Chapter 2
From the Digital Divide to the Robotics Divide? Reflections on Technology, Power, and Social Change

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2.1 Introduction

Technology is an inseparable part of our lives. While we are ultimately responsible for its creation, there can be no doubt that technology, in turn, is shaping our very existence, and, as with any social institution, it has taken on a life of its own as a consequence of its complexity and evolution. The technology we use on a daily basis is not just hardware; it is also software, the way we organize ourselves, and the tools and machines we develop. Humans, as living beings, are technological tools of the highest level of complexity. And, just like machines, we can be dissected and elements of our organism can be transplanted or redesigned. Furthermore, our machines and organizational systems are not overtly transparent to us; owing to their complexity, they require comprehensive preliminary training (via educational institutions) and financing for development (hence science–technology policies are now a strategic issue in knowledge societies) and have become a core element in explaining power and social inclusion. No other form of social exclusion is more dramatic than death as a result of superior military technology (science fiction films, like the Terminator saga, abound with robots or alien beings that develop weapons of mass destruction). In this chapter, we discuss some key dimensions of our technological society, in order, in a second phase, to investigate the characteristics of what we call the new robotics divide.

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2.2 Science, Technology, Society, and Power

In all societies throughout history, science and technology have played a crucial role. We only need to look at the impact of agriculture, writing, or, from a military perspective, the discovery of bronze and iron. Technological innovation has always been linked to the race to obtain technology (at the outset), among the relevant actors in any given historical context. Today, technological innovations shape our power structures and determine the economic, political, and social inclusion or exclusion of individuals, companies, and states. Many of the hidden battles being waged today between countries and between companies have to do with innovation, industrial espionage, and access to key technologies. The difference is that, nowadays, science and technology have developed into a crucial institutional complex that attracts heavy investment and have also become a strategic issue as regards political action. Below, we highlight some features of our current historical context:

- First, we are immersed in a scientific and technological revolution which increasingly affects more dimensions of social life while also acting as a barrier around which new social and economic inclusion and exclusion processes are articulated (López Peláez 2003). In this context, science policies have become a crucial issue for modern societies. Given that "the technological revolution provides the necessary infrastructure for the process of formation of the global, informational economy, and it is fostered by the functional demands generated by this economy" (Castells and Hall 1994: 23), science and technology policies (i.e., those that aim to influence scientific and technological innovation at a specific level of development and orientation via plans drawn up by the political authorities that bring into play their financial, administrative, and educational resources) have become a strategic factor in the twenty-first century.
- Second, from a historical perspective, "(…) the ability or inability of societies to master technology, and particularly technologies that are strategically decisive in each historical period, largely shapes their destiny, to the point where we could say that while technology *per se* does not determine historical evolution and social change, technology (or the lack of it) embodies the capacity of societies to transform themselves, as well as the uses to which societies, always in a conflictive process, decide to put their technological potential" (Castells 1996: 33).
- Third, our culture, our way of life, and our personal and collective aspirations are built on science and technology, as well as the concepts, images, and metaphors that we associate with them. From measuring the speed of cars to learning how to cook, our material culture cannot be separated from our technology, our scientific knowledge. Moreover, since the Renaissance at least, the way we deal with problems is highly influenced by scientific methodology: The scientific gaze gives us the freedom and allows us to transcend tradition and custom in order to respond creatively too and transform the environment. Our

education and science and technology systems contribute to the development of this approach and form a key institutional complex in modern societies.

- Fourth, and as a result of the above, science and technology play a key role in structuring our societies. Indeed, from the moment the first tools were developed by Homo sapiens, technology has always played a key role in human existence. However, it is also true that the importance of technology today, and our own self-knowledge acquired via such innovations as the cell phone, computers, television, or the Internet, makes one wonder about the consequences of the way we design, develop, and implement new technologies and how they contribute to strengthening hierarchical structures or asymmetric distributions of power. And it is precisely this kind of question that inspires fantasy literature to explore the conflict between humans and machines, people and androids, or cyborgs, sentient beings with both organic and cybernetic parts, and robots and humans. If technologies, both old and new, play a key role in the economy, in the production of goods and services, in behavior patterns, in forms of social and political organization, in leisure, and in forms of participation, to speak of a newly emerging technologically advanced society, we should ask ourselves who is included and who is excluded from technological dynamics. That question has been raised in the last three decades in relation to the Internet (the "digital divide"), and now, we need to ask that same question in relation to the technology that seeks to replicate intelligent behavior in autonomous machines: robotics.

