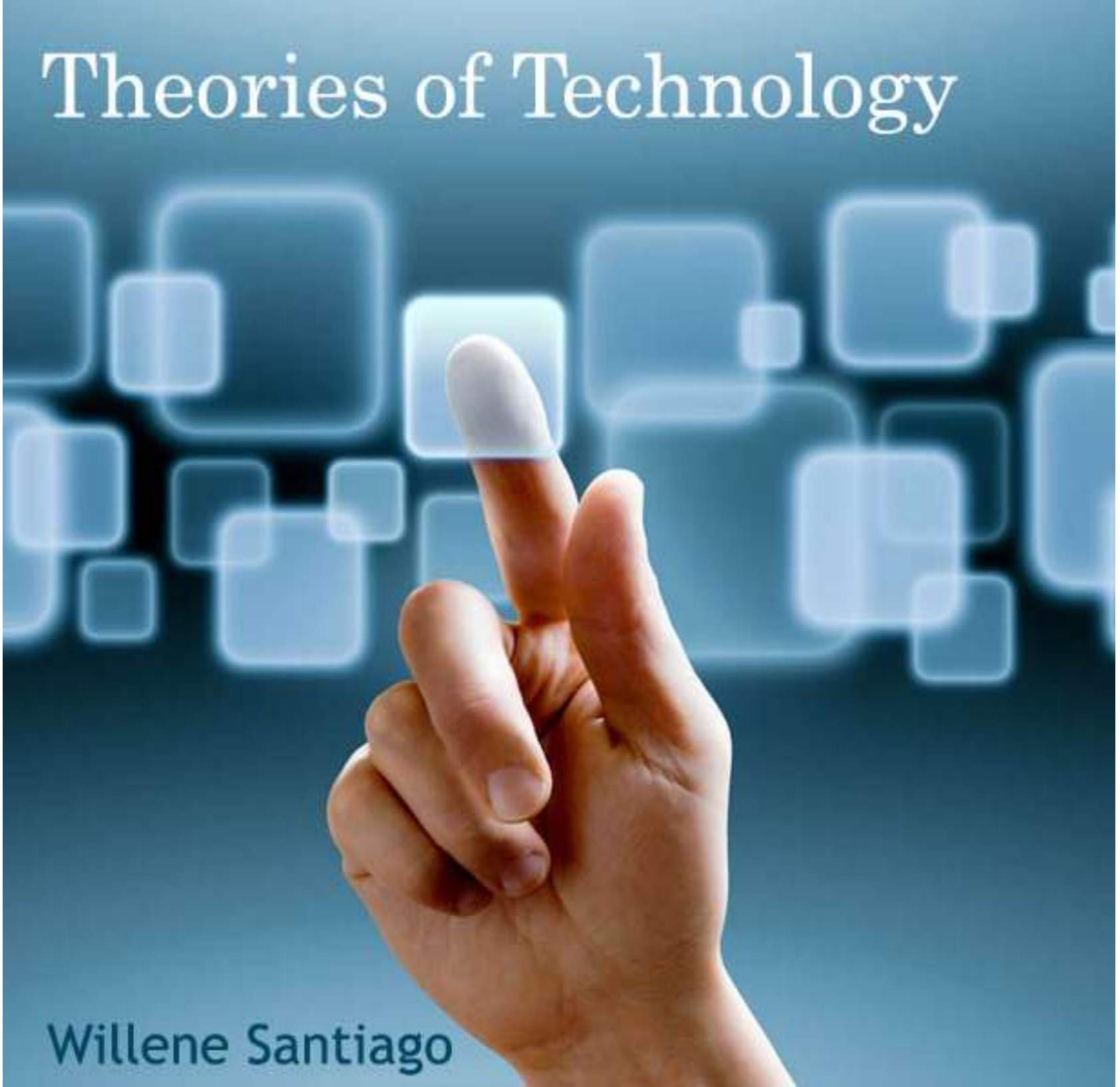
Theories of Technology



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Chapter- 1

Theories of Technology

There are a number of theories attempting to address technology, which tend to be associated with the disciplines of science and technology studies (STS) and communication studies. Most generally, the theories attempt to address the relationship between technology and society and prompt questions about agency, determinism/autonomy, and teleonomy.

If forced, one might categorize them into social and group theories. Additionally, one might distinguish between descriptive and critical theories. *Descriptive* theories attempt to address the definition and substance of technology, how does it emerge, change, and, of course, what is its relation to the human/social sphere? More substantively, to what extent is technology autonomous and how much force does it have in determining social structure or human practice? *Critical* **theories of technology** often take a descriptive theory as their basis and articulate concerns and ask in what ways can that relationship be changed?

Social theories

Descriptive approaches

- Actor-network theory (ANT) - posits a heterogeneous network of humans and non-humans as equal interrelated actors. It strives for impartiality in the description of human and nonhuman actors and the reintegration of the natural and social worlds. For example, Latour (1992) argues that instead of worrying whether we are anthropomorphizing technology, we should embrace it as inherently anthropomorphic: technology is made by humans, substitutes for the actions of humans, and shapes human action. What is important is the chain and gradients of actors' actions and competences, and the degree to which we choose to have figurative representations. Key concepts include the **inscription** of beliefs, practices, relations into technology, which is then said to **embody** them. Key authors include Latour (1997) and Callon (1999).

- Social construction of technology (SCOT) - argues that technology does not determine human action, but that human action shapes technology. Key concepts include:

- **interpretive flexibility**: "Technological artifacts are culturally constructed and interpreted ... By this we mean not only that there is flexibility in how people think of or interpret artifacts but also that there is flexibility in how artifacts are designed."
- **relevant social group**: shares a particular set of meanings about an artifact
- **closure** and stabilization: when the relevant social group has reached a consensus
- wider context: "the sociocultural and political situation of a social group shapes its norms and values, which in turn influence the meaning given to an artifact"

Key authors include Pinch and Bijker (1992) and Kline.

- Structuration theory - defines structures as rules and resources organized as properties of social systems. The theory employs a recursive notion of actions constrained and enabled by structures which are produced and reproduced by that action. Consequently, in this theory technology is not rendered as an artifact, but instead examines how people, as they interact with a technology in their ongoing practices, enact structures which shape their emergent and situated use of that technology. Key authors include DeSantis and Poole (1990), and Orlikowski (1992).

- Systems theory - considers the historical development of technology and media with an emphasis on inertia and heterogeneity, stressing the connections between the artifact being built and the social, economic, political and cultural factors surrounding it. Key concepts include **reverse salients** when elements of a system lag in development with respect to others, differentiation, operational closure, and autopoietic autonomy. Key authors include Thomas P. Hughes (1992) and Luhmann (2000).

Critical theories

- Values in Design - asks how do we ensure a place for values (alongside technical standards such as speed, efficiency, and reliability) as criteria by which we judge the quality and acceptability of information systems and new media. How do values such as privacy, autonomy, democracy, and social justice become integral to conception, design, and development, not merely retrofitted after completion? Key thinkers include Nissenbaum (2001).

Other stances

Additionally, many authors have posed technology so as to critique and or emphasize aspects of technology as addressed by the mainline theories. For example, Steve Woolgar (1991) considers *technology as text* in order to critique the sociology of scientific knowledge as applied to technology and to distinguish between three responses to that

notion: the instrumental response (interpretive flexibility), the interpretivist response (environmental/organizational influences), the reflexive response (a double hermeneutic). Pfaffenberger (1992) treats *technology as drama* to argue that a recursive structuring of technological artifacts and their social structure discursively regulate the technological construction of political power. A technological drama is a discourse of technological "statements" and "counterstatements" within the processes of technological regularization, adjustment, and reconstitution.

An important philosophical approach to technology has been taken by Bernard Stiegler, whose work has been influenced by other philosophers and historians of technology including Gilbert Simondon and André Leroi-Gourhan.

Group theories

There are also a number of technology related theories that address how (media) technology affects group processes. Broadly, these theories are concerned with the social effects of communication media. Some (e.g., media richness) are concerned with questions of media choice (i.e., when to use what medium effectively). Other theories (social presence, SIDE, media naturalness) are concerned with the consequences of those media choices (i.e., what are the social effects of using particular communication media).

- Social presence theory (Short, et al., 1976) is a seminal theory of the social effects of communication technology. Its main concern is with telephony and telephone conferencing (the research was sponsored by the British Post Office, now British Telecom). It argues that the social impact of a communication medium depend on the *social presence* it allows communicators to have. Social presence is defined as a property of the medium itself: the degree of acoustic, visual, and physical contact that it allows. The theory assumes that more contact will increase the key components of "presence": greater intimacy, immediacy, warmth and inter-personal rapport. As a consequence of social presence, social influence is expected to increase. In the case of communication technology, the assumption is that more text-based forms of interaction (e-mail, instant messaging) are less social, and therefore less conducive to social influence.

- Media richness theory (Daft & Lengel, 1986) shares some characteristics with social presence theory. It posits that the amount of information communicated differs with respect to a medium's *richness*. The theory assumes that resolving ambiguity and reducing uncertainty are the main goals of communication. Because communication media differ in the rate of understanding they can achieve in a specific time (with "rich" media carrying more information), they are not all capable of resolving uncertainty and ambiguity well. The more restricted the medium's capacity, the less uncertainty and equivocality it is able to manage. It follows that the richness of the media should be matched to the task so as to prevent over simplification or complication.

- Media naturalness theory (Kock, 2001; 2004) builds on human evolution ideas and has been proposed as an alternative to media richness theory. Media naturalness theory argues that since our Stone Age hominid ancestors have communicated primarily face-to-face, evolutionary pressures have led to the development of a brain that is consequently designed for that form of communication. Other forms of communication are too recent and unlikely to have posed evolutionary pressures that could have shaped our brain in their direction. Using communication media that suppress key elements found in face-to-face communication, as many electronic communication media do, thus ends up posing cognitive obstacles to communication. This is particularly the case in the context of complex tasks (e.g., business process redesign, new product development, online learning), because such tasks seem to require more intense communication over extended periods of time than simple tasks.

- Media synchronicity theory (MST, Dennis & Valacich, 1999]) redirects richness theory towards the *synchronicity* of the communication.

- The social identity model of deindividuation effects (or SIDE model, Postmes, Spears and Lea 1999; Reicher, Spears and Postmes, 1995; Spears & Lea, 1994) was developed as a response to the idea that anonymity and reduced presence made communication technology socially impoverished (or "deindividuated"). It provided an alternative explanation for these "deindividuation effects" based on theories of social identity (e.g., Turner et al., 1987). The SIDE model distinguishes cognitive and strategic effects of a communication technology. Cognitive effects occur when communication technologies make "salient" particular aspects of personal or social identity. For example, certain technologies such as email may disguise characteristics of the sender that individually differentiate them (i.e., that convey aspects of their personal identity) and as a result more attention may be given to their social identity. The strategic effects are due to the possibilities, afforded by communication technology, to selectively communicate or enact particular aspects of identity, and disguise others. SIDE therefore sees the social and the technological as mutually determining, and the behavior associated with particular communication forms as the product or interaction of the two.

- Time, interaction, and performance (TIP; McGrath, 1991) theory describes work groups as time-based, multi-modal, and multi-functional social systems. Groups interact in one of the modes of inception, problem solving, conflict resolution, and execution. The three functions of a group are production (towards a goal), support (affective) and well-being (norms and roles).

Analytic theories

Finally, there are theories of technology which are not defined or claimed by a proponent, but are used by authors in describing existing literature, in contrast to their own or as a review of the field.

For example, Markus and Robey (1988) propose a general technology theory consisting of the causal structures of agency (technological, organizational, imperative, emergent), its structure (variance, process), and the level (micro, macro) of analysis.

Orlikowski (1992) notes that previous conceptualizations of technology typically differ over scope (is technology more than hardware?) and role (is it an external objective force, the interpreted human action, or an impact moderated by humans?) and identifies three models:

1. technological imperative: focuses on organizational characteristics which can be measured and permits some level of contingency
2. strategic choice: focuses on how technology is influenced by the context and strategies of decision-makers and users
3. technology as a trigger of structural change: views technology as a social object

DeSanctis and Poole (1994) similarly write of three views of technology's effects:

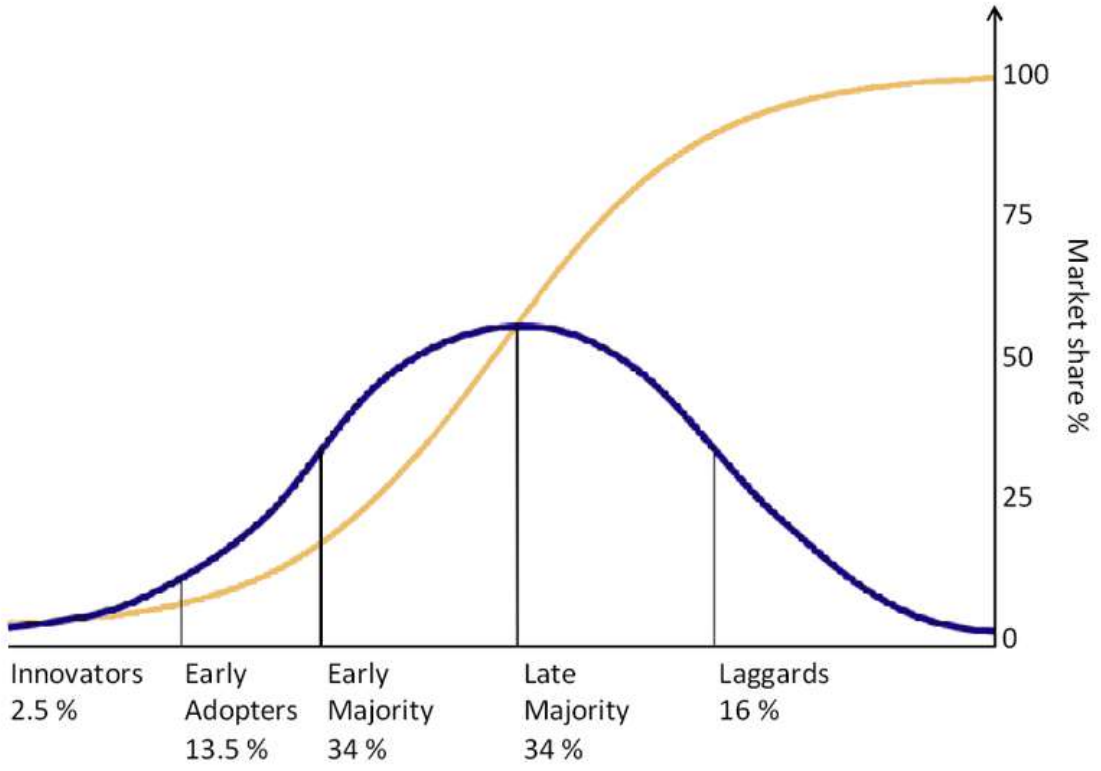
1. decision-making: the view of engineers associated with positivist, rational, systems rationalization, and deterministic approaches
2. institutional school: technology is an opportunity for change, focuses on social evolution, social construction of meaning, interaction and historical processes, interpretive flexibility, and an interplay between technology and power
3. an integrated perspective (social technology): soft-line determinism, with joint social and technological optimization, structural symbolic interaction theory

Bimber (1998) addresses the determinacy of technology effects by distinguishing between the:

1. normative: an autonomous approach where technology is an important influence on history only where societies attached cultural and political meaning to it (e.g., the industrialization of society)
2. nomological: a naturalistic approach wherein an inevitable technological order arises based on laws of nature (e.g., steam mill had to follow the hand mill).
3. unintended consequences: a fuzzy approach that is demonstrative that technology is contingent (e.g., a car is faster than a horse, but unbeknownst to its original creators become a significant source of pollution)

Chapter- 2

Diffusion of Innovations



The diffusion of innovations according to Rogers. With successive groups of consumers adopting the new technology (shown in blue), its market share (yellow) will eventually reach the saturation level. In mathematics the S curve is known as the logistic function.

Diffusion of Innovations is a theory of how, why, and at what rate new ideas and technology spread through cultures. The concept was first studied by the French sociologist Gabriel Tarde (1890) and by German and Austrian anthropologists such as Friedrich Ratzel and Leo Frobenius. Its basic epidemiological or internal-influence form was formulated by H. Earl Pemberton, who provided examples of institutional diffusion such as postage stamps and compulsory school laws.

History

Diffusion of innovation theory seeks to explain the spread of new ideas. First developed in the early 1950s using research in rural sociology, it continues to be widely used. Rogers proposed 4 main elements that influence the spread of a new idea: the innovation, communication channels, time, and a social system. That is, diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. Individuals progress through 5 stages: knowledge, persuasion, decision, implementation, and confirmation. If the innovation is adopted, it spreads via various communication channels. During communication, the idea is rarely evaluated from a scientific standpoint; rather, subjective perceptions of the innovation influence diffusion. The process occurs over time. Finally, social systems determine diffusion, norms on diffusion, roles of opinion leaders and change agents, types of innovation decisions, and innovation consequences. To use Rogers' model in health requires us to assume that the innovation in classical diffusion theory is equivalent to scientific research findings in the context of practice, an assumption that has not been rigorously tested.

The origins of the diffusion of innovations theory are varied and span across multiple disciplines. Rogers identifies six main traditions that impacted diffusion research: anthropology, early sociology, rural sociology, education, industrial, and medical sociology. The diffusion of innovation theory has been largely influenced by the work of rural sociologists . In the book *Diffusion of Innovations*, Rogers synthesizes research from over 508 diffusion studies and produces a theory for the adoption of innovations among individuals and organization.

Elements

The key elements in diffusion research are:

Element	Definition
Innovation	Rogers defines an innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" .
Communication channels	A communication channel is "the means by which messages get from one individual to another".
Time	"The innovation-decision period is the length of time required to pass through the innovation-decision process" . "Rate of adoption is the relative speed with which an innovation is adopted by members of a social system".
Social system	"A social system is defined as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal".

Decisions

Two factors determine what type a particular decision is :

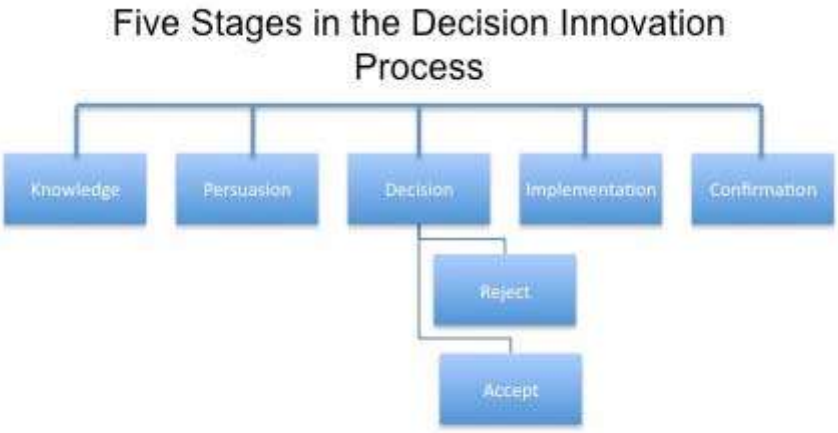
- Whether the decision is made freely and implemented voluntarily,
- Who makes the decision.

Based on these considerations, three types of innovation-decisions have been identified within diffusion of innovations.

Type	Definition
Optional Innovation-Decision	This decision is made by an individual who is in some way distinguished from others in a social system.
Collective Innovation-Decision	This decision is made collectively by all individuals of a social system.
Authority Innovation-Decision	This decision is made for the entire social system by few individuals in positions of influence or power.

Mechanism

Diffusion of an innovation occurs through a five–step process. This process is a type of decision-making. It occurs through a series of communication channels over a period of time among the members of a similar social system. Ryan and Gross first indicated the identification of adoption as a process in 1943 (Rogers 1962, p. 79). Rogers categorizes the five stages (steps) as: awareness, interest, evaluation, trial, and adoption. An individual might reject an innovation at any time during or after the adoption process. In later editions of the Diffusion of Innovations Rogers changes the terminology of the five stages to: knowledge, persuasion, decision, implementation, and confirmation. However the descriptions of the categories have remained similar throughout the editions.



Five stages of the adoption process

Stage	Definition
Knowledge	In this stage the individual is first exposed to an innovation but lacks information about the innovation. During this stage of the process the individual has not been inspired to find more information about the innovation.
Persuasion	In this stage the individual is interested in the innovation and actively seeks information/detail about the innovation.
Decision	In this stage the individual takes the concept of the innovation and weighs the advantages/disadvantages of using the innovation and decides whether to adopt or reject the innovation. Due to the individualistic nature of this stage Rogers notes that it is the most difficult stage to acquire empirical evidence (Rogers 1964, p. 83).
Implementation	In this stage the individual employs the innovation to a varying degree depending on the situation. During this stage the individual determines the usefulness of the innovation and may search for further information about it.
Confirmation	Although the name of this stage may be misleading, in this stage the individual finalizes their decision to continue using the innovation and may use the innovation to its fullest potential.

Rates of adoption

The rate of adoption is defined as: the relative speed with which members of a social system adopt an innovation. It is usually measured by the length of time required for a certain percentage of the members of a social system to adopt an innovation. The rates of adoption for innovations are determined by an individual's adopter category. In general

individuals who first adopt an innovation require a shorter adoption period (adoption process) than late adopters.

