high rate of amputation. A ball of soft lead made a ragged entry and shattered bone. Battlefield conditions, inadequately trained surgeons, and no understanding of asepsis resulted in necrosis, gangrene, and amputation. The surgical outcome often produced a painful stump, despite new flap techniques.

In the last half of the nineteenth century, a proliferation of injured people—civil war veterans, industrial workers, and those hurt in railroad, trolley, auto, and other accidents—fueled change in medical procedures and design of devices. Middle-class consumers embraced the aesthetics of lifelike designs instead of peg legs and eye patches (Herschbach 1997). The popularity of social Darwinism further increased the stigma of having a body that might use a prosthesis, and municipalities began to outlaw begging, a common livelihood for such people. Yet, veterans often preferred the valorous empty sleeve or pant leg to an awkward and heavy commercial device, even though after 1870 every honorably discharged Union soldier of the Civil War was entitled to a modern limb.

World War I brought widespread attention to veterans in Europe, the Soviet Union, and the United States who had suffered amputation on the battlefield and became wearers of prosthetic limbs as part of their transition to civilian life and the postwar industrial workforce (Panchasi 1995). The Great War also brought attention to the emerging surgical specialty of facial reconstruction and, consequently, facial prostheses, which gained relevance through the work of Anna Coleman Ladd and others. The most significant advances in prosthetics and rehabilitation began with World War II (Sauerborn 1998; Ott 2005). Not only were so many soldiers wounded, but many more survived their injuries. In 1945, the U.S. surgeon general requested that the National Academy of Sciences initiate a research program related to rehabilitation of the injured. This project generated the field of biomechanics and understanding of body forces. As a result, prosthetics began to be imagined differently, using robotics, ergonomics, kinesiology (movement), and human engineering (Serlin 2004). By the 1950s, professionals working in prosthetics and orthotics needed board certification. Government-funded research during wartime or related to war's consequences has continued to generate innovations in prosthetics. For example, a contemporary soldier injured by shrapnel from an improvised explosive device ripping through an exposed extremity will likely learn to use an Otto Bock "Utah" limb with a microprocessing chip that reads the environmental interface hundreds of times a second to facilitate motion—a user no longer "swings" the leg.

Medicine, science, and engineering have regularly deployed prosthetics to "fix" bodies perceived as having deficits, such as skeletal "deficiencies," including those born without various bones or those with atypical bodies resulting from medical treatment, such as infants born in the late 1950s with physical anomalies after their mothers took the drug Thalidomide. The advent of microsurgery, skin grafting, burn treatment, medications, and a range of medical techniques influenced both survival and the nature of the outcome for people who use prosthetic devices. For example, metal and wood were good for limb but not for facial designs. Rubber, latex, vulcanite, and plastics were appropriate for facial appliances and as components of more complicated limb designs. Acrylic resins, introduced in the 1930s, silicones in the 1960s, and hydroxyapatite in the 1980s have enabled implanted and integrated devices to take shape.

Because the contexts in which prosthetics may occur are so varied, the disciplines that engage with and discuss them are equally varied. Where technology is understood as a medium for breaking boundaries, pushing into the next frontier, and creating a new body-machine interface, the prosthesis-as-metaphor is especially rich. In the popular imagination, prosthetics has a rich visual, political, and material vocabulary. Historians, looking at prosthetics, examine macro forces that brought them into being such as war, industrialization, medicine, accident and injury, and materials science, as well as individual and community experience. Product designers deal with aesthetics of the hardware (Pullin 2009). Rehabilitation focuses on the process of incorporation of the artificial part into one's mechanical and psychic sense of self. In sociology, psychology, and anthropology, a prosthesis can function as a social symbol and a political allegory for one's self. As metaphor and metonymy, the concept of the prosthetic may compensate for an injury, serve as a symbol of devotion to country, provide an object of sexual fetish, or act as an anodyne for grief and mourning (Wills 1995; Mitchell and Snyder 2001). A prosthetic can serve as an index of modernity, manhood, or malevolence—or sometimes all three.

In disability studies, prosthetics is not typically the stuff of performance art or Hollywood special effects makeup. Yet scientists, designers, engineers, and journalists have come to rely on these metaphors and narratives of inspiration in framing analyses of prosthetics. As interpreted by journalists who cover this technology, as well as science fiction writers, filmmakers, video gamers, and graphic artists, prosthetics turns a person into a cyborg or bionic human. Such cultural producers commonly approach the subject based upon technological potential, while the actual disabled body plays only a minor role. For example, when the media feature wounded soldiers as recipients of prosthetics, the practical utility of the device is often secondary to its status as an example of bionic technology. ("Bionics" describes both the application of biological principles to engineering and design and the replacement of biological entities with electronic and mechanical components.) Discourse about cyborgs began in earnest with Donna Haraway's "Cyborg Manifesto" (1991; originally published in 1985) which offered a feminist critique of the military-industrial character of the cyborg, a hybrid term announcing the integration of the cybernetic and the organic. For Haraway, the cyborg consciously transcends human material limits and collapses the boundaries between machine and organism. The romance of the cyborg in the popular imagination is exemplified by a disabled or typically abled body that can become super-abled when engineered with superpowers that enhance human potential.

The political development of a disability rights movement in the twentieth century has gradually altered the cultural environment in which designers, engineers, and medical practitioners work. As disability became understood as a civil rights issue, the inclusion of users as authorities gained prominence. Consumer and creator input brought the split-hook hand, the Flex-Foot and sprint leg, and countless changes in medical practice. This is because while biomechanical invention has expanded the functionality of the human form, it has also raised significant ethical and political issues, such as using a device to "pass" as nondisabled, or for what age or demographic group a particular device is appropriate, or whether the benefits of an appliance are sufficient to be subsidized by insurance. Other debates focus on the implications of runners who use prosthetic devices in athletic competitions, or whether cochlear implants foster cultural genocide, or what it means to be disabled, and who should pay the costs for artificial hearts.

These arguments go beyond those about replacements or technological interventions. For example, for many people with disabilities, acquiring and using a prosthetic limb is most often a strategy for creating access or restoring function rather than for enhancement. According to the U.S. Centers for Disease Control and Prevention, of the approximately 65,000 amputations performed each year in the United States, some 82 percent are of lower extremities and the result of vascular deficiencies such as occur with diabetes. Thus, presenting prosthetics as a superhuman or transcendent technology eclipses the everyday needs of those who use such technologies.

A critical and interdisciplinary approach to prosthetics, such as that offered by disability studies, leads to a more complex and nuanced comprehension of the human body and the role of culture, politics, and engineering in defining capacity. Unlike rehabilitation medicine or engineering science, disability studies asks questions about the role of prosthetic technology not only in relation to design and function but also in relation to disability rights, political autonomy, and cultural citizenship. Indeed, much critical disability studies scholarship examines the enduring relationship between prosthetic technologies and histories of capitalism, empire, and the military-industrial complex. The use of a prosthetic is thus not a mark of deficiency or postmodern transcendence but rather an important dimension of human experience that demands thoughtful and empathic analysis.