The science–technology complex, or "technoscience" as some theorists call it, is one of the key features of emerging societies and responds to and shapes the historical present in a complex process of mutual interaction, recreation, and reciprocal conditioning. Science, technology, and society are closely linked, and the analysis of science and technology as a product of society, in which it is created and which it shapes reciprocally, has evolved from the analysis of its institutional dimension and the impact of science and technology on society, to the analysis of the social construction of scientific knowledge (which also covers the cognitive dimension of science). The two features of the current, which give rise to so-called technoscience, are as follows: first, the exponential acceleration of knowledge production and second, the reduction in the time needed to develop technologies based on scientific advances that can be applied in a practical context. In short, the consequences of the scientific–technological revolution are global, affect more and more dimensions of social life, and are rooted in permanent innovation. Within this context, robotics has an important role, which we aim to analyze in different chapters of this book.

2.2.1 Citizenship and Science and Technology Development

The key role played by technology in our societies has sparked a heated debate about its characteristics, its unwanted side effects, and the governance of technological development. In democratic societies, in which people want to be in control of their own lives and decide how their societies should be run, technology cannot be excluded. Yet technology should not materialize as if by accident, or be the sole responsibility of the experts, leaving us with no other option than that of uncritical acceptance, silence, or, in the best case scenario, passive resistance. Any catastrophe that is precisely a result of technological advances (such as a nuclear disaster, or an environmental disaster resulting from the sinking of a supertanker—it should not be forgotten that navigation and ships are also technology, technical artifacts) highlights the possible paths and consequences of technology. For this reason, forecasting is not only concerned with setting a timeline for potential implementation in forthcoming years, but also with the competitive position of individual countries, as highlighted in the series of Delphi studies conducted in Japan. As regards the military, it is clear that no nation state can afford to ignore innovation, and, in effect, there is hard-fought competition to achieve a position of dominance.

In democratic societies, debates on science and technology development cover all areas: from questioning the source of science funding to discussing the design, features, and impact of science and technology. Simultaneously, this has been accompanied by a significant increase in research into scientific and technological practices, in what has been called the new "sociology of scientific knowledge," in which not only the impact but also the invention, development, and internal characteristics of science and technology are considered social facts/processes. This research has led to what is now referred to as the "Science Wars" debate (Ross 1996). In a parallel manner, a whole line of research has been developed on the public perception of science and technology in knowledge societies, in which citizens demand to be treated in accordance with their status in all spheres of life and not reduced to mere passive objects when it comes to science and technology policymaking (López and Díaz 2009).

The future evolution of the scientific–technological revolution returns us to the debate on the social models in which it is created and implemented and which, in turn, transforms and shapes. From this perspective, prospective studies on social trends aim to provide qualified information for decision making (López Peláez 2009). In this respect, we cannot analyze the processes of social inclusion and exclusion without considering the technologies that will play a critical role in the coming years. And, from our point of view, robotics will radically transform both our environment and our way of life (Kurzweil 1999). We need information in order to make decisions, and it is precisely the effects of technology on social exclusion, as well as the barriers it creates by redefining what is included and what is excluded from the core of our economy and our way of life that we need to analyze when contemplating how we are going to integrate our own robotic designs into our democratic societies.

The "runaway world" that Anthony Giddens speaks about is undoubtedly a rapidly changing world in terms of science and technology. Although both are products of their social context, from our point of view, there is an important feature that ought to be highlighted: Once stabilized and implemented, the technological advance in question determines future developments while simultaneously constraining and enabling our field of action depending on what it is exactly achieved through such technology. In this regard, Thomas Hughes' (1983) analysis of what he calls "sociotechnical systems" (consisting of physical artifacts, organizations, natural resources, legal mechanisms, and intangible components of organizations, etc.) highlights how such systems evolve from the interaction between economic resources, practical skills, and organizational forms. Once the system is firmly established, it tends to remain stable until the political and economic interests linked to the system are exhausted.

From a different perspective, the analysis of technological development and its social impacts reveals the sociopolitical dimension of technology, which is built on and responds to a specific social model. Technological artifacts can be designed and constructed so as to produce a series of logical and temporal consequences prior to a concrete application. In this regard, technologies can be described as "life forms" that establish ways to build "order" in our world. They hold various possibilities for organizing human life in various ways. Winner (1987) highlights three key features of the process of technology creation and acceptance:

- Consciously or unconsciously, societies "choose" technological structures that have a long-term influence on the way they work, communicate, and live.
- In the decision-making process, people occupy unequal levels of power and awareness.
- The range of choices is greater when technology is introduced for the first time. Once implanted, it establishes a pattern of social order that is very difficult to change. "Because choices tend to become strongly fixed in material equipment, economic investment, and social habit, the original flexibility vanishes for all practical purposes once the initial commitments are made" (Winner 1987: 45).

