Evolutionary theories of technology have gained in prominence since the 1980s. Such theories use concepts and analogies from evolutionary biology to explain technological change and innovation. Part of the inspiration of these theories can be found in previous extensions of evolutionary theory into new realms, such as evolutionary economics (Andersen, 1994; Dopfer, 2005) and evolutionary epistemology (Hahlweg and Hooker, 1989; Callebaut and Pinxten, 1987). Another source of inspiration is found in the more general attempt to construct at a universal theory of evolution that transcends biological evolution. Such a theory, which incorporates ideas from evolutionary epistemology, has alternatively been called universal selection theory or universal Darwinism (Cziko, 1995; Dennett, 1995). The central claim of Universal Darwinism is that Darwinian principles of evolution by natural selection do not just underlie biological processes but underlie all creativity, and are key to the achievement of all functional order. So biological evolution is just a particular instance of a more general phenomenon of evolution by selection.

A prominent approach that incorporates ideas of universal selection theory is the memetic approach to cultural evolution initiated by Richard Dawkins (1976) and since then developed by a number of advocates (Blackmore, 1999; Aunger, 2000; 2002). According to memetic theory, human culture is realized and transmitted through cultural units called memes, which are units of meaning that can express any culturally determined idea, behavior, or design. Memes are like genes in that they can replicate and can be transmitted, and they compete with other memes for survival according to Darwinian principles.

A variety of evolutionary approaches to technological change and innovation now exist. Some of these approaches are more explicitly evolutionary, whereas others make use of concepts of evolutionary biology in a loose way. The influential SCOT approach in the science and technology studies (STS) is an example of the latter (Bijker, Hughes, and Pinch, 1987). In this approach, the development of technological artifacts is claimed to consist of semi-evolutionary processes of variation and selection, in which technology developers design and produce different kinds of artifacts and selection takes place between them by buyers and other actors.

More consistently evolutionary theories of technology make more systematic use of concepts and principles of evolutionary theory for the analysis and explanation of processes of technological change and innovation. In the subsequent three sections, I will analyze three prominent evolutionary theories of technological change and innovation, that have been developed by George Basalla, Joel Mokyr, and Robert Aunger, respectively. Before this, however, I will first briefly outline the main concepts and principles of the theory of evolution itself, as it has been developed in evolutionary biology, and relate them to technology.

The contemporary theory of evolution adheres to three basic principles and assumes that biological species evolve through natural selection. Evolution is the increasing adaptedness of species to their environment, and natural selection is the process by which natural conditions favor hereditable traits of organisms that confer the greatest fitness to the organisms that carry them. This idea of evolution by natural selection is often claimed to rest on three principles: phenotypic variation, heritability, and differential fitness.

1. *Phenotypic variation*. This is the idea that all individuals of a particular species show variation in their behavioral, morphological and/or physiological traits – their 'phenotype'. For example, individual wolves may differ in their hair color, tail length, bone density, aggressiveness, sexual prowess, visual acuity, and so forth.
2. *Heritability*. This is the idea that a part of the variation between individuals in a species is heritable, meaning that some of that variation will be passed on from one generation to the next. In other words, offspring will tend to resemble their parents more than they do other individuals in the population. For example, if visual acuity is a heritable trait in wolves, then the offspring of a particular wolf with high visual acuity will have a higher than average tendency to have high visual acuity.
3. *Differential fitness*. This is the idea that some individuals of a particular species are better adapted to their environment than others and therefore have greater chances of survival and reproduction. That is, individuals in a species differ in their fitness, or their propensity to reproduce (leave offspring). For example, wolves with high visual acuity will tend to leave more offspring than wolves with low visual acuity because high visual acuity is a trait that leads to better adaptation to the environment by wolves, and therefore the trait of high visual acuity will tend to proliferate in future generations of wolves.

The result of these three principles, then, is evolution by natural selection: traits that enhance fitness proliferate in future generations, and individuals in a species are increasingly equipped with such traits. This is assuming that the local environment in which selection takes place remains the same. If the local environment changes, then traits that were previously fitness-enhancing may become less so, and other traits may come to enhance fitness. Such a change in the environment merely alters the course of evolution; the same underlying principles of natural selection remain at work.

The above three principles are the core principles of biological evolution formulated by Darwin in his Origins of Species (1859). Two additional principles specify underlying mechanisms for the processes described in these three principles. One specifies the underlying mechanism of heritability, which, genetics has taught us, is genetic reproduction:

4. *Genetic reproduction*. Inheritance of traits takes place through reproduction of genes.

Another one elaborates the underlying mechanisms driving variation:

5. *Mutation and recombination*. Two principal factors are responsible for the creation of variants: mutation, accidental changes in genomes, and recombination, the crossing between alleles, on which genes are situated, during meiotic cell division.

A sixth important principle of evolutionary biology is already implicit in the previous ones:

6. *Blindness*. Variation and selection are blind processes, meaning that they do not depend on foresight or learning. Put differently, they are nonteleological processes, not the result of any goals or aims but merely the result of conditions in the natural environment.