Within the rate of adoption there is a point at which an innovation reaches critical mass. This is a point in time within the adoption curve that enough individuals have adopted an innovation in order that the continued adoption of the innovation is self-sustaining. In describing how an innovation reaches critical mass, Rogers outlines several strategies in order to help an innovation reach this stage. These strategies are: have an innovation adopted by a highly respected individual within a social network, creating an instinctive desire for a specific innovation. Inject an innovation into a group of individuals who would readily use an innovation, and provide positive reactions and benefits for early adopters of an innovation.

Characteristics

Rogers defines several intrinsic characteristics of innovations that influence an individual's decision to adopt or reject an innovation. The relative advantage is how improved an innovation is over the previous generation. Compatibility is the second characteristic, the level of compatibility that an innovation has to be assimilated into an individual's life. The complexity of an innovation is a significant factor in whether it is adopted by an individual. If the innovation is too difficult to use an individual will not likely adopt it. The fourth characteristic, trialability, determines how easily an innovation may be experimented with as it is being adopted. If a user has a hard time using and trying an innovation this individual will be less likely to adopt it. The final characteristic, observability, is the extent that an innovation is visible to others. An innovation that is more visible will drive communication among the individual's peers and personal networks and will in turn create more positive or negative reactions.

Adopter categories

Rogers defines an adopter category as a classification of individuals within a social system on the basis of innovativeness. In the book *Diffusion of Innovations*, Rogers suggests a total of five categories of adopters in order to standardize the usage of adopter categories in diffusion research. The adoption of an innovation follows an S curve when plotted over a length of time. The categories of adopters are: innovators, early adopters, early majority, late majority, and laggards (Rogers 1962, p. 150)

Adopter category	Definition
Innovators	Innovators are the first individuals to adopt an innovation. Innovators are willing to take risks, youngest in age, have the highest social class, have great financial lucidity, very social and have closest contact to scientific sources and interaction with other innovators. Risk tolerance has them adopting technologies which may ultimately fail. Financial resources help absorb these failures. (Rogers 1962 5th ed, p. 282)

Early Adopters	This is the second fastest category of individuals who adopt an innovation. These individuals have the highest degree of opinion leadership among the other adopter categories. Early adopters are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters. More discrete in adoption choices than innovators. Realize judicious choice of adoption will help them maintain central communication position (Rogers 1962 5th ed, p. 283).
Early Majority	Individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer than the innovators and early adopters. Early Majority tend to be slower in the adoption process, have above average social status, contact with early adopters, and seldom hold positions of opinion leadership in a system (Rogers 1962 5th ed, p. 283)
Late Majority	Individuals in this category will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of skepticism and after the majority of society has adopted the innovation. Late Majority are typically skeptical about an innovation, have below average social status, very little financial lucidity, in contact with others in late majority and early majority, very little opinion leadership.
Laggards	Individuals in this category are the last to adopt an innovation. Unlike some of the previous categories, individuals in this category show little to no opinion leadership. These individuals typically have an aversion to change-agents and tend to be advanced in age. Laggards typically tend to be focused on “traditions”, likely to have lowest social status, lowest financial fluidity, be oldest of all other adopters, in contact with only family and close friends, very little to no opinion leadership.

Heterophily and communication channels

Lazarsfeld and Merton first called attention to the principles of homophily and its opposite, heterophily . Using their definition, Rogers defines homophily as "the degree to which pairs of individuals who interact are similar in certain attributes, such as beliefs, education, social status, and the like". When given the choice, individuals usually choose to interact with someone similar to him or herself. Furthermore, homophilous individuals engage in more effective communication because their similarities lead to greater knowledge gain as well as attitude or behavior change. However, most participants in the diffusion of innovations are heterophilous, meaning they speak different languages, so to speak. The problem is that diffusion requires a certain degree of heterophily; if two individuals are identical, no diffusion occurs because no new information can be exchanged. Therefore, an ideal situation would involve two individuals who are homophilous in every way, except in knowledge of the innovation.

Opinion leaders within a social system

Throughout the diffusion process there is evidence that not all individuals exert an equal amount of influence over all individuals. In this sense there are Opinion Leaders, leaders who are influential in spreading either positive or negative information about an innovation. Rogers relies on the ideas of Katz & Lazarsfeld and the two-step flow theory in developing his ideas on the influence of Opinion Leaders in the diffusion process Opinion Leaders have the most influence during the evaluation stage of the innovation-decision process and late adopters (Rogers 1964, p. 219). In addition opinion leaders have a set of characteristics that set them apart from their followers and other individuals. Opinion Leaders typically have greater exposure to the mass media, more cosmopolitan, greater contact with change agents, more social experience and exposure, higher socioeconomic status, and are more innovative.

Organizations

Innovations are often adopted by organizations through two types of innovation-decisions: collective innovation decisions and authority innovation decisions. The collection-innovation decision occurs when the adoption of an innovation has been made by a consensus among the members of an organization. The authority-innovation decision occurs when the adoption of an innovation has been made by very few individuals with high positions of power within an organization (Rogers 2005, p. 403). Unlike the optional innovation decision process, these innovation-decision processes only occur within an organization or hierarchical group. Within the innovation decision process in an organization there are certain individuals termed "champions" who stand behind an innovation and break through any opposition that the innovation may have caused. The champion within the diffusion of innovation theory plays a very similar role as to the champion used within the efficiency business model Six Sigma. The innovation process within an organization contains five stages that are slightly similar to the innovation-decision process that individuals undertake. These stages are: agenda-setting, matching, redefining/restructuring, clarifying, routinizing.

Consequences of adoption

There are both positive and negative outcomes when an individual or organization chooses to adopt a particular innovation. Rogers states that this is an area that needs further research because of the biased positive attitude that is associated with the adoption of a new innovation (Rogers 2005, p. 470). In the Diffusion of Innovation, Rogers lists three categories for consequences: desirable vs. undesirable, direct vs. indirect, and anticipated vs. unanticipated.

In her article, "Integrating Models of Diffusion of Innovations," Barbara Wejnert details two categories for consequences: public vs. private and benefits vs. costs.

Public vs. Private

Public consequences refer to the impact of an innovation on those other than the actor, while private consequences refer to the impact on the actor itself . Public consequences usually involve collective actors, such as countries, states, organizations, or social movements . The results are usually concerned with issues of societal well-being . Private consequences usually involve individuals or small collective entities, such as a community . The innovations are usually concerned with the improvement of quality of life or the reform of organizational or social structures .

Benefits vs. Costs

The benefits of an innovation obviously refer to the positive consequences, while the costs refer to the negative . Costs may be monetary or nonmonetary, direct or indirect . Direct costs are usually related to financial uncertainty and the economic state of the actor . Indirect costs are more difficult to identify . An example would be the need to buy a new kind of fertilizer to use innovative seeds . Indirect costs may also be social, such as social conflict caused by innovation

Mathematical treatment

The diffusion of an innovation often follows a logistic function or S curve.

International Institute for Applied Systems Analysis (IIASA)

Several papers on the relationship between technology and the economy were written by researchers at the International Institute for Applied Systems Analysis (IIASA). The pertinent papers deal with energy substitution and the role of work in the economy as well as with the long economic cycle. Using the logistic function, these researchers were able to provide new insight into market penetration, saturation and forecasting the diffusion of various innovations, infrastructures and energy source substitutions. Cesare Marchetti published on Kondretiev waves and on diffusion of innovations.

Diffusion data

Diffusion curves for radio, television, VCR, cable, flush toilets, clothes washer, refrigerator, home ownership, air conditioning, dishwater, electrified households, telephone, cordless phones, cellular phone, per capita airline miles, personal computers, internet are available from link on footnote.

Diffusion curves for infrastructures (canals, railroads, highways, pipelines, airlines) are available from a link on the footnote.

Criticism

Much of the evidence for the diffusion of innovations gathered by Rogers comes from agricultural methods and medical practice.

Various computer models have been developed in order to simulate the diffusion of innovations. Veneris developed a systems dynamics computer model which takes into account various diffusion patterns modeled via differential equations.

There are a number of criticisms of the model which make it less than useful for managers. First, technologies are not static. There is continual innovation in order to attract new adopters all along the S-curve. The S-curve does not just 'happen'. Instead, the s-curve can be seen as being made up of a series of 'bell curves' of different sections of a population adopting different versions of a generic innovation.

Rogers has placed the contributions and criticisms of diffusion research into four categories: pro-innovation bias, individual-blame bias, recall problem, and issues of equality equality

Electronic communication social networks

Prior to the introduction of the Internet, it was argued that social networks had a crucial role in the diffusion of innovation particularly Tacit knowledge in the book The IRG Solution - hierarchical incompetence and how to overcome it. The book argued that the widespread adoption of computer networks of individuals would lead to the much better diffusion of innovations, and with greater understanding of their possible shortcomings, and the identification of needed innovations that would not have otherwise occurred - the Relevance paradox.

Chapter- 3

Techno-progressivism

Techno-progressivism, **technoprogressivism**, **tech-progressivism** or **techprogressivism** (a portmanteau combining "technoscience-focused" and "progressivism") is a stance of active support for the convergence of technological change and social change. Techno-progressives argue that technological developments can be profoundly empowering and emancipatory when they are regulated by legitimate democratic and accountable authorities to ensure that their costs, risks and benefits are all fairly shared by the actual stakeholders to those developments.

Stance

Techno-progressivism maintains that accounts of "progress" should focus on scientific and technical dimensions, as well as ethical and social ones. For most techno-progressive perspectives, then, the growth of scientific knowledge or the accumulation of technological powers will not represent the achievement of proper *progress* unless and until it is accompanied by a just distribution of the costs, risks, and benefits of these new knowledges and capacities. At the same time, for most techno-progressive critics and advocates, the achievement of better democracy, greater fairness, less violence, and a wider rights culture are all desirable, but inadequate in themselves to confront the quandaries of contemporary technological societies unless and until they are accompanied by progress in science and technology to support and implement these values.

Strong techno-progressive positions include support for the civil right of a person to either maintain or modify his or her own mind and body, on his or her own terms, through informed, consensual recourse to, or refusal of, available therapeutic or enabling biomedical technology.

Contrasting stance

Bioconservatism (a portmanteau word combining "biology" and "conservatism") is a stance of hesitancy about technological development especially if it is perceived to threaten a given social order. Strong bioconservative positions include opposition to genetic modification of food crops, the cloning and genetic engineering of livestock and pets, and, most prominently, rejection of the genetic, prosthetic, and cognitive modification of human beings to overcome what are broadly perceived as current human biological and cultural limitations.

Bioconservatives range in political perspective from right-leaning religious and cultural conservatives to left-leaning environmentalists and technology critics. What unifies bioconservatives is skepticism about medical and other biotechnological transformations of the living world. Typically less sweeping as a critique of technological society than bioluddism, the bioconservative perspective is characterized by its defense of the natural, deployed as a moral category.

Although techno-progressivism is the stance which contrasts with bioconservatism in the biopolitical spectrum, both techno-progressivism and bioconservatism, in their more moderate expressions, share an opposition to unsafe, unfair, undemocratic forms of technological development, and both recognize that such developmental modes can facilitate unacceptable recklessness and exploitation, exacerbate injustice and incubate dangerous social discontent.

List of notable techno-progressive social critics

- Technocritic Dale Carrico with his accounts of techno-progressivism
- Philosopher Donna Haraway with her accounts of cyborg theory.
- Media theorist Douglas Rushkoff with his accounts of open source.
- Cultural critic Mark Dery and his accounts of cyberculture.
- Science journalist Chris Mooney with his account of the U.S. Republican Party's "war on science".
- Futurist Bruce Sterling with his Viridian design movement.
- Futurist Alex Steffen and his accounts of bright green environmentalism through the Worldchanging blog.
- Science journalist Annalee Newitz with her accounts of the biopunk movement.
- Bioethicist James Hughes of the Institute for Ethics and Emerging Technologies with his accounts of democratic transhumanism.

Techno-progressive subjects of interest

- Anticipatory democracy
- Body modification
- Bioethics
- Biopolitics
- Bright green environmentalism
- Cognitive liberty
- Cosmopolitanism
- Critical theory
- Cyberculture
- Digital freedom
- Emerging technologies
- Equiveillance
- Free software movement
- Guaranteed minimum income
- Information ethics
- Informed consent
- Morphological freedom
- Multiculturalism
- Nanoethics
- Neuroethics
- Neurodiversity
- Non-anthropocentric personhood theory
- Participatory politics
- Permaculture
- Pluralism
- Posthumanism
- Progressivism
- Regulation of science
- Reproductive rights
- Radical democracy
- Roboethics
- Secularism
- Social democracy
- Sustainable development
- Technocriticism
- Technological change
- Technological utopianism
- Technology and society
- World federalism

Controversy

Technocritic Dale Carrico, an academic known for using term "techno-progressive" as a shorthand to describe progressive politics that emphasize technoscientific issues, has expressed concern that some transhumanist ideologues are using the term to describe themselves, with the consequence of possibly misleading the public regarding their actual cultural, social and political views, which may or may not be compatible with critical techno-progressivism.

Chapter- 4

Technological Determinism

Technological determinism is a reductionist theory that presumes that a society's technology drives the development of its social structure and cultural values. The term is believed to have been coined by Thorstein Veblen (1857-1929), an American sociologist. The most radical technological determinist in America in the twentieth century was most likely Clarence Ayres who was a follower of Thorstein Veblen and John Dewey. William Ogburn was also known for his radical technological determinism.

Origin

The term is believed to have been coined by Thorstein Veblen (1857-1929), an American. Veblen's contemporary, popular historian Charles Beard, provided this apt determinist image, "Technology marches in seven-league boots from one ruthless, revolutionary conquest to another, tearing down old factories and industries, flinging up new processes with terrifying rapidity."

Explanation

Most interpretations of technological determinism share two general ideas:

- that the development of technology itself follows a predictable, traceable path largely beyond cultural or political influence, and
- that technology in turn has "effects" on societies that are inherent, rather than socially conditioned or produced because that society organizes itself to support and further develop a technology once it has been introduced.

Strict adherents to technological determinism do not believe the influence of technology differs based on how much a technology is or can be used. Instead of considering technology as part of a larger spectrum of human activity, technological determinism sees technology as the basis for all human activity.

Technological determinism has been summarized as 'The belief in technology as a key governing force in society ...' (Merritt Roe Smith). 'The idea that technological development determines social change ...' (Bruce Bimber). It changes the way people think and how they interact with others and can be described as '...a three-word logical

proposition: "Technology determines history"' (Raymond Williams) . It is, '... the belief that social progress is driven by technological innovation, which in turn follows an "inevitable" course.' (Michael L. Smith). This 'idea of progress' or 'doctrine of progress' is centralised around the idea that social problems can be solved by technological advancement, and this is the way that society moves forward. Technological determinists believe that "'You can't stop progress', implying that we are unable to control technology" (Lelia Green). This suggests that we are somewhat powerless and society allows technology to drive social changes because, "societies fail to be aware of the alternatives to the values embedded in it [technology]" (Merritt Roe Smith).

Technological determinism has been defined as an approach that identifies technology, or technological advances, as the central causal element in processes of social change (Croteau and Hoynes). As a technology is stabilized, its design tends to dictate users' behaviors, consequently diminishing human agency. This stance however ignores the social and cultural circumstances in which the technology was developed. Sociologist Claude Fischer (1992) characterized the most prominent forms of technological determinism as "billiard ball" approaches, in which technology is seen as an external force introduced into a social situation, producing a series of ricochet effects.

Rather than acknowledging that a society or culture interacts with and even shapes the technologies that are used, a technological determinist view holds that "the uses made of technology are largely determined by the structure of the technology itself, that is, that its functions follow from its form" (Neil Postman). However, this is not to be confused with the inevitability thesis (Daniel Chandler), which states that once a technology is introduced into a culture that what follows is the inevitable development of that technology.

For example, we could examine why Romance Novels have become so dominant in our society compared to other forms of novels like the Detective or Western novel. We might say that it was because of the invention of the perfect binding system developed by publishers. This was where glue was used instead of the time-consuming and very costly process of binding books by sewing in separate signatures. This meant that these books could be mass-produced for the wider public. We would not be able to have mass literary without mass production. This example is closely related to Marshall McLuhan's belief that print helped produce the nation state. This moved society on from an oral culture to a literate culture but also introduced a capitalist society where there was clear class distinction and individualism. As Postman maintains

"the printing press, the computer, and television are not therefore simply machines which convey information. They are metaphors through which we conceptualize reality in one way or another. They will classify the world for us, sequence it, frame it, enlarge it, reduce it, argue a case for what it is like. Through these media metaphors, we do not see the world as it is. We see it as our coding systems are. Such is the power of the form of information."

Hard and soft determinism

In examining determinism **Hard determinism** can be contrasted with **Soft Determinism**. A compatibilist says that it is possible for free will and determinism to exist in the world together while a incompatibilist would say that they can not and there must be one or the other. Those who support determinism can be further divided.

Hard determinists would view technology as developing independent from social concerns. They would say that technology creates a set of powerful forces acting to regulate our social activity and its meaning. According to this view of determinism we organize ourselves to meet the needs of technology and the outcome of this organization is beyond our control or we do not have the freedom to make a choice regarding the outcome.

Soft Determinism, as the name suggests, is a more passive view of the way technology interacts with socio-political situations. Soft determinists still subscribe to the fact that technology is the guiding force in our evolution, but would maintain that we have a *chance* to make decisions regarding the outcomes of a situation. This is not to say that free will exists but it is the possibility for us to *roll the dice* and see what the outcome is. A slightly different variant of soft determinism is the 1922 technology-driven theory of social change proposed by William Fielding Ogburn, in which society must adjust to the consequences of major inventions, but often does so only after a period of cultural lag.

Technology as neutral

Individuals who consider technology as neutral see technology as neither good nor bad and what matters are the ways in which we use technology. An example of a neutral viewpoint is, "guns are neutral and its up to how we use them whether it would be 'good or bad'" (Green, 2001). Mackenzie and Wajcman believe that technology is neutral only if it's never been used before, or if no one knows what it is going to be used for (Green, 2001). In effect, guns would be classified as neutral if and only if society were none the wiser of their existence and functionality (Green, 2001). Obviously, such a society is non-existent and once becoming knowledgeable about technology, the society is drawn into a social progression where nothing is 'neutral about society' (Green). According to Lelia Green, if one believes technology is neutral, one would disregard the cultural and social conditions that technology was produced (Green, 2001). This view is also referred to as technological instrumentalism.

Criticism

Scepticism about technological determinism emerged alongside increased pessimism about techno-science in the mid-20th century, in particular around the use of nuclear energy in the production of nuclear weapons, Nazi human experimentation during World War II, and the problems of economic development in the third world (also known as the global south). As a direct consequence, desire for greater control of the course of

development of technology gave rise to disenchantment with the model of technological determinism in academia.

Modern theorists of technology and society no longer consider technological determinism to be a very accurate view of the way in which we interact with technology, even though determinist assumptions and language fairly saturate the writings of many boosters of technology, the business pages of many popular magazines, and much reporting on technology. Instead, research in science and technology studies, social construction of technology and related fields have emphasised more nuanced views that resist easy causal formulations. They emphasise that "The relationship between technology and society cannot be reduced to a simplistic cause-and-effect formula. It is, rather, an 'intertwining'", whereby technology does not determine but "...operates, and are operated upon in a complex social field" (Murphie and Potts).

In his article "Subversive Rationalization: Technology, Power and Democracy with Technology," Andrew Feenberg argues that **technological determinism** is not a very well founded concept by illustrating that two of the founding theses of determinism are easily questionable and in doing so calls for what he calls democratic rationalization (Feenberg 210-212).

Prominent opposition to technologically determinist thinking has emerged within work on the social construction of technology (SCOT). SCOT research, such as that of Mackenzie and Wajcman (1997) argues that the path of innovation and its social consequences are strongly, if not entirely shaped by society itself through the influence of culture, politics, economic arrangements, regulatory mechanisms and the like. In its strongest form, verging on social determinism, "What matters is not the technology itself, but the social or economic system in which it is embedded" (Langdon Winner).

In his influential but contested article "Do Artifacts Have Politics?", Langdon Winner illustrates a form of technological determinism by elaborating instances in which artifacts can have politics.

Although "The deterministic model of technology is widely propagated in society" (Sarah Miller), it has also been widely questioned by scholars. Lelia Green explains that, "When technology was perceived as being outside society, it made sense to talk about technology as neutral". Yet, this idea fails to take into account that culture is not fixed and society is dynamic. When "Technology is implicated in social processes, there is nothing neutral about society" (Lelia Green). This confirms one of the major problems with "technological determinism and the resulting denial of human responsibility for change. There is a loss of human involvement that shape technology and society" (Sarah Miller).

Another conflicting idea is that of technological somnambulism, a term coined by Winner in his essay "Technology as Forms of Life". Winner wonders whether or not we are simply *sleepwalking* through our existence with little concern or knowledge as to how we truly interact with technology. In this view it is still possible for us to wake up and once again take control of the direction in which we are traveling (Winner 104). However, it

requires society to adopt Ralph Schroeder's claim that, "users don't just passively consume technology, but actively transform it".