From Winner's point of view, "What appear to be merely instrumental choices are better seen as choices about the form of social and political life a society builds, choices about the kind of people we want to become" (Winner 1987: 69). From our perspective, technology should be seen as a social fact/process, in which both the social interests that drive their development, and the logic arising from the interaction between technological revolution, capitalist restructuring, and social changes can be traced. Technological revolution penetrates all spheres of human reality. The relationship with the social contexts in which it is created, applied, and which it transforms in often unpredictable ways for its creators, requires a scientific approach that contemplates two aspects: social processes that give rise to the technological society in which we find ourselves and the logic arising from technological developments (and their specific social application), which acts upon and transforms the social reality.

The impact of a new technology is never limited to the purpose for which it was designed. "Technology also implies a transcendence of the materials used to comprise it. When the elements of an invention are assembled in just the right way, they produce an enchanting effect that goes beyond the mere parts. (…) The assembled object becomes much more than the sum of its parts" (Kurzweil 1999:

33). And this applies not only to the materiality of technological artifacts, but also to their social application. Hence, the unanticipated side effects and the unexpected path are taken by technological development for those who design, fund, and implement technology.

Models of social development and interpretation of the world that articulate and provide symbolic support to advanced technological societies—depending on the characteristics of both the technological systems and social interests—have become the subject of sociological analysis of technology. This leads us to the processes by which the "modern image" of society and the world are built. This modern image has become the symbolic universe that has guided technological developments and justified their implementation via the notion of "progress." At the same time, the advanced technological society that arises from this development calls into question basic social consensus and how the previous society was organized: "(…) industrial society *exits the stage of world history on the tip-toes of normality,* via *the back stairs of side effects*. (…) the counter-modernistic scenario currently upsetting the world (…) does not stand in contradiction of modernity, but is rather an expression of reflexive modernization beyond the outlines of industrial society" (Beck 1998: 17, emphasis in the original). In this process, the paradox of the undesirable and unforeseen consequences of scientific and technological development is revealed, forcing us, as Beck puts it, to deal with "the growing capacity of technical options" alongside the growing "incalculability of their consequences" (Beck 1992: 22).

In short, in what follows, we highlight some features of our social model of science and technology development, in which advanced robotics are designed and integrated.

- First, we are immersed in a permanent scientific and technological revolution, which began with the information and communication technology revolution in the 1970s. It is a revolution characterized by the accelerated pace of science and technology developments and converging technologies.
- Second, the unknown effects of the rapid expansion of science and technology in various fields of social and natural life. From genetic engineering to artificial intelligence, new risks and opportunities are transforming our environment, and we face the problem of the undesired consequences of our actions (with a level of "new" radicalism, given that what is at stake is the very survival of the human species). This perspective paved the way for technology assessment as a strategy to democratically redefine the sociotechnical model we want for tomorrow's society. In this process, the social nature of scientific and technical output is revealed in three dimensions:
  - It responds to a way of life that facilitates, as the Spanish philosopher Ortega y Gasset so brilliantly put it, the recreation of an artificial world, in which a future imagined by humankind is made possible.
  - Science and technology development responds to the interaction between various social groups and interests. As such, neither technological determinism (in its "hard" version, which implies the existence of a technological

logic independent of the society in which the technology is created and applied) nor the uncritical identification between sociotechnical progress and development can be defended: The hypothetical "neutrality" of science and technology does not respond to the reality of science and technology as complex human activities.
  - Sociotechnical developments constrain the present and the future in such a way that interaction between science, technology, and society must overcome both technological and social determinism.
- Third, societies based on technoscience are characterized by anticipating the future, which becomes the benchmark that determines action by developing strategies to reduce uncertainty and ensure not only the economic but also the social viability of the future. The need to decide socially about the future of our societies by evaluating technologies has led to the development of prospective methodologies that permit forecasting the characteristics of the immediate future while bringing to the fore the consequences of today's technoeconomic development model (López Peláez et al. 2012). It should not be forgotten that access or not to certain technologies can have a decisive impact on the future: a fact constantly highlighted in the military sphere.

2.2.2 Opening the Black Box of Technological Development: Forecasting and Assessing Technology

The relationship between science, technology, and society in the current historical context has three characteristics that have led to the development of prospective methodologies linked to predicting technological events and social forecasting, which is concerned with social impacts and seeks to provide qualified information for decision making. These three characteristics are as follows: firstly, the speed of development and the new risks associated with the implementation and management of technology, their design, and ultimate goals (as in the case of genetic engineering, robotics, or nanotechnology); second, the impact of new technologies on labor (the primary means of social integration in salaried societies) and political institutions, primarily on the role of the nation state; and third, the relationship between technological revolution, informational capitalism, and the environment, specifically the need to develop environmentally friendly technologies, which was already highlighted in the debate on sustainable development models as early as the 1960s.