In opposition to technological determinism are those who subscribe to the belief of social determinism and postmodernism. Social determinists believe that social circumstances alone select which technologies are adopted, with the result that no technology can be considered "inevitable" solely on its own merits. Technology and culture are not neutral and when knowledge comes into the equation, technology becomes implicated in social processes. The knowledge of how to create and enhance technology, and of how to use technology is socially bound knowledge. Postmodernists take another view, suggesting that what is right or wrong is dependent on circumstance. They believe technological change can have implications on the past, present and future. While they believe technological change is influenced by changes in government policy, society and culture, they consider the notion of change to be a paradox, since change is constant.

Media and cultural studies theorist Brian Winston, in response to technological determinism, developed a model for the emergence of new technologies which is centered on the Law of the suppression of radical potential. In two of his books - *Technologies of Seeing: Photography, Cinematography and Television* (1997) and *Media Technology and Society* (1998) - Winston applied this model to show how technologies evolves over time, and how their 'invention' is mediated and controlled by society and societal factors which suppress the radical potential of a given technology.

Notable Technological Determinists

Thomas L. Friedman, American journalist, columnist and author, admits to being a technological determinist in his book *The World is Flat*.

Futurist Raymond Kurzweil's theories about a technological singularity follow a technologically deterministic view of history.

Some interpret Karl Marx as advocating technological determinism, with such statements as "The windmill gives you society with the feudal lord: the steam-mill, society with the industrial capitalist" (*The Poverty of Philosophy,* 1847), but others argue that Marx was not a determinist.

Technological determinist Walter Ong reviews the societal transition from an oral culture to a written culture in his work "Orality and Literacy." He asserts that this particular development is attributable to the use of new technologies of literacy (particularly print and writing,) to communicate thoughts which could previously only be verbalized. He furthers this argument by claiming that writing is purely context dependent as it is a "secondary modelling system" (8). Reliant upon the earlier primary system of spoken language, writing manipulates the potential of language as it depends purely upon the visual sense to communicate the intended information. Furthermore, the rather stagnant technology of literacy distinctly limits the usage and influence of knowledge, it

unquestionably effects the evolution of society. In fact, Ong asserts that “more than any other single invention, writing has transformed human consciousness” (Ong 1982: 78).

Subset of Technological Determinism

Media determinism, a subset of technological determinism, is a philosophical and sociological position which posits the power of the media to impact society. As a theory of change, it is seen as a cause and effect relationship. New media technologies bring about change in society. Much like the "magic bullet" theories of mass communication, media determinism provides a somewhat simplistic explanation for very complicated scenarios. Cause and effect relationships are reduced to their most basic premise, and explained as such. Techno-centrist theories make everything explainable in light of the media's relation to technological developments. Two leading media determinists are the Canadian scholars Harold Innis and Marshall McLuhan.

Chapter- 5

Technological Singularity

A **technological singularity** is a hypothetical event occurring when technological progress becomes so rapid that it makes the future after the singularity qualitatively different and harder to predict. Many of the most recognized writers on the singularity, such as Vernor Vinge and Ray Kurzweil, define the concept in terms of the technological creation of superintelligence, and allege that a post-singularity world would be unpredictable to humans due to an inability of human beings to imagine the intentions or capabilities of superintelligent entities. Some writers use "the singularity" in a broader way to refer to any radical changes in our society brought about by new technologies such as molecular nanotechnology, although Vinge and other prominent writers specifically state that without superintelligence, such changes would not qualify as a true singularity. Many writers also tie the singularity to observations of exponential growth in various technologies (with Moore's Law being the most prominent example), using such observations as a basis for predicting that the singularity is likely to happen sometime within the 21st century.

Vernor Vinge proposed that the creation of superhuman intelligence would represent a breakdown in the ability of humans to model the future thereafter. He was the first to use the term "singularity" for this notion, in a 1983 article, and a later 1993 article entitled "The Coming Technological Singularity: How to Survive in the Post-Human Era" was widely disseminated on the World Wide Web and helped to popularize the idea. Vinge also compared the event of a technological singularity to the breakdown of the predictive ability of physics at the space-time singularity beyond the event horizon of a black hole.

A technological singularity includes the concept of an intelligence explosion, a term coined in 1965 by I. J. Good. Although technological progress has been accelerating, it has been limited by the basic intelligence of the human brain, which has not, according to Paul R. Ehrlich, changed significantly for millennia. However with the increasing power of computers and other technologies, it might eventually be possible to build a machine that is more intelligent than humanity. If superhuman intelligences were invented, either through the amplification of human intelligence or artificial intelligence, it would bring to bear greater problem-solving and inventive skills than humans, then it could design a yet more capable machine, or re-write its source code to become more intelligent. This more capable machine then could design a machine of even greater capability. These iterations could accelerate, leading to recursive self improvement, potentially allowing enormous

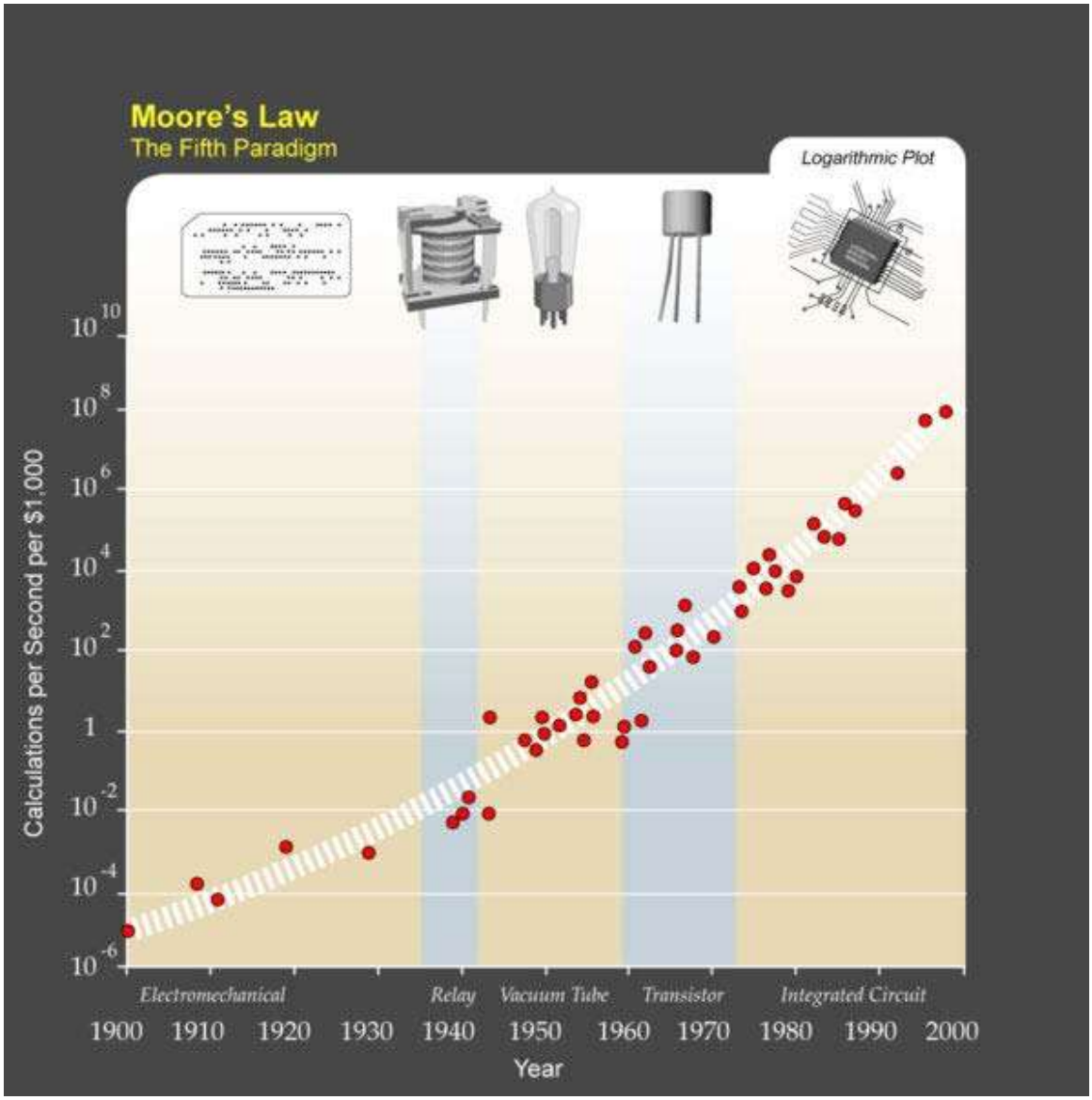
qualitative change before any upper limits imposed by the laws of physics or theoretical computation set in.

Futurist Ray Kurzweil postulates a law of accelerating returns in which the speed of technological change increases exponentially, generalizing Moore's law to technologies predating the integrated circuit, and including material technology (especially as applied to nanotechnology), medical technology and others. Like other authors, though, he reserves the term "Singularity" for a rapid increase in *intelligence* (as opposed to other technologies), writing for example that "The Singularity will allow us to transcend these limitations of our biological bodies and brains ... There will be no distinction, post-Singularity, between human and machine". He also defines his predicted date of the singularity (2045) in terms of when he expects computer-based intelligences to significantly exceed the sum total of human brainpower, writing that advances in computing before that date "will not represent the Singularity" because they do "not yet correspond to a profound expansion of our intelligence."

The term "technological singularity" reflects the idea that such change may happen suddenly, and that it is difficult to predict how such a new world would operate. It is unclear whether an intelligence explosion of this kind would be beneficial or harmful, or even an existential threat, as the issue has not been dealt with by most artificial general intelligence researchers, although the topic of friendly artificial intelligence is investigated by the Singularity Institute for Artificial Intelligence and the Future of Humanity Institute.

Many prominent technologists and academics dispute the plausibility of a technological singularity, including Jeff Hawkins, John Holland, Daniel Dennett, Jaron Lanier, and Gordon Moore, whose eponymous Moore's Law is often cited in support of the concept.

History of the idea



Kurzweil writes that, due to paradigm shifts, a trend of exponential growth extends Moore's law from integrated circuits to earlier transistors, vacuum tubes, relays, and electromechanical computers. He predicts that the exponential growth will continue, and that in a few decades the computing power of all computers will exceed that of human brains, with superhuman artificial intelligence appearing around the same time.

In 1847, R. Thornton, the editor of the Primitive Expounder, wrote (more than half in jest) about the recent invention of a four function mechanical calculator:

...such machines, by which the scholar may, by turning a crank, grind out the solution of a problem without the fatigue of mental application, would by its introduction into

schools, do incalculable injury. But who knows that such machines when brought to greater perfection, may not think of a plan to remedy all their own defects and then grind out ideas beyond the ken of mortal mind!

In 1958, Stanisław Ulam wrote in reference to a conversation with John von Neumann:

One conversation centered on the ever accelerating progress of technology and changes in the mode of human life, which gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue.

In 1965, I. J. Good first wrote of an "intelligence explosion", suggesting that if machines could even slightly surpass human intellect, they could improve their own designs in ways unforeseen by their designers, and thus recursively augment themselves into far greater intelligences. The first such improvements might be small, but as the machine became more intelligent it would become better at becoming more intelligent, which could lead to a cascade of self-improvements and a sudden surge to superintelligence (or a singularity).

Mathematician and author Vernor Vinge greatly popularized Good's notion of an intelligence explosion, addressing the topic in print in the January 1983 issue of *Omni* magazine. In this op-ed piece, Vinge seems to have been the first to use the term "singularity" in a way that was specifically tied to the creation of intelligent machines, writing:

We will soon create intelligences greater than our own. When this happens, human history will have reached a kind of singularity, an intellectual transition as impenetrable as the knotted space-time and the center of a black hole, and the world will pass far beyond our understanding. This singularity, I believe, already haunts a number of science-fiction writers. It makes realistic extrapolation to an interstellar future impossible. To write a story set more than a century hence, one needs a nuclear war in between ... so that the world remains intelligible.

In 1985 Ray Solomonoff introduced the notion of "infinity point" in the time scale of artificial intelligence, analyzed the magnitude of the "future shock" that "we can expect from our AI expanded scientific community" and on social effects. Estimates were made "for when these milestones would occur, followed by some suggestions for the more effective utilization of the extremely rapid technological growth that is expected."

A 1993 article by Vinge, "The Coming Technological Singularity: How to Survive in the Post-Human Era", contains the oft-quoted statement, "Within thirty years, we will have the technological means to create superhuman intelligence. Shortly after, the human era will be ended." Vinge refines his estimate of the time scales involved, adding, "I'll be surprised if this event occurs before 2005 or after 2030."

Vinge continues by predicting that superhuman intelligences will be able to enhance their own minds faster than the humans that created them. "When greater-than-human intelligence drives progress," Vinge writes, "that progress will be much more rapid." This feedback loop of self-improving intelligence, he predicts, will cause large amounts of technological progress within a short period, and that the creation of superhuman intelligence represented a breakdown in humans' ability to model their future. His argument was that authors cannot write realistic characters who surpass the human intellect, as the thoughts of such an intellect would be beyond the ability of humans to express. Vinge named this event "the Singularity". In 1993, Vernor Vinge associated the Singularity more explicitly with I. J. Good's intelligence explosion, and tried to project the arrival time of artificial intelligence (AI) using Moore's law, which thereafter came to be associated with the "Singularity" concept.

Aubrey de Grey has applied the term the "Methuselarity" to the point at which medical technology improves so fast that expected human lifespan increases by more than one year per year.

Robin Hanson, taking "singularity" to refer to sharp increases in the exponent of economic growth, lists the agricultural and industrial revolutions as past "singularities". Extrapolating from such past events, Hanson proposes that the next economic singularity should increase economic growth between 60 and 250 times. An innovation that allowed for the replacement of virtually all human labor could trigger this event.

Eliezer Yudkowsky has suggested that many of the different definitions that have been assigned to *singularity* are mutually incompatible rather than mutually supporting. For example, Kurzweil extrapolates current technological trajectories *past* the arrival of self-improving AI or superhuman intelligence, which Yudkowsky argues represents a tension with both I. J. Good's proposed discontinuous upswing in intelligence and Vinge's thesis on unpredictability.

In 2009, Kurzweil and X-Prize founder Peter Diamandis announced the establishment of Singularity University, whose stated mission is "to assemble, educate and inspire a cadre of leaders who strive to understand and facilitate the development of exponentially advancing technologies in order to address humanity’s grand challenges." Funded by Google, Autodesk, ePlanet Ventures, and a group of technology industry leaders, Singularity University is based at NASA's Ames Research Center in Mountain View, California. The not-for-profit organization runs an annual ten-week graduate program during the summer that covers ten different technology and allied tracks, and a series of executive programs throughout the year. Program faculty include experts in technology, finance, and future studies, and a number of videos of Singularity University sessions have been posted online.

Some prominent technologists such as Bill Joy, founder of Sun Microsystems, have voiced concern over the potential dangers of the Singularity.

Intelligence explosion

Good (1965) speculated on the effects of superhuman machines:

> “ Let an ultraintelligent machine be defined as a machine that can far surpass all the intellectual activities of any man however clever. Since the design of machines is one of these intellectual activities, an ultraintelligent machine could design even better machines; there would then unquestionably be an ‘intelligence explosion,’ and the intelligence of man would be left far behind. Thus the first ultraintelligent machine is the last invention that man need ever make. ”

Most proposed methods for creating superhuman or transhuman minds fall into one of two categories: intelligence amplification of human brains and artificial intelligence. The means speculated to produce intelligence augmentation are numerous, and include bio- and genetic engineering, nootropic drugs, AI assistants, direct brain-computer interfaces, and mind uploading. The existence of multiple paths to a intelligence-explosion make a singularity more likely; for a singularity to not occur they would all have to fail.

Despite the numerous speculated means for amplifying human intelligence, non-human artificial intelligence (specifically seed AI) is the most popular option for organizations trying to advance the singularity. Hanson (1998) is also skeptical of human intelligence augmentation, writing that once one has exhausted the "low-hanging fruit" of easy methods for increasing human intelligence, further improvements will become increasingly difficult to find.

Whether or not an intelligence explosion occurs depends on three factors. The first, accelerating factor, is the new intelligence enhancements made possible by each previous improvement. Contrawise, as the intelligences become more advanced, further advances will become more and more complicated, possibly overcoming the advantage of increased intelligence. Each improvement must be able to beget at least one more improvement, on average, for the singularity to continue. Finally, there is the issue of a hard upper limit. Absent Quantum Computing, eventually the laws of physics will prevent any further improvements.

There are two logically independent, but mutually reinforcing, accelerating effects: increases in the speed of computation, and improvements to the algorithms used. The former is predicted by Moore’s Law and the forecast improvements in hardware, and is comparatively similar to previous technological advance. On the other hand, most AI researchers believe that software is more important than hardware. There is little reason to expect evolution to have optimised human brains for intelligence, suggesting there are low-hanging fruit on the software side.

Speed improvements

The first is the improvements to the speed at which minds can be run. Whether human or AI, better hardware increases the rate of future hardware improvements. Simplistically, Moore's Law suggests that if the first doubling of speed took 18 months, the second would take 18 subjective months; or 9 external months, whereafter, four months, two months, and so on towards a speed singularity. An upper limit on speed may eventually be reached, though it is unclear how high this would be. Hawkins (2008), responding to Good, argued that the upper limit is relatively low;

> “Belief in this idea is based on a naive understanding of what intelligence is. As an analogy, imagine we had a computer that could design new computers (chips, systems, and software) faster than itself. Would such a computer lead to infinitely fast computers or even computers that were faster than anything humans could ever build? No. It might accelerate the rate of improvements for a while, but in the end there are limits to how big and fast computers can run. We would end up in the same place; we'd just get there a bit faster. There would be no singularity.”

Whereas if it were a lot higher than current human levels of intelligence, the effects of the singularity would be enormous enough as to be indistinguishable (to humans) from a singularity with an upper limit. For example, if the speed of thought could be sped up by a million-to-one, a subjective year would pass in 30 physical seconds.

It is difficult to directly compare silicon-based hardware with neurons. But Berglas (2008) notes that computer speech recognition is approaching human capabilities, and that this capability seems to require 0.01% of the volume of the brain. This analogy suggests that modern computer hardware is within a few orders of magnitude of being as powerful as the human brain.

Intelligence improvements

Some intelligence technologies, like seed AI, also have the potential to make themselves more intelligent, not just faster, by modifying their source code. These improvements would make further improvements possible, which would make further improvements possible, and so on.

This mechanism for an intelligence explosion differs from an increase in speed in two ways. Firstly, it doesn't require external effect: machines designing faster hardware still require humans to create the improved hardware, or to program factories appropriately. An AI which was re-writing its own source code, however, could do so while contained in an AI box.

Secondly, as with Vernor Vinge's conception of the singularity, it is much harder to predict the outcome. While speed increases seem to be only a quantitative difference from human intelligence, actual improvements in intelligence would be qualitatively different. Eliezer Yudkowsky compares it to the changes that human intelligence brought: humans changed the world thousands of times more rapidly than evolution had done so, and in totally different ways. Similarly, the evolution of life had been a massive departure and acceleration from the previous geological rates of change, and improved intelligence could cause change to be as different again.

There are substantial dangers associated with an intelligence explosion singularity. Firstly, the goal structure of the AI may not be invariant under self-improvement, potentially causing the AI to optimise something other than was intended. Secondly, AIs could have other uses for the scarce resources mankind uses to survive.

While not actively malicious, there is no reason to think that AIs would actively promote human goals unless they could be programmed as such, and if not, might use the resources currently used to support mankind to promote its own goals, causing human extinction.

Impact

Dramatic changes in the rate of economic growth have occurred in the past because of some technological advancement. Based on population growth, the economy doubled every 250,000 years from the Paleolithic era until the Neolithic Revolution. This new agricultural economy began to double every 900 years, a remarkable increase. In the current era, beginning with the Industrial Revolution, the world's economic output doubles every fifteen years, sixty times faster than during the agricultural era. If the rise of superhuman intelligences causes a similar revolution, argues Robin Hanson, one would expect the economy to double at least quarterly and possibly on a weekly basis.

Existential risk

"The AI does not hate you, nor does it love you, but you are made out of atoms which it can use for something else."

Superhuman intelligences may have goals inconsistent with human survival and prosperity. Berglas (2008) notes that there is no direct evolutionary motivation for an AI to be friendly to humans. In the same way that evolution has no inherent tendency to produce outcomes valued by humans, so too there is little reason to expect an arbitrary optimisation process to promote an outcome desired by mankind, rather than

inadvertently leading to an AI behaving in a way not intended by its creators (such as Nick Bostrom's whimsical example of an AI which was originally programmed with the goal of manufacturing paper clips, such that when it achieves superintelligence it decides to convert the entire planet into a paper clip manufacturing facility). AI researcher Hugo de Garis suggests that artificial intelligences may simply eliminate the human race for access to scarce resources, and humans would be powerless to stop them.