The link between unconditional optimism and science and technology development reached its peak in the 1940s and 1950s when scientific and technological progress was seen as the key to material progress and military supremacy and became a strategic activity that merited unconditional funding from public institutions. Having said that any unconditional funding ought to respect the self-regulatory code of conduct adopted by the scientific community, without interfering in its creative work. The process that led science and technology to become the subject of public debate in the 1960s, and the link between technological progress and scientific development to become problematic, was due to the interaction of several factors: first, the impossibility of providing unlimited resources to fund all the R&D proposals of the scientific community; second, the strategic role that science and technology research played in economic development, which made it the object of political debate; third, the potential risks of technological advances such as nuclear disasters; fourth, the limits of industrialism and technologies based on environmental depredation and the depletion of non-renewable natural resources; and finally, the systematic criticism of technocratic instrumental rationality and the debate on the epistemological status of scientific knowledge. All of this triggered reactions in three spheres: the social sphere (demands for public participation in assessing the impacts of science and technology and demands relating to the regulation of the implementation of technological advances), the political sphere (more interventionist policies were adopted, which sought to obtain results from the strategies devised by political powers), and in the field of social sciences. The end result was the transformation of the implicit contract between science, technology, and state, and the design of a new social contract characterized by the abandonment of technological determinism, the pursuit of citizen participation, and the assessment of the impact of technology developments.

According to these approaches, research on the relationship between technological change and social change should address three key issues: first, the debate on the influence still exercised by technological determinism today; second, the role of science and technology in today's society, both in terms of its institutionalization and the plans for its design, impact, and assessment, and in terms of its public perception of scientific and technological advances; and third, the analysis of science and technology as social facts and processes and hence research into its impact and own internal structure (in the context of both discovery and justification). In our opinion, the secularization of science and scientific activity, which turns it into an object of sociological inquiry, is another step in the process to define knowledge and action as activities inherent to all human beings.

Despite the siren song of technological determinism, and its corresponding sociohistorical determinism, human beings have always been concerned with the future. They have always questioned the consequences of their actions and how to intervene in the likely development of events. The current debate on the relationship between technological change and social change has been repeated many times in the past. The future has always been a cause of concern for humankind. Throughout history, we can trace the many ways of analyzing the changing trends recorded in the present and how to predict the characteristics of the future. From the oracles in classical antiquity (Hernández de la Fuente 2008), to modern prospective studies (Fowles 1978; EFILWC 2003; Georghiou et al. 2008), action in the present cannot be understood without taking into account the objective to be reached within a set period of time.

The basic difference between the various forms of prediction employed throughout history lies precisely in the notion of future with which they operate. In ancient times, and to this day, traditional determinism (technological, historical, social) postulates a single rationale for the development of events in which human subjects are passive recipients of change and are responsible for that change only to the extent to which the process is said to be in their favor (hence the various rites to ask whether the gods are on our side). This model brings us to the Heideggerian analysis of what lies beneath the essence of technology; what Heidegger (1975) describes as *das Gestell*, in which there is no other option other than to wait for a "new advent." In this extreme approach, the future is also determined by inherent laws beyond our control, which take technological determinism to its maximum expression.

This conceptualization of the future from the perspective of determinism entered into crisis after World War II and the development of the so-called Big Science. Big Science saw the future as a playground for human action: a place to be conquered where passivity is no longer an option, and as a result, methods and techniques were needed to analyze and build the future according to political, economic, and military interests. Technological objectives such as the atomic bomb required years of collaborative planning and work, the provision of substantial resources, and a clear assessment of the benefits to be had (which are gained not only from obtaining key technology in military or civilian fields of expertise, but also by assessing the costs and risks of other countries or companies obtaining technology sooner or improving it).

In this new context, technological forecasting became a strategic tool and was soon regarded as a key element in R&D programs in technologically advanced countries. In uncertain environments characterized by strong competition between companies and countries and the need to invest financial and human resources (which are always limited) in technologies that are regarded as key in the immediate future, technological forecasting provides "difficult-to-acquire strategic information for decision making, and it functions as an socioeconomic mobilization tool to raise awareness and to create consensus around promising ways to exploit the opportunities and diminish the risks associated with S&T developments" (Morato et al. 2002: 5).

In advanced technological societies, R&D policies demand qualified information about the future in order to develop short-, medium-, and long-term plans for three main reasons: first, the need to anticipate the characteristics of the technological model within a time frame of 10–15 years, e.g., establishing an energy production, distribution, and consumption model in a country, requires planning, design, construction, and the implementation of a group of production facilities and distribution networks based on the forecasts made; second, errors in forecasting the future immediately give rise to serious problems: "(…) failure to anticipate subtle cumulative long-term changes precipitate sudden short-term consequences (…)" (Abt 2003: 88); and third, the need to establish a continuous reevaluation process of the forecasts and results to adapt to changes in the environment: “The goal becomes making the most adaptive decisions in a timely fashion rather than getting the future right” (Schwartz 2003: 37).

Planning entails forecasting, evaluating, selecting priorities, and making decisions based on the available resources. Debates on the limits of our methodologies for forecasting the future should not make us forget that we are immersed in a scientific and technological system in which we are funding innovations that will be on the market within 10 years and that the ability to cope with present and future risks will depend on our strategic planning and on how we act now to address possible future risks. It should therefore come as no surprise that future studies were developed in the 1950s during the Cold War in the military sphere and in a context of technological innovation (nuclear energy and the space race) that could have had an impact on the existing balance of power. Currently, most of the EU member states, and many countries in other regions of the world, conduct systematic forecasting studies in order to provide qualified information for decision making in the field of science and technology policy.

In democratic societies, risk analysis also has other direct consequences: People want more information and greater participation in the development and implementation of technologies that affect their daily lives. Technology forecasting cannot ignore the social consequences of future developments and the key role played by citizens as consumers (in the case of products) or policymakers (in the case of technologies that affect the definition of our identity as human beings). As a result, the methodologies used in future studies increasingly include analyses on social impacts, thus increasing the amount of information available for decision making.

As highlighted by the so-called Collingridge dilemma (Collingridge 1980), this becomes more relevant due to the fact that it is more difficult to make decisions to guide or shape technology in the initial stages of development given that we know little about its costs, opportunities, risks, and positive and negative effects. On the other hand, once technology has been developed and implemented, and we do have enough knowledge about it, it then becomes very difficult to alter its trajectory. One possible way to overcome this dilemma is to provide, via prospective methodology, adequate information before technological trajectories become irreversible. As a result, prospective studies have become a strategic tool for the internal competitiveness of countries and for the democratic system itself, to the extent that the technology choices we make, or fail to make, often shape our lives in a definitive manner.

In the new context of the relationship between science, technology, and society in democratic societies where citizens are seen as subjects and not objects and therefore demand greater participation in building their own future, public demand to participate in technology assessment has increased. In a parallel manner, the demand for information has increased as regards both the current consequences of scientific and technological development and the diverse possibilities for the future and the forecasts relating to decision making. Finally, a wide field of study has been developed on public perception of science and the nature of scientific knowledge, as well as the interaction between science, technology, technical artifacts, and human action. Using an interdisciplinary perspective, our study will focus on a key technology that will exert a major influence on our society in the future: robotics.

2.2.3 From Technological Determinism to a New Social Contract Between Technology and Democracy?

The debate about the influence of technology on society as an agent of change can be analyzed in terms of the debate on what is known as "technological determinism." The enlightenment project is based on the notion of human's capacity to learn by shaping reality, and as such, every human product is historical and is produced, and responds to, a specific logic of action. It is for this reason that the enlightenment aimed to emancipate human consciousness from of all kinds of external determination and superstition and subject it to a "coming of age" based on the premise of rational behavior.

In this process, science as a knowledge system plays a critical role: It enables the advancement of knowledge, transforms nature, and facilitates a new order derived from the combination of knowledge, freedom, and usefulness. In this context, the legitimacy of science and the practical use of technology lead progress to be regarded primarily as scientific and technological progress that allows us to change our way of life and create a better society. Furthermore, technical artifacts, once introduced, seem to take on a life of their own, to the point that subsequent events tend to be explained as an inevitable consequence of technological innovation. "A sense of technology's power as a crucial agent of change has a prominent place in the culture of modernity. (…) For some three centuries, direct firsthand experience of that power has been a well-nigh universal feature of life in developed and developing countries" (Smith and Marx 1996: 11–12).

Moreover, "The idea of technological determinism takes several forms, which can be described as occupying places along a spectrum between 'hard' and 'soft' extremes. At the 'hard' end of the spectrum, agency (the power to effect change) is imputed to technology itself, or to some of its intrinsic attributes (…) At the other end of the spectrum, the 'soft' determinists begin by reminding us that the history of technology is a history of human actions" (Smith and Marx 1996: 14–15).

The key issue, in our opinion, is not only the social origin of technology, but also its effectiveness once developed, as well as its limitations and opportunities. In this regard, the debate on the internal logic of science and technology development, as highlighted by Mumford, Ortega y Gasset, and other early twentieth-century scholars, leads to the model of social organization in which technology is developed and which, in turn, is reinforced and modified by it. As a historical phenomenon, technology is contingent in origin, yet at the same time, as a historical phenomenon, it is also a part of the trajectories that condition the future. In the works of Mumford and Ellul, technology is not understood as mere machinery, but also as a form of organization, and a whole manner of thinking rooted in efficiency and calculation.