Bostrom (2002) discusses human extinction scenarios, and lists superintelligence as a possible cause:

When we create the first superintelligent entity, we might make a mistake and give it goals that lead it to annihilate humankind, assuming its enormous intellectual advantage gives it the power to do so. For example, we could mistakenly elevate a subgoal to the status of a supergoal. We tell it to solve a mathematical problem, and it complies by turning all the matter in the solar system into a giant calculating device, in the process killing the person who asked the question.

Alternatively, AIs developed under evolutionary pressure to promote their own survival could out-compete humanity. One approach to prevent a negative singularity is an AI box, whereby the artificial intelligence is kept constrained inside a simulated world and not allowed to affect the external world. Such a box would have extremely proscribed inputs and outputs; maybe only a plaintext channel. However, a sufficient intelligent AI may simply be able to escape from any box we can create. For example, it might crack the protein folding problem and use nanotechnology to escape, or simply persuade its human ‘keepers’ to let it out.

Eliezer Yudkowsky proposed that research be undertaken to produce friendly artificial intelligence in order to address the dangers. He noted that if the first real AI was friendly it would have a head start on self-improvement and thus prevent other unfriendly AIs from developing, as well as providing enormous benefits to mankind. The Singularity Institute for Artificial Intelligence is dedicated to this cause.

A significant problem, however, is that unfriendly artificial intelligence is likely to be much easier to create than FAI: while both require large advances in recursive optimisation process design, friendly AI also requires the ability to make goal structures invariant under self-improvement (or the AI will transform itself into something unfriendly) and a goal structure that aligns with human values and doesn’t automatically destroy the human race. An unfriendly AI, on the other hand, can optimize for an arbitrary goal structure, which doesn't need to be invariant under self-modification.

Bill Hibbard also addresses issues of AI safety and morality in his book *Super-Intelligent Machines*.

Implications for human society

In 2009, leading computer scientists, artificial intelligence researchers, and roboticists met at the Asilomar Conference Grounds near Monterey Bay in California. The goal was to discuss the potential impact of the hypothetical possibility that robots could become self-sufficient and able to make their own decisions. They discussed the extent to which computers and robots might be able to acquire autonomy, and to what degree they could use such abilities to pose threats or hazards. Some machines have acquired various forms of semi-autonomy, including the ability to locate their own power sources and choose targets to attack with weapons. Also, some computer viruses can evade elimination and have achieved "cockroach intelligence." The conference attendees noted that self-awareness as depicted in science-fiction is probably unlikely, but that other potential hazards and pitfalls exist.

Some experts and academics have questioned the use of robots for military combat, especially when such robots are given some degree of autonomous functions. A United States Navy report indicates that, as military robots become more complex, there should be greater attention to implications of their ability to make autonomous decisions.

The Association for the Advancement of Artificial Intelligence has commissioned a study to examine this issue, pointing to programs like the Language Acquisition Device, which can emulate human interaction.

Many Singularitarians consider nanotechnology to be one of the greatest dangers facing humanity. For this reason, they often believe that seed AI (an AI capable of making itself smarter) should precede nanotechnology. Others, such as the Foresight Institute, advocate the creation of molecular nanotechnology, which they claim can be made safe for pre-singularity use or expedite the arrival of a beneficial singularity.

Some support the design of "friendly artificial intelligence", meaning that the advances which are already occurring with AI should also include an effort to make AI intrinsically friendly and humane.

Isaac Asimov's Three Laws of Robotics is one of the earliest examples of proposed safety measures for AI:

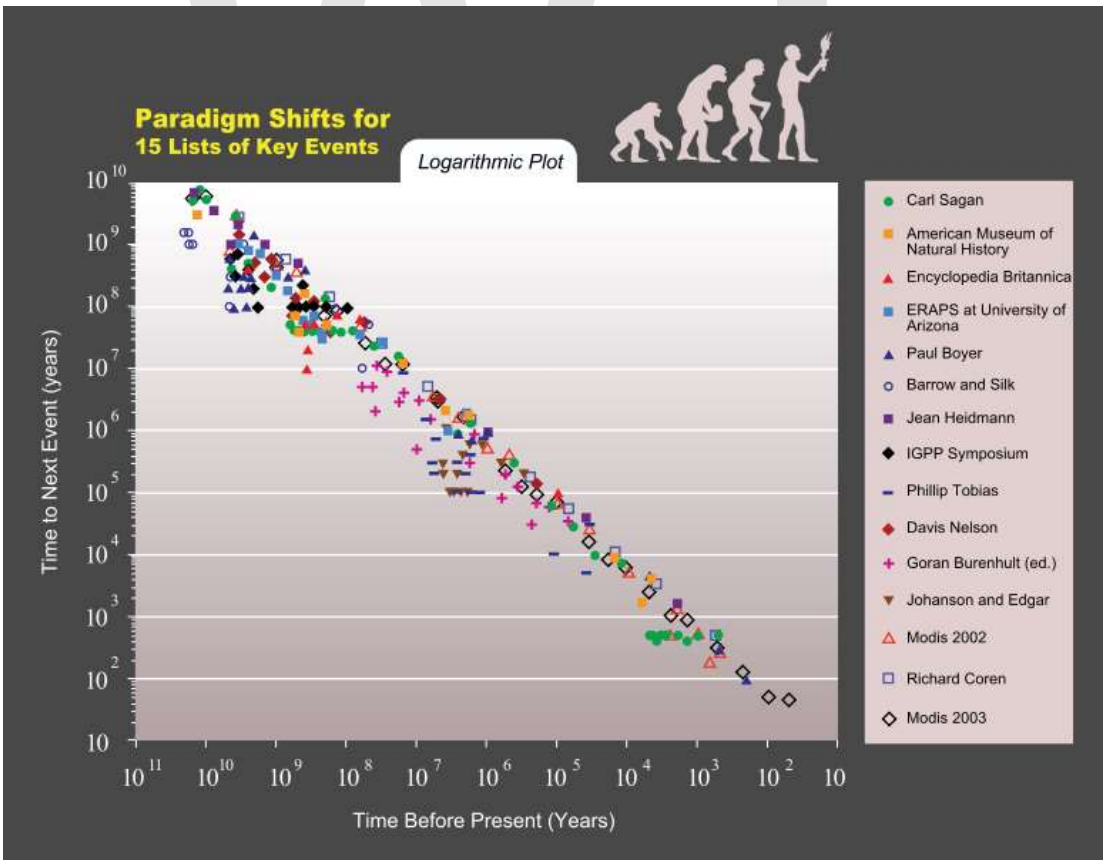
1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given to it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with either the First or Second Law.

Additional laws included in some stories were described as follows:

- *Zeroth Law:* A robot may not harm humanity, or through inaction allow humanity to come to harm.
- *Minus-One Law:* A robot may not harm sentience, or through inaction allow sentience to come to harm.
- *Fourth Law:* A robot must establish its identity as a robot in all cases.
- Alternate *Fourth Law:* A robot must reproduce, unless such reproduction would interfere with the First or Second or Third Law.
- *Fifth Law:* A robot must know it is a robot.

The laws are intended to prevent artificially intelligent robots from harming humans. In Asimov's stories, any perceived problems with the laws tend to arise as a result of a misunderstanding on the part of some human operator; the robots themselves are merely acting to their best interpretation of their rules. In the 2004 film *I, Robot*, loosely based on Asimov's Robot stories, an AI attempts to take complete control over humanity for the purpose of protecting humanity from itself due to an extrapolation of the Three Laws. In 2004, the Singularity Institute launched an Internet campaign called *3 Laws Unsafe* to raise awareness of AI safety issues and the inadequacy of Asimov's laws in particular. (Singularity Institute for Artificial Intelligence 2004)

Accelerating change



According to Kurzweil, his logarithmic graph of 15 lists of paradigm shifts for key historic events shows an exponential trend. The lists' compilers include Carl Sagan, Paul

D. Boyer, *Encyclopædia Britannica*, American Museum of Natural History, and University of Arizona.

Some singularity proponents argue its inevitability through extrapolation of past trends, especially those pertaining to shortening gaps between improvements to technology. In one of the first uses of the term "singularity" in the context of technological progress, Stanislaw Ulam (1958) tells of a conversation with John von Neumann about accelerating change:

One conversation centered on the ever accelerating progress of technology and changes in the mode of human life, which gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue.

Hawkins (1983) writes that "mindsteps", dramatic and irreversible changes to paradigms or world views, are accelerating in frequency as quantified in his mindstep equation. He cites the inventions of writing, mathematics, and the computer as examples of such changes.

Ray Kurzweil's analysis of history concludes that technological progress follows a pattern of exponential growth, following what he calls *The Law of Accelerating Returns*. He generalizes Moore's law, which describes geometric growth in integrated semiconductor complexity, to include technologies from far before the integrated circuit.

Whenever technology approaches a barrier, Kurzweil writes, new technologies will cross it. He predicts paradigm shifts will become increasingly common, leading to "technological change so rapid and profound it represents a rupture in the fabric of human history".(Kurzweil 2001) Kurzweil believes that the singularity will occur before the end of the 21st century, setting the date at 2045 (Kurzweil 2005). His predictions differ from Vinge's in that he predicts a gradual ascent to the singularity, rather than Vinge's rapidly self-improving superhuman intelligence.

This leads to the conclusion that an artificial intelligence that is capable of improving on its own design is also faced with a singularity. Self-augmentation or bootstrapping of intelligence is featured by Dan Simmons in his novel *Hyperion*, where a collection of artificial intelligences debate whether or not to make themselves obsolete by creating a new generation of "ultimate" intelligence.

The Acceleration Studies Foundation, an educational non-profit foundation founded by John Smart, engages in outreach, education, research and advocacy concerning accelerating change.(Acceleration Studies Foundation 2007) It produces the Accelerating Change conference at Stanford University, and maintains the educational site Acceleration Watch.

Presumably, a technological singularity would lead to rapid development of a Kardashev Type I civilization, where a Kardashev Type I civilization is one that has achieved

mastery of the resources of its home planet, Type II of its planetary system, and Type III of its galaxy.

Oft-cited dangers include those commonly associated with molecular nanotechnology and genetic engineering. These threats are major issues for both singularity advocates and critics, and were the subject of Bill Joy's *Wired* magazine article "Why the future doesn't need us".(Joy 2000)

Criticism

Steven Pinker stated in 2008:

"(...) There is not the slightest reason to believe in a coming singularity. The fact that you can visualize a future in your imagination is not evidence that it is likely or even possible. Look at domed cities, jet-pack commuting, underwater cities, mile-high buildings, and nuclear-powered automobiles — all staples of futuristic fantasies when I was a child that have never arrived. Sheer processing power is not a pixie dust that magically solves all your problems. (...)"

Some critics assert that no computer or machine will ever achieve human intelligence, while others hold that the definition of intelligence is irrelevant if the net result is the same.

Martin Ford in *The Lights in the Tunnel: Automation, Accelerating Technology and the Economy of the Future* postulates a "technology paradox" in that before the Singularity could occur, most routine jobs in the economy would be automated since this would require a level of technology inferior to that of the Singularity. This would cause massive unemployment and plummeting consumer demand—which in turn would destroy the incentive to invest in the technologies that would be required to bring on the Singularity.

Criticism of the accelerating returns argument

Theodore Modis and Jonathan Huebner argue that the rate of technological innovation has not only ceased to rise, but is actually now declining (John Smart, however, criticizes Huebner's analysis.) Some evidence for this decline is that the rise in computer clock speeds is slowing, even while Moore's prediction of exponentially increasing circuit density continues to hold. This is due to excessive heat build-up from the chip, which cannot be dissipated quickly enough to prevent the chip from melting when operating at higher speeds. Advancements in speed may be possible in the future by virtue of more power-efficient CPU designs and multi-cell processors.

Others propose that other "singularities" can be found through analysis of trends in world population, world gross domestic product, and other indices. Andrey Korotayev and others argue that historical hyperbolic growth curves can be attributed to feedback loops that ceased to affect global trends in the 1970s, and thus hyperbolic growth should not be expected in the future.

In *The Progress of Computing*, William Nordhaus argued that, prior to 1940, computers followed the much slower growth of a traditional industrial economy, thus rejecting extrapolations of Moore's law to 19th-century computers. Schmidhuber (2006) suggests differences in memory of recent and distant events create an illusion of accelerating change, and that such phenomena may be responsible for past apocalyptic predictions.

Andrew Kennedy, in his 2006 paper for the British Interplanetary Society discussing change and the growth in space travel velocities, stated that although long-term overall growth is inevitable, it is small, embodying both ups and downs, and noted, "New technologies follow known laws of power use and information spread and are obliged to connect with what already exists. Remarkable theoretical discoveries, if they end up being used at all, play their part in maintaining the growth rate: they do not make its plotted curve... redundant." He stated that exponential growth is no predictor in itself, and illustrated this with examples such as quantum theory. The quantum was conceived in 1900, and quantum theory was in existence and accepted approximately 25 years later. However, it took over 40 years for Richard Feynman and others to produce meaningful numbers from the theory. Bethe understood nuclear fusion in 1935, but 75 years later fusion reactors are still only used in experimental settings. Similarly, entanglement was understood in 1935 but not at the point of being used in practice until the 21st century.

A study of patents per thousand persons shows that human creativity does not show accelerating returns, but in fact—as suggested by Joseph Tainter in his seminal *The Collapse of Complex Societies*—a law of diminishing returns. The number of patents per thousand peaked in the period from 1850–1900, and has been declining since. The growth of complexity eventually becomes self-limiting, and leads to a wide spread "general systems collapse". Thomas Homer Dixon in *The Upside of Down: Catastrophe, Creativity and the Renewal of Civilization* maintains that the declining energy returns on investment has led to the collapse of civilizations.

In addition to general criticisms of the singularity concept, several critics have raised issues with Kurzweil's iconic chart. One line of criticism is that a log-log chart of this nature is inherently biased toward a straight-line result. Others identify selection bias in the points that Kurzweil chooses to use. For example, biologist PZ Myers points out that many of the early evolutionary "events" were picked arbitrarily. Kurzweil has rebutted this by charting evolutionary events from 15 neutral sources, and showing that they fit a straight line on a log-log chart.

The Economist mocked the concept with a graph extrapolating that the number of blades on a razor, which has increased over the years from one to as many as five, will increase ever-faster to infinity.

Chapter- 6

Technological Utopianism

Technological utopianism (often called **techno-utopianism** or **technoutopianism**) refers to any ideology based on the belief that advances in science and technology will eventually bring about a utopia, or at least help to fulfill one or another utopian ideal. A **techno-utopia** is therefore a hypothetical ideal society, in which laws, government, and social conditions are solely operating for the benefit and well-being of all its citizens, set in the near- or far-future, when advanced science and technology will allow these ideal living standards to exist; for example, post scarcity, transformations in human nature, the abolition of suffering and even the end of death.

In the late 20th and early 21st centuries, several ideologies and movements, such as the cyberdelic counterculture, the Californian Ideology, transhumanism, singularitarianism, and The Venus Project, have emerged promoting a form of techno-utopia as a reachable goal. Cultural critic Imre Szeman argues technological utopianism is an irrational social narrative because there is no evidence to support it. He concludes that what it shows is the extent to which modern societies place a lot of faith in narratives of progress and technology overcoming things, despite all evidence to the contrary.

History

Technological utopianism from the 19th to mid-20th centuries

Karl Marx believed that science and democracy were the right and left hands of what he called the move from the realm of necessity to the realm of freedom. He argued that advances in science helped delegitimize the rule of kings and the power of the Christian Church.

19th century socialists, feminists and republicans were generally advocates of reason and science. Techno-utopianism, atheism, and rationalism have been associated with the democratic, revolutionary and utopian Left for most of the last two hundred years. Radicals like Joseph Priestley pursued scientific investigation while advocating democracy and freedom from religious tyranny. Robert Owen, Charles Fourier and Henri de Saint-Simon in the early 19th century inspired communalists with their visions of a future scientific and technological evolution of humanity using reason as its secular religion. Radicals seized on Darwinian evolution to validate the idea of social progress.

Edward Bellamy's socialist utopia in *Looking Backward*, which inspired hundreds of socialist clubs in the late 19th century United States and a national political party, was as highly technological as Bellamy's imagination. For Bellamy and the Fabian Socialists, socialism was to be brought about as a painless corollary of industrial development.

Marx and Engels saw more pain and conflict involved, but agreed about the inevitable end. Marxists argued that the advance of technology laid the groundwork not only for the creation of a new society, with different property relations, but also for the emergence of new human beings reconnected to nature and themselves. At the top of the agenda for empowered proletarians was "to increase the total productive forces as rapidly as possible." The 19th and early 20th century Left, from social democrats to communists, were focused on industrialization, economic development and the promotion of reason, science and the idea of progress.

One such promotion of science and social progress was the promotion of eugenics. Holding that in studies of families, such as the Jukes and Kallikaks, science had proven that many traits such as criminality and alcoholism were hereditary, many advocated the sterilization of those displaying negative traits. Forcible sterilization programs were implemented in several states in the United States.

After Auschwitz, the optimism of positivist views led to more pessimistic conceptions of science. The Holocaust, as Theodor Adorno underlined, seemed to shatter the ideal of Condorcet and others thinkers of the Enlightenment, which commonly equated scientific progress with social progress.

Technological utopianism from late 20th and early 21st centuries

The Goliath of totalitarianism will be brought down by the David of the microchip.

– Ronald Reagan, The Guardian, 14 June 1989

A movement of techno-utopianism began to flourish again in the dot-com culture of the 1990s, particularly in the West Coast of the United States, especially based around Silicon Valley. The Californian Ideology was a set of beliefs combining bohemian and anti-authoritarian attitudes from the counterculture of the 1960s with techno-utopianism and support for libertarian economic policies. It was reflected in, reported on, and even actively promoted in the pages of *Wired* magazine, which was founded in San Francisco in 1993 and served for a number years as the "bible" of its adherents.

This form of techno-utopianism reflected a belief that technological change revolutionizes human affairs, and that digital technology in particular - of which the Internet was but a modest harbinger - would increase personal freedom by freeing the individual from the rigid embrace of bureaucratic big government. "Self-empowered knowledge workers" would render traditional hierarchies redundant; digital communications would allow them to escape the modern city, an "obsolete remnant of the industrial age".

Its adherents claim it transcended conventional "right/left" distinctions in politics by rendering politics obsolete. However, techno-utopianism disproportionately attracted adherents from the libertarian right end of the political spectrum. Therefore, techno-utopians often have a hostility toward government regulation and a belief in the superiority of the free market system. Prominent "oracles" of techno-utopianism included George Gilder and Kevin Kelly, an editor of *Wired* who also published several books.

During the late 1990s dot-com boom, when the speculative bubble gave rise to claims that an era of "permanent prosperity" had arrived, techno-utopianism flourished, typically among the small percentage of the population who were employees of Internet startups and/or owned large quantities of high-tech stocks. With the subsequent crash, many of these dot com techno-utopians had to rein in some of their beliefs in the face of the clear return of traditional economic reality.

In the late 1990s and especially during the first decade of the 21st century, technorealism and techno-progressivism are stances that have risen among advocates of technological change as critical alternatives to techno-utopianism. However, technological utopianism persists in the 21st century as a result of new technological developments and their impact on society.

Principles

Bernard Gendron, a professor of philosophy at the University of Wisconsin–Milwaukee, defines the four principles of modern technological utopians in the late 20th and early 21st centuries as follows:

1. We are presently undergoing a (postindustrial) revolution in technology;
2. In the postindustrial age, technological growth will be sustained (at least);
3. In the postindustrial age, technological growth will lead to the end of economic scarcity;
4. The elimination of economic scarcity will lead to the elimination of every major social evil.

Criticism

Critics claim that techno-utopianism's identification of social progress with scientific progress is a form of positivism and scientism. Critics of modern libertarian techno-utopianism point out that it tends to focus on "government interference" while dismissing the positive effects of the regulation of business. They also point out that it has little to say about the environmental impact of technology and that its ideas have little relevance for much of the rest of the world that are still relatively quite poor.

In his 2010 study *System Failure: Oil, Futurity, and the Anticipation of Disaster*, Canada Research Chairholder in cultural studies Imre Szeman argues that technological

utopianism is one of the social narratives that prevent people from acting on the knowledge they have concerning the effects of oil on the environment.

Chapter- 7

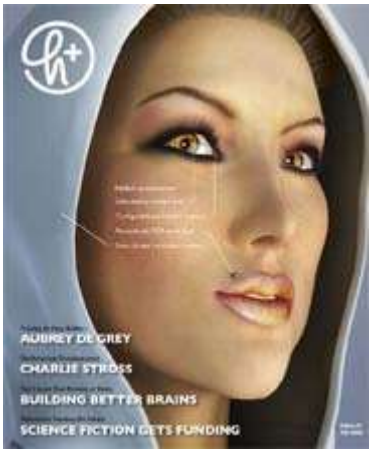
Transhumanism

Transhumanism is an international intellectual and cultural movement that affirms the possibility and desirability of fundamentally transforming the human condition by developing and making widely available technologies to eliminate aging and to greatly enhance human intellectual, physical, and psychological capacities. Transhumanist thinkers study the potential benefits and dangers of emerging technologies that could overcome fundamental human limitations, as well as study the ethical matters involved in developing and using such technologies. They predict that human beings may eventually be able to transform themselves into beings with such greatly expanded abilities as to merit the label "posthuman". Transhumanism is therefore viewed as a subset of philosophical "posthumanism".

The contemporary meaning of the term "transhumanism" — which is now symbolized by **H+** (previously **>H**) and often used as a synonym for "human enhancement" — was foreshadowed by one of the first professors of futurology, FM-2030, who taught "new concepts of the Human" at The New School of New York City in the 1960s, when he began to identify people who adopt technologies, lifestyles and world views *transitional* to "posthumanity" as "transhuman". This foresight would lay the intellectual groundwork for British philosopher Max More to begin articulating the principles of transhumanism as a futurist philosophy in 1990, and organizing in California an intelligentsia that has since grown into the worldwide transhumanist movement.

The transhumanist vision of a transformed future humanity, which is influenced by the techno-utopias depicted in some great works of science fiction, has attracted many supporters and detractors from a wide range of perspectives. Transhumanism has been condemned by one critic, Francis Fukuyama, as the world's most dangerous idea, while one proponent, Ronald Bailey, counters that it is the "movement that epitomizes the most daring, courageous, imaginative, and idealistic aspirations of humanity".

History



Cover of the first issue of H+ *Magazine*, a web-based quarterly publication that focuses on transhumanism, covering the scientific, technological, and cultural developments that are challenging and overcoming human limitations.

According to philosophers who have studied and written about the history of transhumanist thought, transcendentalist impulses have been expressed at least as far back as in the quest for immortality in the Epic of Gilgamesh, as well as historical quests for the Fountain of Youth, Elixir of Life, and other efforts to stave off aging and death. Transhumanist philosophy, however, is rooted in Renaissance humanism and the Enlightenment. For example, Giovanni Pico della Mirandola called on people to "sculpt their own statue", and the Marquis de Condorcet speculated about the use of medical science to indefinitely extend the human life span, while Benjamin Franklin dreamed of suspended animation, and after Charles Darwin "it became increasingly plausible to view the current version of humanity not as the endpoint of evolution but rather as a possibly quite early phase." However, there is ongoing debate within the transhumanist community about whether the philosophy of Friedrich Nietzsche can be considered an influence, despite its exaltation of the "overman", due to its emphasis on self-actualization rather than technological transformation.

Nikolai Fyodorov, a 19th-century Russian philosopher, advocated radical life extension, physical immortality and even resurrection of the dead using scientific methods. In the 20th century, a direct and influential precursor to transhumanist concepts was geneticist J.B.S. Haldane's 1923 essay *Daedalus: Science and the Future*, which predicted that great benefits would come from applications of advanced sciences to human biology—and that every such advance would first appear to someone as blasphemy or perversion, "indecent and unnatural". J. D. Bernal speculated about space colonization, bionic implants, and cognitive enhancement, which have been common transhumanist themes since then. Biologist Julian Huxley, brother of author Aldous Huxley (a childhood friend of Haldane's), appears to have been the first to use the actual word "transhumanism". Writing in 1957, he defined transhumanism as "man remaining man, but transcending

himself, by realizing new possibilities of and for his human nature". This definition differs, albeit not substantially, from the one commonly in use since the 1980s.

Computer scientist Marvin Minsky wrote on relationships between human and artificial intelligence beginning in the 1960s. Over the succeeding decades, this field continued to generate influential thinkers, such as Hans Moravec and Raymond Kurzweil, who oscillated between the technical arena and futuristic speculations in the transhumanist vein. The coalescence of an identifiable transhumanist movement began in the last decades of the 20th century. In 1966, FM-2030 (formerly F.M. Esfandiary), a futurist who taught "new concepts of the Human" at The New School in New York City, began to identify people who adopt technologies, lifestyles and world views transitional to "posthumanity" as "transhuman". In 1972, Robert Ettinger contributed to the conceptualization of "transhumanity" in his book *Man into Superman*. FM-2030 published the *Upwingers Manifesto* in 1973 to stimulate transhumanly conscious activism.

The first self-described transhumanists met formally in the early 1980s at the University of California, Los Angeles, which became the main center of transhumanist thought. Here, FM-2030 lectured on his "Third Way" futurist ideology. At the EZTV Media venue frequented by transhumanists and other futurists, Natasha Vita-More presented *Breaking Away*, her 1980 experimental film with the theme of humans breaking away from their biological limitations and the Earth's gravity as they head into space. FM-2030 and Vita-More soon began holding gatherings for transhumanists in Los Angeles, which included students from FM-2030's courses and audiences from Vita-More's artistic productions. In 1982, Vita-More authored the *Transhumanist Arts Statement*, and, six years later, produced the cable TV show *TransCentury Update* on transhumanity, a program which reached over 100,000 viewers.

In 1986, Eric Drexler published *Engines of Creation: The Coming Era of Nanotechnology,* which discussed the prospects for nanotechnology and molecular assemblers, and founded the Foresight Institute. As the first non-profit organization to research, advocate for, and perform cryonics, the Southern California offices of the Alcor Life Extension Foundation became a center for futurists. In 1988, the first issue of *Extropy Magazine* was published by Max More and Tom Morrow. In 1990, More, a strategic philosopher, created his own particular transhumanist doctrine, which took the form of the *Principles of Extropy*, and laid the foundation of modern transhumanism by giving it a new definition:

Transhumanism is a class of philosophies that seek to guide us towards a posthuman condition. Transhumanism shares many elements of humanism, including a respect for reason and science, a commitment to progress, and a valuing of human (or transhuman) existence in this life. [...] Transhumanism differs from humanism in recognizing and anticipating the radical alterations in the nature and possibilities of our lives resulting from various sciences and technologies [...].

In 1992, More and Morrow founded the Extropy Institute, a catalyst for networking futurists and brainstorming new memeplexes by organizing a series of conferences and, more importantly, providing a mailing list, which exposed many to transhumanist views for the first time during the rise of cyberculture and the cyberdelic counterculture. In 1998, philosophers Nick Bostrom and David Pearce founded the World Transhumanist Association (WTA), an international non-governmental organization working toward the recognition of transhumanism as a legitimate subject of scientific inquiry and public policy. In 2002, the WTA modified and adopted *The Transhumanist Declaration*. *The Transhumanist FAQ*, prepared by the WTA, gave two formal definitions for transhumanism:

1. The intellectual and cultural movement that affirms the possibility and desirability of fundamentally improving the human condition through applied reason, especially by developing and making widely available technologies to eliminate aging and to greatly enhance human intellectual, physical, and psychological capacities.
2. The study of the ramifications, promises, and potential dangers of technologies that will enable us to overcome fundamental human limitations, and the related study of the ethical matters involved in developing and using such technologies.

A number of similar definitions have been collected by Anders Sandberg, an academic and prominent transhumanist.

In possible contrast with other transhumanist organizations, WTA officials considered that social forces could undermine their futurist visions and needed to be addressed. A particular concern is the equal access to human enhancement technologies across classes and borders. In 2006, a political struggle within the transhumanist movement between the libertarian right and the liberal left resulted in a more centre-leftward positioning of the WTA under its former executive director James Hughes. In 2006, the board of directors of the Extropy Institute ceased operations of the organization, stating that its mission was "essentially completed". This left the World Transhumanist Association as the leading international transhumanist organization. In 2008, as part of a rebranding effort, the WTA changed its name to "Humanity+" in order to project a more humane image. Humanity Plus and Betterhumans publish *h+ Magazine*, a periodical edited by R. U. Sirius which disseminates transhumanist news and ideas.

Theory

It is a matter of debate whether transhumanism is a branch of "posthumanism" and how posthumanism should be conceptualised with regard to transhumanism. The latter is often referred to as a variant or activist form of posthumanism by its conservative, Christian and progressive critics, but also by pro-transhumanist scholars who, for example, characterise it as a subset of "philosophical posthumanism". A common feature of transhumanism and philosophical posthumanism is the future vision of a new intelligent species, into which humanity will evolve, which will supplement humanity or supersede

it. Transhumanism stresses the evolutionary perspective, including sometimes the creation of a highly intelligent animal species by way of cognitive enhancement (i.e. biological uplift), but clings to a "posthuman future" as the final goal of participant evolution.

Nevertheless, the idea to create intelligent artificial beings, proposed, for example, by roboticist Hans Moravec, has influenced transhumanism. Moravec's ideas and transhumanism have also been characterised as a "complacent" or "apocalyptic" variant of posthumanism and contrasted with "cultural posthumanism" in humanities and the arts. While such a "cultural posthumanism" would offer resources for rethinking the relations of humans and increasingly sophisticated machines, transhumanism and similar posthumanisms are, in this view, not abandoning obsolete concepts of the "autonomous liberal subject" but are expanding its "prerogatives" into the realm of the posthuman. Transhumanist self-characterisations as a continuation of humanism and Enlightenment thinking correspond with this view.

Some secular humanists conceive transhumanism as an offspring of the humanist freethought movement and argue that transhumanists differ from the humanist mainstream by having a specific focus on technological approaches to resolving human concerns (i.e. technocentrism) and on the issue of mortality. However, other progressives have argued that posthumanism, whether it be its philosophical or activist forms, amount to a shift away from concerns about social justice, from the reform of human institutions and from other Enlightenment preoccupations, toward narcissistic longings for a transcendence of the human body in quest of more exquisite ways of being. In this view, transhumanism is abandoning the goals of humanism, the Enlightenment, and progressive politics.

Aims

While many transhumanist theorists and advocates seek to apply reason, science and technology for the purposes of reducing poverty, disease, disability, and malnutrition around the globe, transhumanism is distinctive in its particular focus on the applications of technologies to the improvement of human bodies at the individual level. Many transhumanists actively assess the potential for future technologies and innovative social systems to improve the quality of all life, while seeking to make the material reality of the human condition fulfill the promise of legal and political equality by eliminating congenital mental and physical barriers.

Transhumanist philosophers argue that there not only exists a perfectionist ethical imperative for humans to strive for progress and improvement of the human condition but that it is possible and desirable for humanity to enter a transhuman phase of existence, in which humans are in control of their own evolution. In such a phase, natural evolution would be replaced with deliberate change.

Some theorists, such as Raymond Kurzweil, think that the pace of technological innovation is accelerating and that the next 50 years may yield not only radical

technological advances but possibly a technological singularity, which may fundamentally change the nature of human beings. Transhumanists who foresee this massive technological change generally maintain that it is desirable. However, some are also concerned with the possible dangers of extremely rapid technological change and propose options for ensuring that advanced technology is used responsibly. For example, Bostrom has written extensively on existential risks to humanity's future welfare, including risks that could be created by emerging technologies.

Ethics

Transhumanists engage in interdisciplinary approaches to understanding and evaluating possibilities for overcoming biological limitations. They draw on futurology and various fields of ethics such as bioethics, infoethics, nanoethics, neuroethics, roboethics, and technoethics mainly but not exclusively from a philosophically utilitarian, socially progressive, politically and economically liberal perspective. Unlike many philosophers, social critics, and activists who place a moral value on preservation of natural systems, transhumanists see the very concept of the specifically "natural" as problematically nebulous at best, and an obstacle to progress at worst. In keeping with this, many prominent transhumanist advocates refer to transhumanism's critics on the political right and left jointly as "bioconservatives" or "bioluddites", the latter term alluding to the 19th century anti-industrialisation social movement that opposed the replacement of human manual labourers by machines.

Currents

There is a variety of opinion within transhumanist thought. Many of the leading transhumanist thinkers hold views that are under constant revision and development. Some distinctive currents of transhumanism are identified and listed here in alphabetical order:

- Abolitionism, an ethical ideology based upon a perceived obligation to use technology to eliminate involuntary suffering in all sentient life.
- Democratic transhumanism, a political ideology synthesizing liberal democracy, social democracy, radical democracy and transhumanism.
- Extropianism, an early school of transhumanist thought characterized by a set of principles advocating a proactive approach to human evolution.
- Immortalism, a moral ideology based upon the belief that technological immortality is possible and desirable, and advocating research and development to ensure its realization.
- Libertarian transhumanism, a political ideology synthesizing libertarianism and transhumanism.
- Postgenderism, a social philosophy which seeks the voluntary elimination of gender in the human species through the application of advanced biotechnology and assisted reproductive technologies.

- Singularitarianism, a moral ideology based upon the belief that a technological singularity is possible, and advocating deliberate action to effect it and ensure its safety.
- Technogaianism, an ecological ideology based upon the belief that emerging technologies can help restore Earth's environment, and that developing safe, clean, alternative technology should therefore be an important goal of environmentalists.

Spirituality

Although some transhumanists report having religious or spiritual views, they are for the most part atheists, agnostics and secular humanists. A vocal minority of transhumanists, however, follow liberal forms of Eastern philosophies such as Buddhism and Yoga or have merged their transhumanist ideas with established Western religions such as liberal Christianity or Mormonism. Despite the prevailing secular attitude, some transhumanists pursue hopes traditionally espoused by religions, such as "immortality", while several controversial new religious movements, originating in the late 20th century, have explicitly embraced transhumanist goals of transforming the human condition by applying technology to the alteration of the mind and body, such as Raëlism. However, most thinkers associated with the transhumanist movement focus on the practical goals of using technology to help achieve longer and healthier lives; while speculating that future understanding of neurotheology and the application of neurotechnology will enable humans to gain greater control of altered states of consciousness, which were commonly interpreted as "spiritual experiences", and thus achieve more profound self-knowledge.

Secular transhumanists are strong materialists and naturalists who do not believe in a transcendent human soul. Transhumanist personhood theory also argues against the unique identification of moral actors and subjects with biological humans, judging as speciesist the exclusion of non-human and part-human animals, and sophisticated machines, from ethical consideration. Many believe in the compatibility of human minds with computer hardware, with the theoretical implication that human consciousness may someday be transferred to alternative media, a speculative technique commonly known as "mind uploading". One extreme formulation of this idea may be found in Frank Tipler's proposal of the Omega Point. Drawing upon ideas in digitalism, Tipler has advanced the notion that the collapse of the Universe billions of years hence could create the conditions for the perpetuation of humanity in a simulated reality within a megacomputer, and thus achieve a form of "posthuman godhood". Tipler's thought was inspired by the writings of Pierre Teilhard de Chardin, a paleontologist and Jesuit theologian who saw an evolutionary telos in the development of an encompassing noosphere, a global consciousness.

The idea of uploading personality to a non-biological substrate and the underlying assumptions are criticised by a wide range of scholars, scientists and activists, sometimes with regard to transhumanism itself, sometimes with regard to thinkers such as Marvin Minsky or Hans Moravec, who are often seen as its originators. Relating the underlying assumptions, for example, to the legacy of cybernetics, some have argued that this

materialist hope engenders a spiritual monism, a variant of philosophical idealism. Viewed from a conservative Christian perspective, the idea of mind uploading is asserted to represent a denigration of the human body characteristic of gnostic belief. Transhumanism and its presumed intellectual progenitors have also been described as neo-gnostic by non-Christian and secular commentators.

The first dialogue between transhumanism and faith was the focus of an academic seminar held at the University of Toronto in 2004. Because it might serve a few of the same functions that people have traditionally sought in religion, religious and secular critics maintained that transhumanism is itself a religion or, at the very least, a pseudoreligion. Some even dismissed transhumanism as technological utopianism turned into a new religious movement. Religious critics alone faulted the philosophy of transhumanism as offering no eternal truths nor a relationship with the divine. They commented that a philosophy bereft of these beliefs leaves humanity adrift in a foggy sea of postmodern cynicism and anomie. Transhumanists responded that such criticisms reflect a failure to look at the actual content of the transhumanist philosophy, which far from being cynical, is rooted in optimistic, idealistic attitudes that trace back to the Enlightenment. Following this dialogue, William Sims Bainbridge conducted a pilot study, published in the Journal of Evolution and Technology, suggesting that religious attitudes were negatively correlated with acceptance of transhumanist ideas, and indicating that individuals with highly religious worldviews tended to perceive transhumanism as being a direct, competitive (though ultimately futile) affront to their spiritual beliefs.

Since 2009, the American Academy of Religion holds a “Transhumanism and Religion” consultation during its annual meeting where scholars in the field of religious studies seek to identify and critically evaluate any implicit religious beliefs that might underlie key transhumanist claims and assumptions; consider how transhumanism challenges religious traditions to develop their own ideas of the human future, in particular the prospect of human transformation, whether by technological or other means; and provide critical and constructive assessments of an envisioned future that place greater confidence in nanotechnology, robotics, and information technology to achieve virtual immortality and create a superior posthuman species.

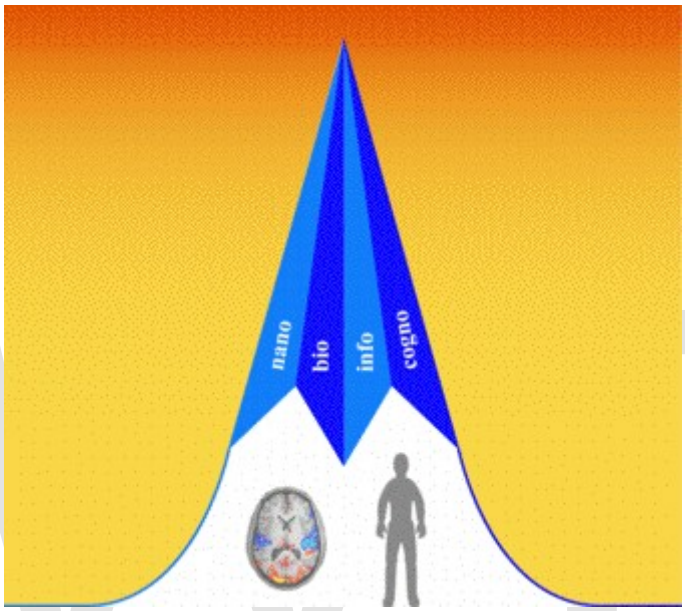
Practice

While some transhumanists take an abstract and theoretical approach to the perceived benefits of emerging technologies, others have offered specific proposals for modifications to the human body, including heritable ones. Transhumanists are often concerned with methods of enhancing the human nervous system. Though some propose modification of the peripheral nervous system, the brain is considered the common denominator of personhood and is thus a primary focus of transhumanist ambitions.

As proponents of self-improvement and body modification, transhumanists tend to use existing technologies and techniques that supposedly improve cognitive and physical performance, while engaging in routines and lifestyles designed to improve health and

longevity. Depending on their age, some transhumanists express concern that they will not live to reap the benefits of future technologies. However, many have a great interest in life extension strategies, and in funding research in cryonics in order to make the latter a viable option of last resort rather than remaining an unproven method. Regional and global transhumanist networks and communities with a range of objectives exist to provide support and forums for discussion and collaborative projects.

Technologies of interest



Converging Technologies, a 2002 report exploring the potential for synergy among nano-, bio-, info- and cogno-technologies, has become a landmark in near-future technological speculation.

Transhumanists support the emergence and convergence of technologies such as nanotechnology, biotechnology, information technology and cognitive science (NBIC), and hypothetical future technologies such as simulated reality, artificial intelligence, superintelligence, mind uploading, chemical brain preservation, and cryonics. They believe that humans can and should use these technologies to become more than human. They therefore support the recognition and/or protection of cognitive liberty, morphological freedom, and procreative liberty as civil liberties, so as to guarantee individuals the choice of using human enhancement technologies on themselves and their children. Some speculate that human enhancement techniques and other emerging technologies may facilitate more radical human enhancement no later than the midpoint of the 21st century.

A 2002 report, *Converging Technologies for Improving Human Performance*, commissioned by the National Science Foundation and US Department of Commerce, contains descriptions and commentaries on the state of NBIC science and technology by major contributors to these fields. The report discusses potential uses of these

technologies in implementing transhumanist goals of enhanced performance and health, and ongoing work on planned applications of human enhancement technologies in the military and in the rationalization of the human-machine interface in industry.

While international discussion of the converging technologies and NBIC concepts includes strong criticism of their transhumanist orientation and alleged science fictional character, research on brain and body alteration technologies has accelerated under the sponsorship of the US Department of Defense, which is interested in the battlefield advantages they would provide to the "supersoldiers" of the United States and its allies. There has already been a brain research program to "extend the ability to manage information" while military scientists are now looking at stretching the human capacity for combat to a maximum 168 hours without sleep.

Arts and culture

Transhumanist themes have become increasingly prominent in various literary forms during the period in which the movement itself has emerged. Contemporary science fiction often contains positive renditions of technologically enhanced human life, set in utopian (especially techno-utopian) societies. However, science fiction's depictions of enhanced humans or other posthuman beings frequently come with a cautionary twist. The more pessimistic scenarios include many horrific or dystopian tales of human bioengineering gone wrong. In the decades immediately before transhumanism emerged as an explicit movement, many transhumanist concepts and themes began appearing in the speculative fiction of authors of the Golden Age of Science Fiction such as Robert A. Heinlein (Lazarus Long series, 1941–87), A. E. van Vogt (*Slan*, 1946), Isaac Asimov (*I, Robot*, 1950), Arthur C. Clarke (*Childhood's End*, 1953) and Stanislaw Lem (*Cyberiad*, 1967).