In this regard, their pessimism ties in with Heidegger's critique of technology for whom the essence of technology is not technological at all but a way of life embedded in the language he calls *das Gestell*, or framing, in which everything is reduced to pure commodity and instrumental calculation, and where human identity as a concept is dispersed in the process. In contrast to these negative conceptions, yet placing technological logic beyond the notion of technoscience, Ortega y Gasset adheres to a universal model of thought and action to determine society, proposing technical analysis as a strategy to produce the artificial worlds that typify the human condition as opposed to the natural world. By definition, "possible worlds" are infinite, and as such, many "techniques" which characterize specific sociohistorical projects have been developed throughout history.

These perspectives on the relationship between science, technology, and society are a forerunner to what we believe is key in understanding the interaction between science, technology, and society today:

- On the one hand, the breaking of the covenant between science and the state, which has led to new methods of evaluation, the incorporation of prospective methodology to provide critical information in decision making, and the development of science and technology policies and strategic tools to ensure the economic and social integration of emerging societies, as well as a line of research that investigates public perceptions of scientific and technological progress and impacts.
- And on the other hand, the analysis of science and technology as social products in an area of research that has come to be known as "science, technology, and society." From a strictly sociological perspective, it is important to mention the fields of study that focus on science as an institution, which evolved from the Mertonian school of thought, as well as the so-called new sociology of scientific knowledge, which regards social facts not only as the application and impact of technologies, but also as their process of gestation, design, and modeling.

Modernity has been built on the confidence in the link between scientific knowledge and material progress. This link stems from the utilitarian dimension that characterized both the scientific revolution and the technological evolution linked to the industrial revolution. Although the practical application of scientific progress has not always followed a linear process, examples such as the competitions held to develop technologies and devices in order to accurately measure latitude at sea in order to locate the exact position of a ship and its course clearly demonstrate the link between scientific knowledge, technology, and practical application. The legitimation of science and technology as an engine of progress has been brought about by both the degree of knowledge it provides and the degree of knowledge and well-being embedded in objects, tools, and technologies used in everyday life.

Public ambivalence toward the consequences of technological development is due to the emerging risks and the analysis of technoscience activity as a social process, which is not solely governed by the search for truth and benefits to humankind, but responds to a complex set of interactions between interests of various kinds and the crisis of the scientific paradigm as a cognitive paradigm, as the standard of truth. However, this complex process contrasts with technoscientific advances in daily life. New technologies are projected onto our self-understanding of reality, to the point of becoming, in the words of Bolter, "defining technologies," which are used as metaphors, models, or symbols around which thoughts and actions are organized. From this perspective, the relationship between technoscience metaphors, language, thought, and individual and collective action should be highlighted. Metaphor, as a model for understanding reality, conditions and facilitates our individual and social and even scientific perception of the world. Therefore, the analysis of metaphors becomes an essential tool in order to expand and structure our knowledge and action.

The reliance on technology, and the rapid introduction of all kinds of innovations in everyday life, raises suspicion and causes a certain degree of apprehension (we can see both extremes in a paradigmatic way in contemporary films about robots, from The Terminator to I, Robot). This complex view of the relationship between technoscience progress and development stems from the interaction of several factors:

- First, the impossibility of providing unlimited resources to fund all R&D proposals by the scientific community.
- Second, the strategic role of science and technology research in economic development, which makes it an object of political debate.
- Third, the potential risks of technological advances such as nuclear disasters.
- Fourth, the limits of industrialism and technologies based on environmental depredation and depletion of non-renewable natural resources.
- Fifth, the social divide caused by technology that redefines the boundaries of social inclusion and transforms the context at an individual, company, and country levels. In this regard, there is a strong debate on the positive and negative effects of new information and communication technologies and globalization on several important realms of society such as the economy, the welfare state.
- And finally, the systematic criticism of technocratic instrumental rationality and the debate about the epistemological status of scientific knowledge.

As noted above, this has elicited a reaction in three spheres: the social sphere (demands for public participation in assessing the impacts of science and technology and demands relating to the regulation of the implementation of technological advances), the political sphere "the old laissez-faire policy, which regarded the regulation of science and technology innovation as a matter of internal corporate control, is transforming into a new more interventionist policy where public authorities develop and implement a series of technical, administrative and legislative tools for channeling technoscience development and monitoring its effects on nature and society" (Albornoz and López Cerezo 2007: 45), and in the field of social sciences (as reflected in the research conducted by the so-called new sociology of scientific knowledge, the sociology of technology, and the philosophy of science and technology).