The cyberpunk genre, exemplified by William Gibson's *Neuromancer* (1984) and Bruce Sterling's *Schismatrix* (1985), has particularly been concerned with the modification of human bodies. Other novels dealing with transhumanist themes that have stimulated broad discussion of these issues include *Blood Music* (1985) by Greg Bear, *The Xenogenesis Trilogy* (1987–1989) by Octavia Butler; *The Beggar's Trilogy* (1990–94) by Nancy Kress; much of Greg Egan's work since the early 1990s, such as *Permutation City* (1994) and *Diaspora* (1997); The Culture novels of Iain M. Banks; *The Bohr Maker* (1995) by Linda Nagata; *Oryx and Crake* (2003) by Margaret Atwood; *The Elementary Particles* (Eng. trans. 2001) and *The Possibility of an Island* (Eng. trans. 2006) by Michel Houellebecq; *Mindscan* (2005) by Robert J. Sawyer; and *Glasshouse* (2005) by Charles Stross. Many of these works are considered part of the cyberpunk genre or its postcyberpunk offshoot.

Fictional transhumanist scenarios have also become popular in other media during the late twentieth and early twenty first centuries. Such treatments are found in comic books (*Captain America*, 1941; *Transmetropolitan*, 1997; *The Surrogates*, 2006), films (*2001: A Space Odyssey*, 1968; *Blade Runner*, 1982; *Gattaca*, 1997; *Repo! The Genetic Opera*, 2008), television series (the Cybermen of *Doctor Who*, 1966; *The Six Million Dollar*

Man, 1973; the Borg of *Star Trek: The Next Generation*, 1989; manga and anime (*Galaxy Express 999*, 1978; *Appleseed*, 1985; *Ghost in the Shell*, 1989; *Neon Genesis Evangelion*, 1995; and the *Gundam* metaseries, 1979), computer games (*Metal Gear Solid*, 1998; *Deus Ex*, 2000; *Half-Life 2*, 2004; and *BioShock*, 2007), and role-playing games (*Shadowrun*, 1989, *Transhuman Space, 2002). The word "Transhumanism" flashes in the introduction sequence to the television program Fringe.*

In addition to the work of Natasha Vita-More, curator of the Transhumanist Arts & Culture center, transhumanist themes appear in the visual and performing arts. Carnal Art, a form of sculpture originated by the French artist Orlan, uses the body as its medium and plastic surgery as its method. Commentators have pointed to American performer Michael Jackson as having used technologies such as plastic surgery, skin-lightening drugs and hyperbaric oxygen therapy over the course of his career, with the effect of transforming his artistic persona so as to blur identifiers of gender, race and age. The work of the Australian artist Stelarc centers on the alteration of his body by robotic prostheses and tissue engineering. Other artists whose work coincided with the emergence and flourishing of transhumanism and who explored themes related to the transformation of the body are the Yugoslavian performance artist Marina Abramovic and the American media artist Matthew Barney. A 2005 show, *Becoming Animal*, at the Massachusetts Museum of Contemporary Art, presented exhibits by twelve artists whose work concerns the effects of technology in erasing boundaries between the human and non-human. Steampunk musician and Internet personality Dr. Steel often deals with the subject of transhumanism in his music and videos; he has been interviewed on his views by the Institute for Ethics and Emerging Technologies and has even published a paper on the subject.

Controversy

The scientific community classifies many elements of transhumanist thought and research to be within the realm of fringe science because it departs significantly from the mainstream and often directly challenges orthodox theories. The very notion and prospect of human enhancement and related issues also arouse public controversy. Criticisms of transhumanism and its proposals take two main forms: those objecting to the likelihood of transhumanist goals being achieved (practical criticisms); and those objecting to the moral principles or world view sustaining transhumanist proposals or underlying transhumanism itself (ethical criticisms). However, these two strains sometimes converge and overlap, particularly when considering the ethics of changing human biology in the face of incomplete knowledge.

Critics or opponents often see transhumanists' goals as posing threats to human values. Some also argue that strong advocacy of a transhumanist approach to improving the human condition might divert attention and resources from social solutions. As most transhumanists support non-technological changes to society, such as the spread of civil rights and civil liberties, and most critics of transhumanism support technological advances in areas such as communications and health care, the difference is often a matter of emphasis. Sometimes, however, there are strong disagreements about the very

principles involved, with divergent views on humanity, human nature, and the morality of transhumanist aspirations. At least one public interest organization, the U.S.-based Center for Genetics and Society, was formed, in 2001, with the specific goal of opposing transhumanist agendas that involve transgenerational modification of human biology, such as full-term human cloning and germinal choice technology. The Institute on Biotechnology and the Human Future of the Chicago-Kent College of Law critically scrutinizes proposed applications of genetic and nanotechnologies to human biology in an academic setting.

Some of the most widely known critiques of the transhumanist program refer to novels and fictional films. These works of art, despite presenting imagined worlds rather than philosophical analyses, are used as touchstones for some of the more formal arguments.

Infeasibility (*Futurehype* argument)

In his 1992 book *Futurehype: The Tyranny of Prophecy*, sociologist Max Dublin points out many past failed predictions of technological progress and argues that modern futurist predictions will prove similarly inaccurate. He also objects to what he sees as scientism, fanaticism, and nihilism by a few in advancing transhumanist causes, and writes that historical parallels exist to millenarian religions and Communist doctrines. Several notable transhumanists have predicted that death-defeating technologies will arrive (usually late) within their own conventionally expected lifetimes. *Wired* magazine founding executive editor Kevin Kelly has argued these transhumanists have overly optimistic expectations of when dramatic technological breakthroughs will occur because they hope to be saved from their own deaths by those developments. Despite his sympathies for transhumanism, in his 2002 book *Redesigning Humans: Our Inevitable Genetic Future*, public health professor Gregory Stock is skeptical of the technical feasibility and mass appeal of the cyborgization of humanity predicted by Raymond Kurzweil, Hans Moravec and Kevin Warwick. He believes that throughout the 21st century, many humans will find themselves deeply integrated into systems of machines, but will remain biological. Primary changes to their own form and character will arise not from cyberware but from the direct manipulation of their genetics, metabolism, and biochemistry.

In his 2006 book *Future Hype: The Myths of Technology Change*, computer scientist and engineer Bob Seidensticker argues that today's technological achievements are not unprecedented. Exposing major myths of technology and examining the history of high tech hype, he aims to uncover inaccuracies and misunderstandings that may characterise the popular and transhumanist views of technology, to explain how and why these views have been created, and to illustrate how technological change in fact proceeds.

Those thinkers who defend the likelihood of massive technological change within a relatively short timeframe emphasize what they describe as a past pattern of exponential increases in humanity's technological capacities. This emphasis appears in the work of popular science writer Damien Broderick, notably his 1997 book, *The Spike*, which contains his speculations about a radically changed future. Kurzweil develops this

position in much detail in his 2005 book, *The Singularity Is Near*. Broderick points out that many of the seemingly implausible predictions of early science fiction writers have, indeed, come to pass, among them nuclear power and space travel to the moon. He also claims that there is a core rationalism to current predictions of very rapid change, asserting that such observers as Kurzweil have a good track record in predicting the pace of innovation.

Hubris (*Playing God* argument)

There are two distinct categories of criticism, theological and secular, that have been referred to as "playing god" arguments:

The first category is based on the alleged inappropriateness of humans substituting themselves for an actual god. This approach is exemplified by the 2002 Vatican statement *Communion and Stewardship: Human Persons Created in the Image of God,* in which it is stated that, "Changing the genetic identity of man as a human person through the production of an infrahuman being is radically immoral", implying, as it would, that "man has full right of disposal over his own biological nature". At the same time, this statement argues that creation of a superhuman or spiritually superior being is "unthinkable", since true improvement can come only through religious experience and "realizing more fully the image of God". Christian theologians and lay activists of several churches and denominations have expressed similar objections to transhumanism and claimed that Christians already enjoy, however post mortem, what radical transhumanism promises such as indefinite life extension or the abolition of suffering. In this view, transhumanism is just another representative of the long line of utopian movements which seek to immanentize the eschaton i.e. try to create "heaven on earth".

The biocomplexity spiral is a depiction of the multileveled complexity of organisms in their environments, which is seen by many critics as the ultimate obstacle to transhumanist ambition.

The second category is aimed mainly at "algeny", which Jeremy Rifkin defined as "the upgrading of existing organisms and the design of wholly new ones with the intent of 'perfecting' their performance", and, more specifically, attempts to pursue transhumanist goals by way of genetically modifying human embryos in order to create "designer babies". It emphasizes the issue of biocomplexity and the unpredictability of attempts to guide the development of products of biological evolution. This argument, elaborated in particular by the biologist Stuart Newman, is based on the recognition that the cloning and germline genetic engineering of animals are error-prone and inherently disruptive of embryonic development. Accordingly, so it is argued, it would create unacceptable risks to use such methods on human embryos. Performing experiments, particularly ones with permanent biological consequences, on developing humans, would thus be in violation of accepted principles governing research on human subjects. Moreover, because improvements in experimental outcomes in one species are not automatically transferable to a new species without further experimentation, there is claimed to be no ethical route to genetic manipulation of humans at early developmental stages.

As a practical matter, however, international protocols on human subject research may not present a legal obstacle to attempts by transhumanists and others to improve their offspring by germinal choice technology. According to legal scholar Kirsten Rabe Smolensky, existing laws would protect parents who choose to enhance their child's genome from future liability arising from adverse outcomes of the procedure.

Religious thinkers allied with transhumanist goals, such as the theologians Ronald Cole-Turner and Ted Peters, reject the first argument, holding that the doctrine of "co-creation" provides an obligation to use genetic engineering to improve human biology.

Transhumanists and other supporters of human genetic engineering do not dismiss the second argument out of hand, insofar as there is a high degree of uncertainty about the likely outcomes of genetic modification experiments in humans. However, bioethicist James Hughes suggests that one possible ethical route to the genetic manipulation of humans at early developmental stages is the building of computer models of the human genome, the proteins it specifies, and the tissue engineering he argues that it also codes for. With the exponential progress in bioinformatics, Hughes believes that a virtual model of genetic expression in the human body will not be far behind and that it will soon be possible to accelerate approval of genetic modifications by simulating their effects on virtual humans. Public health professor Gregory Stock points to artificial chromosomes as an alleged safer alternative to existing genetic engineering techniques. Transhumanists therefore argue that parents have a moral responsibility called procreative beneficence to make use of these methods, if and when they are shown to be reasonably safe and effective, to have the healthiest children possible. They add that this responsibility is a moral judgment best left to individual conscience rather than imposed by law, in all but extreme cases. In this context, the emphasis on freedom of choice is called procreative liberty.

Contempt for the flesh (*Fountain of Youth* argument)

Philosopher Mary Midgley, in her 1992 book *Science as Salvation*, traces the notion of achieving immortality by transcendence of the material human body (echoed in the transhumanist tenet of mind uploading) to a group of male scientific thinkers of the early 20th century, including J.B.S. Haldane and members of his circle. She characterizes these ideas as "quasi-scientific dreams and prophesies" involving visions of escape from the body coupled with "self-indulgent, uncontrolled power-fantasies". Her argument focuses on what she perceives as the pseudoscientific speculations and irrational, fear-of-death-driven fantasies of these thinkers, their disregard for laymen, and the remoteness of their eschatological visions. Some transhumanists see the 2006 film *The Fountain*'s theme of thanatophobia and critique of the quixotic quest for eternal youth as depicting some of these criticisms.

What is perceived as contempt for the flesh in the writings of Marvin Minsky, Hans Moravec, and some transhumanists, has also been the target of other critics for what they claim to be an instrumental conception of the human body. Reflecting a strain of feminist criticism of the transhumanist program, philosopher Susan Bordo points to "contemporary obsessions with slenderness, youth, and physical perfection", which she sees as affecting both men and women, but in distinct ways, as "the logical (if extreme) manifestations of anxieties and fantasies fostered by our culture." Some critics question other social implications of the movement's focus on body modification. Political scientist Klaus-Gerd Giesen, in particular, has asserted that transhumanism's concentration on altering the human body represents the logical yet tragic consequence of atomized individualism and body commodification within a consumer culture.

Nick Bostrom asserts that the desire to regain youth, specifically, and transcend the natural limitations of the human body, in general, is pan-cultural and pan-historical, and is therefore not uniquely tied to the culture of the 20th century. He argues that the transhumanist program is an attempt to channel that desire into a scientific project on par with the Human Genome Project and achieve humanity's oldest hope, rather than a puerile fantasy or social trend.

Trivialization of human identity (*Enough* argument)

In the US, the Amish are a religious group probably most known for their avoidance of certain modern technologies. Transhumanists draw a parallel by arguing that in the near-future there will probably be "Humanish", people who choose to "stay human" by not adopting human enhancement technologies, whose choice they believe must be respected and protected.

In his 2003 book *Enough: Staying Human in an Engineered Age*, environmental ethicist Bill McKibben argued at length against many of the technologies that are postulated or supported by transhumanists, including germinal choice technology, nanomedicine and life extension strategies. He claims that it would be morally wrong for humans to tamper with fundamental aspects of themselves (or their children) in an attempt to overcome universal human limitations, such as vulnerability to aging, maximum life span, and biological constraints on physical and cognitive ability. Attempts to "improve" themselves through such manipulation would remove limitations that provide a necessary context for the experience of meaningful human choice. He claims that human lives would no longer seem meaningful in a world where such limitations could be overcome technologically. Even the goal of using germinal choice technology for clearly *therapeutic* purposes should be relinquished, since it would inevitably produce temptations to tamper with such things as cognitive capacities. He argues that it is possible for societies to benefit from renouncing particular technologies, using as examples Ming China, Tokugawa Japan and the contemporary Amish.

Transhumanists and other supporters of technological alteration of human biology, such as science journalist Ronald Bailey, reject as extremely subjective the claim that life

would be experienced as meaningless if some human limitations are overcome with enhancement technologies. They argue that these technologies will not remove the bulk of the individual and social challenges humanity faces. They suggest that a person with greater abilities would tackle more advanced and difficult projects and continue to find meaning in the struggle to achieve excellence. Bailey also claims that McKibben's historical examples are flawed, and support different conclusions when studied more closely. For example, few groups are more cautious than the Amish about embracing new technologies, but though they shun television and use horses and buggies, some are welcoming the possibilities of gene therapy since inbreeding has afflicted them with a number of rare genetic diseases.

Genetic divide (*Gattaca* argument)

Some critics of libertarian transhumanism have focused on its likely socioeconomic consequences in societies in which divisions between rich and poor are on the rise. Bill McKibben, for example, suggests that emerging human enhancement technologies would be disproportionately available to those with greater financial resources, thereby exacerbating the gap between rich and poor and creating a "genetic divide". Lee M. Silver, a biologist and science writer who coined the term "reprogenetics" and supports its applications, has nonetheless expressed concern that these methods could create a two-tiered society of genetically engineered "haves" and "have nots" if social democratic reforms lag behind implementation of enhancement technologies. Critics who make these arguments do not thereby necessarily accept the transhumanist assumption that human enhancement is a positive value; in their view, it should be discouraged, or even banned, because it could confer additional power upon the already powerful. The 1997 film *Gattaca*'s depiction of a dystopian society in which one's social class depends entirely on genetic modifications is often cited by critics in support of these views.

These criticisms are also voiced by non-libertarian transhumanist advocates, especially self-described democratic transhumanists, who believe that the majority of current or future social and environmental issues (such as unemployment and resource depletion) need to be addressed by a combination of political and technological solutions (such as a guaranteed minimum income and alternative technology). Therefore, on the specific issue of an emerging genetic divide due to unequal access to human enhancement technologies, bioethicist James Hughes, in his 2004 book *Citizen Cyborg: Why Democratic Societies Must Respond to the Redesigned Human of the Future*, argues that progressives or, more precisely, techno-progressives must articulate and implement public policies (such as a universal health care voucher system that covers human enhancement technologies) in order to attenuate this problem as much as possible, rather than trying to ban human enhancement technologies. The latter, he argues, might actually worsen the problem by making these technologies unsafe or available only to the wealthy on the local black market or in countries where such a ban is not enforced.

Threats to morality and democracy (*Brave New World* argument)

Various arguments have been made to the effect that a society that adopts human enhancement technologies may come to resemble the dystopia depicted in the 1932 novel *Brave New World* by Aldous Huxley. Sometimes, as in the writings of Leon Kass, the fear is that various institutions and practices judged as fundamental to civilized society would be damaged or destroyed. In his 2002 book *Our Posthuman Future* and in a 2004 *Foreign Policy* magazine article, political economist and philosopher Francis Fukuyama designates transhumanism the world's most dangerous idea because he believes that it may undermine the egalitarian ideals of democracy in general and liberal democracy in particular, through a fundamental alteration of "human nature". Social philosopher Jürgen Habermas makes a similar argument in his 2003 book *The Future of Human Nature*, in which he asserts that moral autonomy depends on not being subject to another's unilaterally imposed specifications. Habermas thus suggests that the human "species ethic" would be undermined by embryo-stage genetic alteration. Critics such as Kass, Fukuyama, and a variety of Christian authors hold that attempts to significantly alter human biology are not only inherently immoral but also threats to the social order. Alternatively, they argue that implementation of such technologies would likely lead to the "naturalizing" of social hierarchies or place new means of control in the hands of totalitarian regimes. The AI pioneer Joseph Weizenbaum criticizes what he sees as misanthropic tendencies in the language and ideas of some of his colleagues, in particular Marvin Minsky and Hans Moravec, which, by devaluing the human organism per se, promotes a discourse that enables divisive and undemocratic social policies.

In a 2004 article in *Reason,* science journalist Ronald Bailey has contested the assertions of Fukuyama by arguing that political equality has never rested on the facts of human biology. He asserts that liberalism was founded not on the proposition of effective equality of human beings, or *de facto* equality, but on the assertion of an equality in political rights and before the law, or *de jure* equality. Bailey asserts that the products of genetic engineering may well ameliorate rather than exacerbate human inequality, giving to the many what were once the privileges of the few. Moreover, he argues, "the crowning achievement of the Enlightenment is the principle of tolerance". In fact, he argues, political liberalism is already the solution to the issue of human and posthuman rights since, in liberal societies, the law is meant to apply equally to all, no matter how rich or poor, powerful or powerless, educated or ignorant, enhanced or unenhanced. Other thinkers who are sympathetic to transhumanist ideas, such as philosopher Russell Blackford, have also objected to the appeal to tradition, and what they see as alarmism, involved in *Brave New World*-type arguments.

Dehumanization (*Frankenstein* argument)

Australian artist Patricia Piccinini's concept of what human-animal hybrids might look like are provocative creatures which are part of a sculpture entitled *The Young Family*, produced to address the reality of such possible parahumans in a compassionate way. Transhumanists would call for the recognition of self-aware parahumans as persons.

Biopolitical activist Jeremy Rifkin and biologist Stuart Newman accept that biotechnology has the power to make profound changes in organismal identity. They argue against the genetic engineering of human beings, because they fear the blurring of the boundary between human and artifact. Philosopher Keekok Lee sees such developments as part of an accelerating trend in modernization in which technology has been used to transform the "natural" into the "artifactual". In the extreme, this could lead to the manufacturing and enslavement of "monsters" such as human clones, human-animal chimeras or bioroids, but even lesser dislocations of humans and non-humans from social and ecological systems are seen as problematic. The film *Blade Runner* (1982), the novels *The Boys From Brazil* (1978) and *The Island of Dr. Moreau* (1896) depict elements of such scenarios, but Mary Shelley's 1818 novel *Frankenstein* is most often alluded to by critics who suggest that biotechnologies could create objectified and socially unmoored people and subhumans. Such critics propose that strict measures be implemented to prevent what they portray as dehumanizing possibilities from ever happening, usually in the form of an international ban on human genetic engineering.

Writing in *Reason* magazine, Ronald Bailey has accused opponents of research involving the modification of animals as indulging in alarmism when they speculate about the creation of subhuman creatures with human-like intelligence and brains resembling those of Homo sapiens. Bailey insists that the aim of conducting research on animals is simply to produce human health care benefits.

A different response comes from transhumanist personhood theorists who object to what they characterize as the anthropomorphobia fueling some criticisms of this research, which science writer Isaac Asimov termed the "Frankenstein complex". They argue that,

provided they are self-aware, human clones, human-animal chimeras and uplifted animals would all be unique persons deserving of respect, dignity, rights and citizenship. They conclude that the coming ethical issue is not the creation of so-called monsters but what they characterize as the "yuck factor" and "human-racism" that would judge and treat these creations as monstrous.

Specter of coercive eugenicism (*Eugenics Wars* argument)

Some critics of transhumanism allege an ableist bias in the use of such concepts as "limitations", "enhancement" and "improvement". Some even see the old eugenics, social Darwinist and master race ideologies and programs of the past as warnings of what the promotion of eugenic enhancement technologies might unintentionally encourage. Some fear future "eugenics wars" as the worst-case scenario: the return of coercive state-sponsored genetic discrimination and human rights violations such as compulsory sterilization of persons with genetic defects, the killing of the institutionalized and, specifically, segregation from, and genocide of, "races" perceived as inferior. Health law professor George Annas and technology law professor Lori Andrews are prominent advocates of the position that the use of these technologies could lead to such human-posthuman caste warfare.

For most of its history, eugenics has manifested itself as a movement to sterilize against their will the "genetically unfit" and encourage the selective breeding of the genetically fit. The major transhumanist organizations strongly condemn the coercion involved in such policies and reject the racist and classist assumptions on which they were based, along with the pseudoscientific notions that eugenic improvements could be accomplished in a practically meaningful time frame through selective human breeding. Most transhumanist thinkers instead advocate a "new eugenics", a form of egalitarian liberal eugenics. In their 2000 book *From Chance to Choice: Genetics and Justice*, (non-transhumanist) bioethicists Allen Buchanan, Dan Brock, Norman Daniels and Daniel Wikler have argued that liberal societies have an obligation to *encourage* as wide an adoption of eugenic enhancement technologies as possible (so long as such policies do not infringe on individuals' reproductive rights or exert undue pressures on prospective parents to use these technologies) in order to maximize public health and minimize the inequalities that may result from both natural genetic endowments and unequal access to genetic enhancements. Most transhumanists holding similar views nonetheless distance themselves from the term "eugenics" (preferring "germinal choice" or "reprogenetics") to avoid having their position confused with the discredited theories and practices of early-20th-century eugenic movements.

Existential risks (*Terminator* argument)

Struck by a passage from Unabomber Theodore Kaczynski's anarcho-primitivist manifesto (quoted in Ray Kurzweil's 1999 book, *The Age of Spiritual Machines*), computer scientist Bill Joy became a notable critic of emerging technologies. Joy's 2000 essay "Why the future doesn't need us" argues that human beings would likely guarantee their own extinction by developing the technologies favored by transhumanists. It

invokes, for example, the "grey goo scenario" where out-of-control self-replicating nanorobots could consume entire ecosystems, resulting in global ecophagy. Joy's warning was seized upon by appropriate technology organizations such as the ETC Group. Related notions were also voiced by self-described neo-luddite Kalle Lasn, a culture jammer who co-authored a 2001 spoof of Donna Haraway's 1985 *Cyborg Manifesto* as a critique of the techno-utopianism he interpreted it as promoting. Lasn argues that high technology development should be completely relinquished since it inevitably serves corporate interests with devastating consequences on society and the environment.

In his 2003 book *Our Final Hour*, British Astronomer Royal Martin Rees argues that advanced science and technology bring as much risk of disaster as opportunity for progress. However, Rees does not advocate a halt to scientific activity; he calls for tighter security and perhaps an end to traditional scientific openness. Advocates of the precautionary principle, such as many in the environmental movement, also favor slow, careful progress or a halt in potentially dangerous areas. Some precautionists believe that artificial intelligence and robotics present possibilities of alternative forms of cognition that may threaten human life. The *Terminator* franchise's doomsday depiction of the emergence of an A.I. that becomes a superintelligence - Skynet, a malignant computer network which initiates a nuclear war in order to exterminate the human species, has often been cited by some involved in this debate.

Transhumanists do not necessarily rule out specific restrictions on emerging technologies so as to lessen the prospect of existential risk. Generally, however, they counter that proposals based on the precautionary principle are often unrealistic and sometimes even counter-productive, as opposed to the technogaian current of transhumanism which they claim is both realistic and productive. In his television series *Connections*, science historian James Burke dissects several views on technological change, including precautionism and the restriction of open inquiry. Burke questions the practicality of some of these views, but concludes that maintaining the *status quo* of inquiry and development poses hazards of its own, such as a disorienting rate of change and the depletion of our planet's resources. The common transhumanist position is a pragmatic one where society takes deliberate action to ensure the early arrival of the benefits of safe, clean, alternative technology rather than fostering what it considers to be anti-scientific views and technophobia.

One transhumanist solution proposed by Nick Bostrom is differential technological development, in which attempts would be made to influence the sequence in which technologies developed. In this approach, planners would strive to retard the development of possibly harmful technologies and their applications, while accelerating the development of likely beneficial technologies, especially those that offer protection against the harmful effects of others. An argument for an "anti-progressionist and pessimistic version of transhumanism" has also been presented by Philippe Verdoux.

Chapter- 8

Other Theories of Technology

Technological revival

Definition of the concept

The **technological revival** concept, which can also be called technological reminiscence, consists in using the technology of today to bring back to life the technological contents of yesterday.

Applicability of the technological revival concept

The technological revival concept lies within the idea of a certain nostalgia of the multimedia contents of yesterday (Radio, television, video games...) It expresses itself fully with the rising coming of Web 2.0. It can take various forms:

- To use the high-tech possibilities to make rebirth radiophonic or televisual programs of yesterday. The Internet high flow authorizes,now, this practice on a general basis. As a matter of fact, the vintage multimedias contents are relatively easy to digitize, so that they can, then, being downloaded (NB: respect of the royalties)

EX: Setting on line on Internet, some old television programs.

- To connect a technological system of yesterday with a system of today.

EX: To connect a video game console of the 1st generation (Standard Nintendo Nes 8 bytes) on a video projector, a plasma screen...

Technical terms related to the technological revival

VHS RIP: Televisual program setted on line at the disposal of the Net surfers and whose native source of recording comes from the VHS standard (analogical)

Radio RIP: Radiophonic program setted on line at the disposal of the Net surfers and whose native source of recording comes from a radio set.

Limits of application

The technological revival works rather well with multimedia contents dating from the 90's, 80's or 70's. Beyond that, it becomes difficult to combine revival technological and quality.

Technology management

Technology Management is set of management disciplines that allows organizations to manage its technological fundamentals to create competitive advantage. Typical concepts used in technology management are technology strategy (a logic or role of technology in organization), technology forecasting (identification of possible relevant technologies for the organization, possibly through technology scouting), technology roadmapping (mapping technologies to business and market needs), technology project portfolio (a set of projects under development) and technology portfolio (a set of technologies in use).

The role of the technology management function in an organization is understand the value of certain technology for the organization. Continuous development of technology is valuable as long as there is a value for the customer and therefore the technology management function in an organization should be able to argue when to invest on technology development and when to withdraw.

Technology Management can also be defined as the integrated planning, design, optimization, operation and control of technological products, processes and services, a better definition would be the management of the use of technology for human advantage.

The *Association of Technology, Management, and Applied Engineering* defines **Technology Management** as the field concerned with the supervision of personnel across the technical spectrum and a wide variety of complex technological systems. Technology Management programs typically include instruction in production and operations management, project management, computer applications, quality control, safety and health issues, statistics, and general management principles.

Perhaps the most authoritative input to our understanding of technology is the diffusion of innovations theory developed in the first half of the twentieth century. It suggests that all innovations follow a similar diffusion pattern - best known today in the form of an "s" curve though originally based upon the concept of a standard distribution of adopters. In

broad terms the "s" curve suggests four phases of a technology life cycle - *emerging*, *growth*, *mature* and *aging*.

These four phases are coupled to increasing levels of acceptance of an innovation or, in our case a new technology. In recent times for many technologies an inverse curve - which corresponds to a declining cost per unit - has been postulated. This may not prove to be universally true though for information technology where much of the cost is in the initial phase it has been a reasonable expectation.

The second major contribution to this area is the Carnegie Mellon Capability Maturity Model. This model proposes that a series of progressive capabilities can be quantified through a set of threshold tests. These tests determine *repeatability*, *definition*, *management* and *optimization*. The model suggests that any organization has to master one level before being able to proceed to the next.

The third significant contribution comes from Gartner - the research service, it is the hype cycle, this suggests that our modern approach to marketing technology results in the technology being over hyped in the early stages of growth.

Taken together these concepts provide a foundation for formalizing the approach to managing technology.

Strategy of Technology

The **Strategy of Technology** doctrine involves a country using its advantage in technology to create and deploy weapons of sufficient power and numbers so as to overawe or beggar its opponents, forcing them to spend their limited resources on developing hi-tech countermeasures and straining their economy.

The Strategy of Technology is described in the eponymous book written by Stefan T. Possony and Jerry Pournelle in 1970. This was required reading in the U.S. service academies, the Air War College, and the National War College during the latter half of the Cold War.

Cold War

The classic example of the successful deployment of this strategy was the nuclear build-up between the U.S. and U.S.S.R. during the Cold War.

Some observers believe that the Vietnam War was a necessary attritive component to this war — Soviet industrial capacity was diverted to conventional arms in North Vietnam, rather than development of new weapons and nuclear weapons — but evidence would

need to be found that the then-current administration of the US saw it thus. Current consensus and evidence holds that it was but a failed defensive move in the Cold War, in the context of the Domino Doctrine.

The coup-de-grace is variously opined to be Stealth technology especially as embodied in the cruise missile, which would have required an unattainable number of installations to secure the Soviet border; the Gulf War, which proved stealth and easily overcame Soviet-doctrine Iraqi forces; or Ronald Reagan's Strategic Defense Initiative, a clear attempt to obsolesce the Soviet nuclear arsenal, creating an immense expense for the Soviets to maintain parity.

Opposing views and controversies

It is argued that the strategy was not a great success in the Cold War; that the Soviet Union did little to try to keep up with the SDI system, and that the War in Afghanistan caused a far greater drain on Soviet resources. However, the Soviets spent a colossal amount of money on their *Buran* space shuttle in an attempt to compete with a perceived military threat from the American Space Shuttle program, which was to be used in the SDI.

There is a further consideration. It is not seriously in doubt that despite the excellent education and training of Soviet technologists and scientists, it was the nations of Europe and North America, in particular the United States, which made most of the running in technical development.

The Soviet Union did have some extraordinary technical breakthroughs of their own. For example: the 15% efficiency advantage of Soviet rocket engines which used exhaust gases to power the fuel pumps, or of the Squall supersonic cavitation torpedo. It was also able to use both its superlative espionage arm and the inherent ability of central planning to concentrate resources to great effect.

But the United States found a way to use its opponent's strengths for its own purposes. In the late 1990s, it emerged that many stolen technological secrets were funnelled by an arm of American intelligence to the Soviet Union. The documents were real. They were of versions of the product which contained a critical but not obvious flaw.

Such was the complexity and depth of the stolen secrets that to check them would have required an effort almost as great as developing a similar product from scratch. Such an effort was possible in nations of the West because the cost could be defrayed by commercial sales. In Soviet states this was not an option. This sort of technological jiu-jitsu may set the pattern of future engagements.

Technocentrism

Technocentrism is a term that denotes a value system that is centred on technology and its ability to affect, control and protect the environment. Technocentrics have absolute faith in technology and industry and firmly believe that humans have control over nature. Although technocentrics may accept that environmental problems exist, they do not see them as problems to be solved by a reduction in industry. Rather, environmental problems are seen as problems to be solved using science and technology. Indeed, technocentrics see the way forward for both developed and developing countries, and the solutions to environmental problems, as lying in scientific and technological advancement (sometimes referred to as sustainopreneurship).

Technocentrism is often contrasted with ecocentrism. Ecocentrics, including deep ecologists, see themselves as being subject to nature, rather than in control of it. They lack faith in modern technology and the bureaucracy attached to it. Ecocentrics will argue that the natural world should be respected for its processes and products, and that low impact technology and self-sufficiency is more desirable than technological control of nature.

Origin of term

The term was claimed to have been coined by Seymour Papert in 1987 as a combination of *techno*- and *egocentrism*:

I coined the word technocentrism from Piaget's use of the word egocentrism. This does not imply that children are selfish, but simply means that when a child thinks, all questions are referred to the self, to the ego. Technocentrism is the fallacy of referring all questions to the technology.

However, references to technocentrism date back well before this (see, for example and). Among the earliest references cited by O'Riordan in his book "Environmentalism" (which includes extensive discussion of ecocentric and technocentric modes of thought) is that of Hays in 1959 where technocentrism is characterised as:

The application of rational and 'value-free' scientific and managerial techniques by a professional elite, who regarded the natural environment as 'neutral stuff' from which man could profitably shape his destiny.

Technocracy

Technocracy is a form of government in which engineers, scientists, health professionals and other technical experts are in control of decision making in their respective fields. The term *technocracy* derives from the Greek words *tekhne* meaning *skill* and *kratos* meaning *power*, as in *government*, or *rule*. Thus the term technocracy denotes a system of government where those who have knowledge, expertise or skills compose the governing body. In a technocracy decision makers would be selected based upon how highly knowledgeable they are, rather than how much political capital they hold.

Technocrats are individuals with technical training and occupations who perceive many important societal problems as being solvable, often while proposing technology-focused solutions. The administrative scientist Gunnar K. A. Njalsson theorizes that technocrats are primarily driven by their cognitive "problem-solution mindsets" and only in part by particular occupational group interests. Their activities and the increasing success of their ideas are thought to be a crucial factor behind the modern spread of technology and the largely ideological concept of the "Information society." Technocrats may be distinguished from "econocrats" and "bureaucrats" whose problem-solution mindsets differ from those of the technocrats.

In all cases technical and leadership skills are selected through bureaucratic processes on the basis of specialized knowledge and performance, rather than democratic elections. Some forms of technocracy are a form of meritocracy, a system where the "most qualified" and those who decide the validity of qualifications are the same people. Other forms have been described as not being an oligarchic human group of controllers, but rather an administration by science without the influence of special interest groups.

Precursors and related concepts

Before the term technocracy was coined technocratic or quasi-technocratic ideas involving governance by technical experts were promoted by various individuals, most notably early socialist theorists such as Henri de Saint-Simon. This was expressed by the belief in state ownership over the economy, with the function of the state being transformed from one of political rule over men into a scientific administration of things and a direction of processes of production under scientific management. Scientific socialist theorist Friedrich Engels had a similar view; the state would die out and ceases to be a state when the government of people and interference in social affairs is replaced by an administration of things and technical processes.

The American economist Thorstein Veblen was an early advocate of technocracy, and was involved in the Technical Alliance as was Howard Scott and M. King Hubbert. Veblen believed that technological developments would eventually lead toward a socialistic organization of economic affairs. Veblen saw socialism as one intermediate phase in an ongoing evolutionary process in society that would be brought about by the

natural decay of the business enterprise system and by the inventiveness of engineers. Daniel Bell sees an affinity between Veblen and the Technocracy movement.

Development of the term

William Henry Smyth, a Californian engineer, invented the word "technocracy" in 1919 to describe "the rule of the people made effective through the agency of their servants, the scientists and engineers". Smyth used the term "Technocracy" in his 1919 article "'Technocracy'—Ways and Means to Gain Industrial Democracy," in the journal *Industrial Management* (57). However, Smyth's usage referred to Industrial democracy: a movement to integrate workers into decision making through existing firms or revolution. The term came to mean government by technical decision making in 1932.

Technocracy and engineering

Technocracy is one solution to a problem faced by engineers in the early twentieth century. Following Samuel Haber Donald Stabile argues that engineers were faced with a conflict between physical efficiency and cost efficiency in the new corporate capitalist enterprises of the late nineteenth century United States. Profit-conscious, non-technical managers of firms where the engineers work, because of their perceptions of market demand, often impose limits on the projects that engineers desire to undertake.

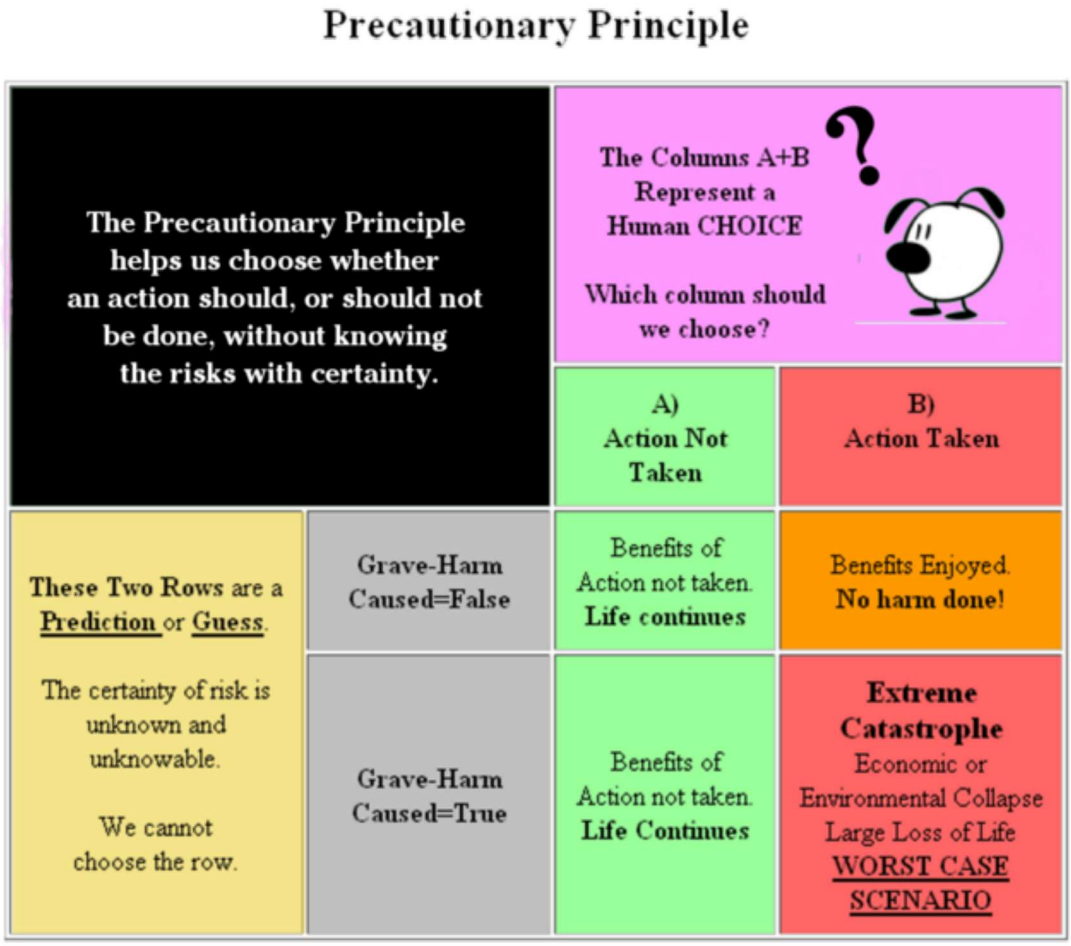
The prices of all inputs vary with market forces thereby upsetting the engineer's careful calculations. As a result, the engineer loses control over projects and must continually revise plans. To keep control over projects the engineer must attempt to exert control over these outside variables and transform them into constant factors.

Technocracy and world politics

The Indian Prime Minister Dr. Manmohan Singh is said to be a technocrat.

Chapter- 9

Precautionary Principle



The Precautionary Principle illustrated as a decision matrix

The **precautionary principle** states that if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is harmful, the burden of proof that it is *not* harmful falls on those taking the action.

This principle allows policy makers to make discretionary decisions in situations where there is the possibility of harm from taking a particular course or making a certain decision when extensive scientific knowledge on the matter is lacking. The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result.

In some legal systems, as in the law of the European Union, the application of the precautionary principle has been made a statutory requirement.

Formulations of the precautionary principle

Many definitions of the precautionary principle exist. Precaution may be defined as "*caution in advance*," "*caution practised in the context of uncertainty*," or *informed prudence*. All definitions have two key elements.

1. an expression of a need by decision-makers to anticipate harm before it occurs. Within this element lies an implicit reversal of the onus of proof: under the precautionary principle it is the responsibility of an activity proponent to establish that the proposed activity will not (or is very unlikely to) result in significant harm.
2. the establishment of an obligation, if the level of harm may be high, for action to prevent or minimise such harm even when the absence of scientific certainty makes it difficult to predict the likelihood of harm occurring, or the level of harm should it occur. The need for control measures increases with both the level of possible harm and the degree of uncertainty.

One of the primary foundations of the precautionary principle, and globally accepted definitions, results from the work of the Rio Conference, or "Earth Summit" in 1992. Principle #15 of the Rio Declaration notes:

"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

This definition is important for several reasons. First, it explains the idea that scientific uncertainty should not preclude preventative measures to protect the environment. Second, the use of "cost-effective" measures indicates that costs can be considered. This is different from a "no-regrets" approach, which ignores the costs of preventative action.

The 1998 Wingspread Statement on the Precautionary Principle summarizes the principle this way: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are

not fully established scientifically." (The Wingspread Conference on the Precautionary Principle was convened by the Science and Environmental Health Network).

The February 2, 2000 European Commission Communication on the Precautionary Principle notes: "The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU".

The January 29, 2000 Cartagena Protocol on Biosafety says: "Lack of scientific certainty due to insufficient relevant scientific information . . . shall not prevent the Party of import, in order to avoid or minimize such potential adverse effects, from taking a decision, as appropriate, with regard to the import of the living modified organism in question."

It is important to emphasize that, although this principle operates in the context of scientific uncertainty, it is considered by its proponents to be applicable only when, on the basis of the best scientific advice available, there is good reason to believe that harmful effects might occur.

The precautionary principle is most often applied in the context of the impact of human actions on the environment and human health, as both involve complex systems where the consequences of actions may be unpredictable.

As applied to environmental policy, the precautionary principle stipulates that for practices such as the release of radiation or toxins or massive deforestation the burden of proof lies with the advocates. Concerning potential risks to public health, examples of cases in which the precautionary principle has been advocated (but not always accepted) are: the commercialization of genetically modified foods, the use of growth hormones in cattle raising, measures to prevent the "mad cow" disease, health claims linked to phthalates in PVC toys, among many others.