The ultimate consequence is the transformation of the implicit contract between science, technology, and state, and the design of what can be called "a new social contract for science and technology." Social change and technological change are closely related. We cannot take a passive stance and accept technological determinism as an intrinsic law of historical evolution. Technology is a social product and can be built and reoriented according to social consensus. In fact, in the process of being developed, technology already reproduces the basic social consensus of advanced capitalist societies, as well as its patterns of inequality. In order to further consolidate democratic citizenship in the twenty-first century, we need more and better information on scientific development and its potential impacts, greater scientific literacy, and more and better prospective studies that allow us to anticipate the opportunities and risks of key technologies, such as robotics. We must move toward a new social consensus between science, technology, political power, and citizens in order to jointly build a democratic society in which new opportunities permit improving our standards of living and lifestyles.

2.3 From the Digital Divide to the Robotics Divide

Genes, bytes, and robots are going to transform our social life. Our bodies will be redefined through genetic enhancements and more technology, until eventually evolving into cyborgs. Simultaneously, robot intelligence and capabilities will introduce an alter ego in our social environment, and in the same way, they already play a central role in performing tasks in industrial sectors. And all of this is going to materialize in cosmopolitan but unequal and stratified societies, which will possibly create new forms of inequality that will superimpose themselves on older forms of inequality. At the same time, there will be new opportunities, and, to some extent, the worlds of work and entertainment will be redefined and possibly even the world of intimate relationships, including sexual relationships (Levy 2007). The convergence of biology, robotics, and artificial intelligence suggests, therefore, a threefold horizon of possibilities: human genetic enhancement in order to improve our capabilities and make way for a new stage in the evolution of the species; the development of enhanced artificial intelligence until finally producing autonomous machines and robots capable of improving and repairing themselves, which will give rise to sentient beings that are more intelligent than humans; and a mixed future, in which machines such as nanorobots coexist with biological improvements to the human brain, producing a mixture of information and communication robot–human technologies, which will also permit us to take a new leap in the history of life on earth and beyond.

2.3.1 What is New in Robotics?

Twentieth-century literature and film reflect some of the social representations of the potentially negative consequences of progress, of which three merit particular attention: first, the modification of human life and the altering of the species, as shown in works that criticize the eagerness of scientists to modify human nature (as represented in the figure of Dr. Frankenstein or in the current debates on cloning and producing “designer humans”); second, the undesirable consequences of the misuse of science and technology, as can be observed in works that criticize the misuse of nuclear energy. Associated with immoral use, such technologies can produce negative consequences that call into question the viability of the human species and even the very essence of life on earth; and third, the fear of out-of-control technoscience, which, by developing its own potential, becomes independent from human beings; first, creating a way of life governed by the demands of the technological systems themselves to then creating intelligent machines that confront and defeat human beings (as seen in The Terminator, 2001: A Space Odyssey, and The Matrix).

Technophobes and technophiles share a common assumption: Technology, once implemented, shapes the future in a sometimes unexpected but always consistent way. Choosing a technological trajectory is not a trivial matter, and the consequences can be positive or negative for a very long period of time. From a sociological perspective, technologies can serve to transform and recreate nature and human life, or interpret reality and express social conflicts and consensus. And, in times of such rapid technological innovation as the present, reflective uncertainty about the impact of technology is paradoxically linked to the uncritical, rapid, and massive incorporation of all types of artifacts and technologies in everyday life. The technophobe or technocritic in theory and the technophile in practice would seem to be the most common typology in modern societies. In this environment, in which public concern about the health risks of technological innovation is linked to the massive and rapid incorporation of every artifact or technology to hit the market (López Peláez and Díaz 2007), it becomes even more relevant, if possible, to ask the classic question of any prospective analysis: What will be the effects or foreseeable impacts of new technologies in the coming years and how can their consequences be addressed?

The interaction between humans and machines, and especially the possibility of developing robots that can reproduce human behavior and intelligence, is a fascinating field of research. Not only do we transfer our capabilities to robots, but we are increasingly inclined to implant technology and machinery in our own bodies, to the point of making robots more like humans than machines and transforming humans into machines that are more like robots, i.e., cyborgs. From the perspective of the so-called NBIC convergence (Roco and Bainbridge 2002), new possibilities have arisen for transforming the human species by way of a post-modified human life, in which artificial intelligence, genetics, and robotics will make way for a new stage in the history of humankind. The debate on the emergence of a new species has sparked heated discussions in leading forecasting journals (Technological Forecasting and Social Change 2006: 95–127). Moreover, the new models of social relationships that will be established within this context, in which the frontiers between humans and machines will be blurred, highlight the extent to which the current technological trajectories and social models in which we design and implement robots will shape the immediate future in an increasingly irreversible way (as has happened in the past with other crucial technologies). Not only do we need to consider the emergence of a new species, but also the development of a new social subject (as robots are also designed to work as a team, learn together, and interact socially with humans and other robots) in an ontological way. Recent research shows the emergence of a new colleague for purposes of leisure and entertainment, or a partner for romantic and sexual relationships. Given that technology is developed and implemented uncritically and according to market demands, it would come as no surprise that while we are debating on the rights and obligations of robots, they will quickly colonize the sphere of our private lives and become much more to us than a videogame or a pet, but perhaps even romantic partners.