An important element of the precautionary principle is that its most meaningful applications pertain to those that are potentially irreversible, for example where biodiversity may be reduced. With respect to bans on substances like mercury in thermometers, freon in refrigeration, or even carbon dioxide exhaust from automobile engines and power plants, it implies:

... a willingness to take action in advance of scientific proof [or] evidence of the need for the proposed action on the grounds that further delay will prove ultimately most costly to society and nature, and, in the longer term, selfish and unfair to future generations.

The concept includes an implicit ethical responsibility towards maintaining the integrity of natural systems, and acknowledges the fallibility of human understanding.

Some environmental commentators take a more stringent interpretation of the precautionary principle, stating that proponents of a new potentially harmful technology must show the new technology is without major harm before the new technology is used.

Origins and theory

The formal concept evolved out of the German socio-legal tradition in the 1930s, centering on the concept of good household management. In German the concept is *Vorsorgeprinzip*, which translates into English as *precaution principle*.

Many of the concepts underpinning the precautionary principle pre-date the term's inception. For example, the essence of the principle is captured in a number of cautionary aphorisms such as "an ounce of prevention is worth a pound of cure", "better safe than sorry", and "look before you leap". The precautionary principle may also be interpreted as the evolution of the ancient medical principle of "first, do no harm" to apply to institutions and institutional decision-making processes rather than individuals.

The precautionary principle is in some ways an expansion of the English common law concept of ‘duty of care’ originating in the decisions of the judge Lord Esher in the late 1800s. According to Lord Esher: “Whenever one person is by circumstances placed in such a position with regard to another that everyone of ordinary sense who did think, would at once recognise that if he did not use ordinary care and skill in his own conduct with regard to those circumstances, he would cause danger or injury to the person, or property of the other, a duty arises to use ordinary care and skill to avoid such danger”. This statement clearly contains elements of foresight and responsibility, but does not refer to a lack of certainty, as the word “would” is used rather than “might”, or “could”. The other important difference is that the duty of care applies only to people and property, not to the environment.

In economics, the precautionary principle has been analysed in terms of the effect on rational decision-making of the interaction of irreversibility and uncertainty. Authors such as Epstein (1980) and Arrow and Fischer (1974) show that irreversibility of possible future consequences creates a quasi-option effect which should induce a "risk-neutral" society to favor current decisions that allow for more flexibility in the future. Gollier et al. (2000) conclude that "more scientific uncertainty as to the distribution of a future risk– that is, a larger variability of beliefs– should induce Society to take stronger prevention measures today."

Application

The application of the precautionary principle is hampered by both lack of political will, as well as the wide range of interpretations placed on it. One study identified 14 different

formulations of the principle in treaties and nontreaty declarations. R.B. Stewart (2002) reduced the precautionary principle to four basic versions:

1. Scientific uncertainty should not automatically preclude regulation of activities that pose a potential risk of significant harm (Non-Preclusion PP).
2. Regulatory controls should incorporate a margin of safety; activities should be limited below the level at which no adverse effect has been observed or predicted (Margin of Safety PP).
3. Activities that present an uncertain potential for significant harm should be subject to best technology available requirements to minimize the risk of harm unless the proponent of the activity shows that they present no appreciable risk of harm (BAT PP).
4. Activities that present an uncertain potential for significant harm should be prohibited unless the proponent of the activity shows that it presents no appreciable risk of harm (Prohibitory PP).

In deciding how to apply the principle, analysis may use a cost-benefit analysis that factors in both the opportunity cost of not acting, and the option value of waiting for further information before acting. One of the difficulties of the application of the principle in modern policy-making is that there is often an irreducible conflict between different interests, so that the debate necessarily involves politics.

Strong vs. weak

Strong precaution holds that regulation is required whenever there is a possible risk to health, safety, or the environment, even if the supporting evidence is speculative and even if the economic costs of regulation are high. In 1982, the United Nations World Charter for Nature gave the first international recognition to the strong version of the principle, suggesting that when "potential adverse effects are not fully understood, the activities should not proceed." The widely publicized Wingspread Declaration, from a meeting of environmentalists in 1998, is another example of the strong version. 'Strong precaution' can also be termed as a "no-regrets" principle, where costs are not considered in preventative action.

Weak precaution holds that lack of scientific evidence does not preclude action if damage would otherwise be serious and irreversible. Humans practice weak precaution every day, and often incur costs, to avoid hazards that are far from certain: we do not walk in moderately dangerous areas at night, we exercise, we buy smoke detectors, we buckle our seatbelts.

According to a publication by the New Zealand Treasury Department,

The weak version [of the Precautionary Principle] is the least restrictive and allows preventive measures to be taken in the face of uncertainty, but does not require them (eg, Rio Declaration 1992; United Nations Framework Convention of Climate Change 1992). To satisfy the threshold of harm, there must be some evidence relating to both the

likelihood of occurrence and the severity of consequences. Some, but not all, require consideration of the costs of precautionary measures. Weak formulations do not preclude weighing benefits against the costs. Factors other than scientific uncertainty, including economic considerations, may provide legitimate grounds for postponing action. Under weak formulations, the requirement to justify the need for action (the burden of proof) generally falls on those advocating precautionary action. No mention is made of assignment of liability for environmental harm.

Strong versions justify or require precautionary measures and some also establish liability for environmental harm, which is effectively a strong form of "polluter pays". For example, the Earth Charter states: "When knowledge is limited apply a precautionary approach …. Place the burden of proof on those who argue that a proposed activity will not cause significant harm, and make the responsible parties liable for environmental harm." Reversal of proof requires those proposing an activity to prove that the product, process or technology is sufficiently "safe" before approval is granted. Requiring proof of "no environmental harm" before any action proceeds implies the public is not prepared to accept any environmental risk, no matter what economic or social benefits may arise (Peterson, 2006). At the extreme, such a requirement could involve bans and prohibitions on entire classes of potentially threatening activities or substances (Cooney, 2005). Over time, there has been a gradual transformation of the precautionary principle from what appears in the Rio Declaration to a stronger form that arguably acts as restraint on development in the absence of firm evidence that it will do no harm.

International agreements and declarations

The World Charter for Nature, which was adopted by the UN General Assembly in 1982, was the first international endorsement of the precautionary principle. The principle was implemented in an international treaty as early as the 1987 Montreal Protocol, and among other international treaties and declarations is reflected in the 1992 Rio Declaration on Environment and Development (signed at the United Nations Conference on Environment and Development).

"Principle" vs. "approach"

No introduction to the precautionary principle would be complete without brief reference to the difference between the precautionary **principle** and the precautionary **approach**. Principle 15 of the Rio Declaration 1992 states that: "in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation." As Garcia (1995) pointed out, "the wording, largely similar to that of the principle, is subtly different in that: (1) it recognizes that there may be differences in local capabilities to apply the approach, and (2) it calls for cost-effectiveness in applying the approach, e.g., taking economic and social costs into account." The 'approach' is generally considered a softening of the 'principle'.

"As Recuerda has noted, the distinction between the ´precautionary principle` and a ´precautionary approach` is diffuse and, in some contexts, controversial. In the negotiations of international declarations, the United States has opposed the use of the term ´principle` because this term has special connotations in legal language, due to the fact that a ´principle of law` is a source of law. This means that it is compulsory, so a court can quash or confirm a decision through the application of the precautionary principle. In this sense, the precautionary principle is not a simple idea or a desideratum but a source of law. This is the legal status of the precautionary principle in the European Union. On the other hand, an ´approach` usually does not have the same meaning,16 although in some particular cases an approach could be binding. A precautionary approach is a particular ´lens` used to identify risk that every prudent person possesses (Recuerda, 2008)

European Commission

On 2 February 2000, the European Commission issued a Communication on the precautionary principle, in which it adopted a procedure for the application of this concept, but without giving a detailed definition of it. Paragraph 2 of article 191 of the Lisbon Treaty states that

"Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay."

After the adoption of the European Commission's Communication on the precautionary principle, the principle has come to inform much EU policy, including that in areas beyond that of environmental policy. It is implemented, for example, in the EU food law and also affects, among others, policies relating to consumer protection, trade and research, and technological development. While a comprehensive definition of the precautionary principle was never formally adopted by the EU, a working definition and implementation strategy for the EU context has been proposed by Rene von Schomberg in Fisher et al. (2006):

"Where, following an assessment of available scientific information, there are reasonable grounds for concern for the possibility of adverse effects but scientific uncertainty persists, provisional risk management measures based on a broad cost/benefit analysis whereby priority will be given to human health and the environment, necessary to ensure the chosen high level of protection in the Community and proportionate to this level of protection, may be adopted, pending further scientific information for a more comprehensive risk assessment, without having to wait until the reality and seriousness of those adverse effects become fully apparent".

USA

On July 18, 2005, the City of San Francisco passed a Precautionary Principle Purchasing ordinance, which requires the city to weigh the environmental and health costs of its $600 million in annual purchases – for everything from cleaning supplies to computers. Members of the Bay Area Working Group on the Precautionary Principle including the Breast Cancer Fund, helped bring this to fruition.

Japan

In 1997, Japan tried to use the consideration of the precautionary principle in a WTO SPS Agreement on the Application of Sanitary and Phytosanitary Measures case, as Japan's requirement to test each variety of agricultural products (apples, cherries, peaches, walnuts, apricots, pears, plums and quinces) for the efficacy of treatment against codling moths was challenged.

This moth is a pest that does not occur in Japan, and whose introduction has the potential to cause serious damage. The United States claimed that it was not necessary to test each variety of a fruit for the efficacy of the treatment, and that this varietal testing requirement was unnecessarily burdensome.

Australia

The most important Australian court case so far, due to its exceptionally detailed consideration of the precautionary principle, is Telstra Corporation Limited v Hornsby Shire Council. The case was heard in the New South Wales Land and Environment Court under Justice CJ Preston (24 April 2006).

The Principle was summarised by reference to the NSW *Protection of the Environment Administration Act 1991*, which itself provides a good definition of the principle:

"If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reasoning for postponing measures to prevent environmental degradation. In the application of the principle… decisions should be guided by: (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and (ii) an assessment of risk-weighted consequence of various options".

The most significant points of Justice Preston's decision are the following findings:

1. The principle and accompanying need to take precautionary measures is "triggered" when two prior conditions exist: a threat of serious or irreversible damage, and scientific uncertainty as to the extent of possible damage.
2. Once both are satisfied, "a proportionate precautionary measure may be taken to avert the anticipated threat of environmental damage, but it should be proportionate."

3. The threat of serious or irreversible damage should invoke consideration of five factors: the scale of threat (local, regional etc); the perceived value of the threatened environment; whether the possible impacts are manageable; the level of public concern, and whether there is a rational or scientific basis for the concern.
4. The consideration of the level of scientific uncertainty should involve factors which may include: what would constitute sufficient evidence; the level and kind of uncertainty; and the potential to reduce uncertainty.
5. The principle shifts the burden of proof. If the principle applies, the burden shifts: "a decision maker must assume the threat of serious or irreversible environmental damage is… a reality [and] the burden of showing this threat… is negligible reverts to the proponent…"
6. The precautionary principle invokes preventative action: "the principle permits the taking of preventative measures without having to wait until the reality and seriousness of the threat become fully known".
7. "The principle should not be used to try to avoid all risks."
8. The precautionary measures appropriate will depend on the combined effect of "the degree of seriousness and irreversibility of the threat and the degree of uncertainty… the more significant and uncertain the threat, the greater…the precaution required". "…measures should be adopted… proportionate to the potential threats".

Corporate

The Body Shop International, a UK-based cosmetics company, recently included the Precautionary Principle in their 2006 Chemicals Strategy.

Environment/health

Fields typically concerned by the precautionary principle are the possibility of:

- Global warming or abrupt climate change in general
- Extinction of species
- Introduction of new and potentially harmful products into the environment, threatening biodiversity (e.g., genetically modified organisms)
- Threats to public health, due to new diseases and techniques (e.g., AIDS transmitted through blood transfusion)
- Persistent or acute pollution (asbestos, endocrine disruptors...)
- Food safety (e.g., Creutzfeldt-Jakob disease)
- Other new biosafety issues (e.g., artificial life, new molecules)

The precautionary principle is often applied to biological fields because changes cannot be easily contained and have the potential of being global. The principle has less relevance to contained fields such as aeronautics, where the few people undergoing risk have given informed consent (e.g., a test pilot). In the case of technological innovation, containment of impact tends to be more difficult if that technology can self-replicate. Bill

Joy emphasized the dangers of replicating genetic technology, nanotechnology, and robotic technology in his article in *Wired Magazine*, "Why the future doesn't need us", though he does not specifically cite the precautionary principle. The application of the principle can be seen in the public policy of requiring pharmaceutical companies to carry out clinical trials to show that new medications are safe.

Oxford based philosopher Nick Bostrom discusses the idea of a future powerful superintelligence, and the risks that we/it face should it attempt to gain atomic level control of matter.

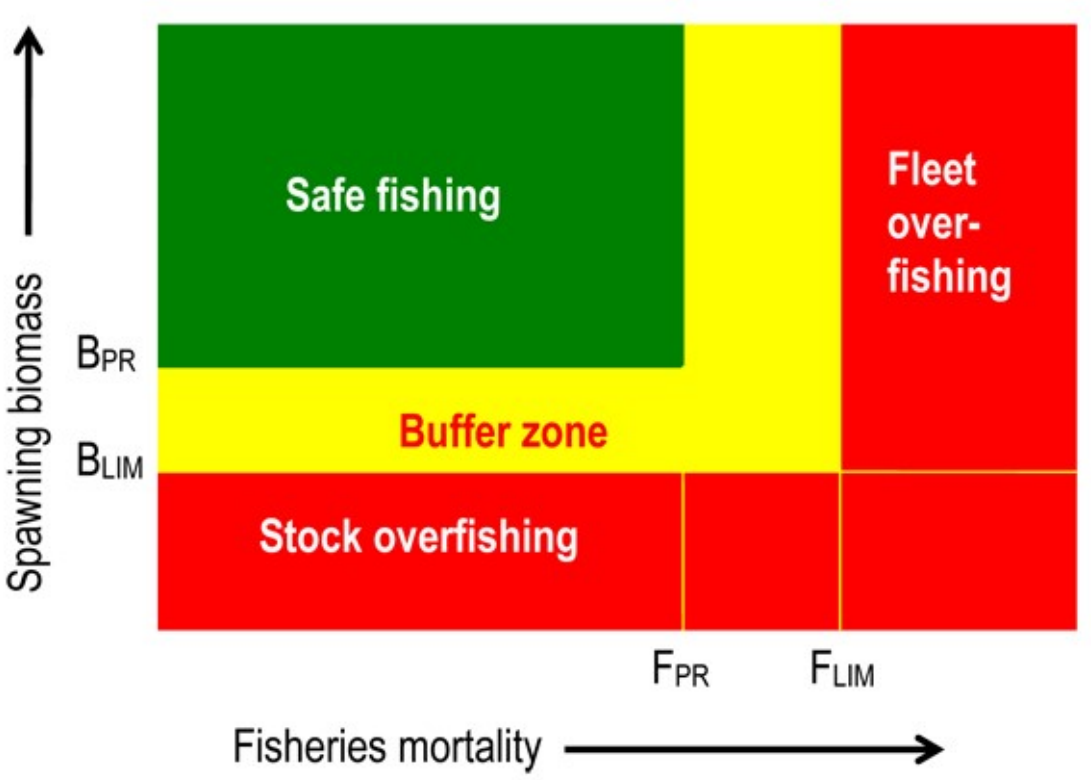
Application of the principle modifies the status of innovation and risk assessment: it is not the risk that must be avoided or amended, but a potential risk that must be prevented. Thus, in the case of regulation of scientific research, there is a third party beyond the scientist and the regulator: the consumer.

In an analysis concerning application of the precautionary principle to nanotechnology, Chris Phoenix and Mike Treder posit that there are *two forms* of the principle, which they call the "strict form" and the "active form". The former "requires inaction when action might pose a risk", while the latter means "choosing less risky alternatives when they are available, and [...] taking responsibility for potential risks."The academic Thomas Alured Faunce has argued for stronger application of the precautionary principle by chemical and health technology regulators particularly in relation to TI02 and ZNO nanoparticles in sunscreens, biocidal nanosilver in waterways and products whose manufacture, handling or recycling exposes humans to the risk of inhaling multi-walled carbon nanotubes.

Change of laws controlling societal norms

Associate Justice Martha Sosman's dissent in Goodridge v. Department of Public Health, the decision of the Supreme Judicial Court of Massachusetts that mandated legalization of same sex marriage, is an example of the precautionary principle as applied by analogy to changes in culturally significant social policy. She describes the myriad societal structures that rest on the institution of marriage, and points out the uncertainty of how they will be affected by this re-definition. The disagreement of the majority illustrates the difficulty of reaching agreement on the value of competing perspectives. Although the Goodridge case involved interpreting the state constitution, the substantive canon in Anglo-American jurisprudence that derogations of fundamental societal values should be narrowly construed is analogous to the precautionary principle favoring a statutory interpretation that comports with rather than damages the common law and established norms.

Resource management



The Traffic Light colour convention, showing the concept of Harvest Control Rule (HCR), specifying when a rebuilding plan is mandatory in terms of precautionary and limit reference points for spawning biomass and fishing mortality rate.

Several natural resources like fish stocks are now managed by precautionary approach, through Harvest Control Rules (HCR) based upon the precautionary principle. The figure indicates how the principle is implemented in the cod fisheries management proposed by the International Council for the Exploration of the Sea.

In classifying endangered species, the precautionary principle means that if there is doubt about an animal's or plant's exact conservation status, the one that would cause the strongest protective measures to be realized should be chosen. Thus, a species like the Silvery Pigeon that might exist in considerable numbers and simply be under-recorded or might just as probably be long extinct is not classified as "data deficient" or "extinct" (which both do not require any protective action to be taken), but as "critically endangered" (the conservation status that confers the need for the strongest protection), whereas the increasingly rare, but probably not yet endangered Emerald Starling is classified as "data deficient", because there is urgent need for research to clarify its status rather than for conservation action to save it from extinction.

If, for example, a large ground-water body that many people use for drinking water is contaminated by bacteria (e-coli 0157 H7, campylobacter or leptospirosis) and the source of contamination is strongly suspected to be dairy cows but the exact science is not yet able to provide absolute proof, then the cows should be removed from the environment until they are proved, by the dairy industry, not to be the source or until that industry ensures that such contamination will not recur.

Criticisms

Threshold of plausibility

The Wingspread Statement version of the PP takes the form "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically". When applying this principle, it is recommended that society establish a minimal threshold of scientific certainty or plausibility before undertaking precautions. Normally, no minimal threshold of plausibility is specified as a “triggering” condition, so that any indication that a proposed product or activity might harm health or the environment is sufficient to invoke the principle. Often the only precaution taken is a ban on the product or activity.

In Sancho vs. DOE, Helen Gillmor, Senior District Judge, wrote in a dismissal of Wagner's lawsuit which included a popular worry that the LHC could cause "destruction of the earth" by a black hole:

> Injury in fact requires some “credible threat of harm.” *Cent. Delta Water Agency v. United States*, 306 F.3d 938, 950 (9th Cir. 2002). At most, Wagner has alleged that experiments at the Large Hadron Collider (the “Collider”) have “potential adverse consequences.” Speculative fear of future harm does not constitute an injury in fact sufficient to confer standing. *Mayfield*, 599 F.3d at 970.

Negative consequences of application

The Precautionary Principle may cause resentment, since people are more aware of negative changes than they are positive changes (i.e. a ban is more noted than allowing a proposal to proceed). Because of this effect, a technology which brings advantages may be banned by PP because of its potential for negative impacts, leaving the positive benefits unrealized.

The Hazardous Air Pollutant provisions in the 1990 amendments to the U.S. Clean Air Act are an example of the Precautionary Principle where the onus is now on showing a listed compound is harmless. Under this rule no distinction is made between those air Pollutants that provide a higher or lower risk, so operators tend to choose less-examined agents that are not on the existing list.

A California researcher has pointed out the fallacy of extrapolating possible risk of a proposed product or action, without examining equally closely the possible risks of **not** adopting the proposal. When looking at the proposal, policymakers tend to apply PP to that proposal while assuming the alternative(s) to be risk-free, which places an unfair burden on the proponents of the new product or activity.

Internal Inconsistency

The Precautionary Principle, applied to itself as a policy decision, may rule out its own use depending on the precise definition used; for example, Prohibitory PP as a policy decision would need to demonstrate that no substantial damage would result from the prohibition of products and technologies. For a potential example of this, the uncertain safety and long-term environmental effects of nuclear power led to its disfavor by precautionary groups, which may have resulted in greater carbon emissions through the use of coal power.

Perspective

- Critics of the principle argue that it is impractical, since every implementation of a technology carries some risk of negative consequences. For example, when the arrival of amplified music came on the scene, the risk of electrocution and deafness arose. However, this did not prevent it from becoming an artistic and cultural norm.

- A summary of some representative objections to the precautionary principle are described in a Reason article by Ronald Bailey which, using the Wingspread consensus as a starting point, argues the possibilities for misapplication of the principle.