The analysis of probable technological trajectories therefore needs to focus on the social models from which such trajectories are built, always bearing in mind that they could change unexpectedly for those responsible for them. Sociological analysis is precisely what allows us to understand the different possible scenarios arising from expert forecasting in the field of robotics. Increasingly intelligent robots, the increasing robotization of human bodies, and the new possibilities to solve major problems that threaten us as a species (climate change, pollution, the conquest, and colonization of outer space, etc.) all allow us to envisage what Kurzweil calls “the new singularity”: a new post-human, post-machine subject. However, if we consider not only the convergence of technologies, but also their practical application in line with the criteria of market societies and the prevailing values of cosmopolitan societies, a key question arises: Will the stratification and segmentation of capitalist societies be reproduced? Are we facing a new divide, the robotics divide, which transcends the current digital divide?

And as to technologically enhanced cyborgs and humans with increased capacity and power, will they be freer, or will they, in reality, reproduce the behavior patterns engraved in the technology they incorporate? According to Norbert Wiener and Joe Weizenbaum, pioneers in the field, implanting integrated circuits in the brains of animals to govern their behavior, could also lead to designing systems to control human beings, where cyborgs would just be robots whose design is based on the human body. Today, we now know about the experiments performed with the so-called ratbot; a rat with electrodes implanted in its brain, thanks to which its behavior can be governed via radio control (Balaguer and Dormido 2007: 490–494). In short, the analysis of future technological trends brings us face to face with society’s socioeconomic logic, our relationship with the environment, our behavior patterns, and how we use our power and contributes to opening not only the black box of robotics technology, but also the black box of our technological society.

2.3.2 Approaching a Definition of the Robotics Divide

The term digital divide refers, in particular, to how technology, and access to it, redefines the power structure in contemporary human societies. The questions we pose in this collective work are key for the twenty-first century. Will robotics, which is characterized by converging technologies, rapid progress, and a progressive reduction in costs, be incorporated into our societies under the current market model? Will it create a new technological, social, and political divide? Will it transform power relations between individuals, groups, communities, and states in the same way as crucial military technology? Will it change our everyday social interactions by forming part of our daily lives in the same way it has changed industry where industrial robotics is already mature and fully established? These are crucial questions, because, as we have seen in the past with other key technologies in the Western societies, technology is not neutral, and its foreseeable impacts arise from the socioeconomic models in which we are immersed. In addition, asking these questions obliges us to do two things: first, to provide data on foreseeable trends, risks, and opportunities in line with the best practice of technology assessment; and second, to provide data to enhance our scientific and technological literacy and, with it, our ability to intervene in decision making (whether political decisions via participation and representation mechanisms established in democratic societies or decisions as consumers, which have a crucial effect on the demand for goods and services).

In the following chapters, we present some results on the emerging robotics divide. In our opinion, all technology is implemented in an unequal way, owing to both its cost and usage requirements and the fact that new technologies are almost exclusively used first by what is referred to as "early adopters" to progressively expand into ever-wider layers of the population. In a parallel manner, the type of technology designed depends on the needs it aims to satisfy and the logic that lies behind every technology application, thus causing a set of frequently unanticipated, and often unwanted, side effects. Over a period of 15 years, we have conducted an ambitious prospective research project in the field of new technologies and in the area of advanced robotics in particular. From the results obtained, we have defined a new scenario: the *robotics divide*. In defining this new scenario, we have taken into account the following four dimensions:

- First, the economic as well as science and technology resources that are needed to develop robotics technology in all areas.
- Second, the ability of companies, users, and civil society to reorganize in order to increase economic productivity and incorporate industrial and service robotics into a wider number of spheres.
- Third, the market economy model and distribution of existing resources in advanced societies.
- Fourth, areas in which robotics technology entails redefining power in relation to military and space programs, as well as in the Internet (in which so-called

intelligent agents play a crucial role in accessing goods and services, which are increasingly only available online).

Given these dimensions, we can define the robotics divide as follows: *the distance or separation between those individuals, companies and states that possess the economic, as well as scientific and technological capacity and resources to develop robotics technology, have redefined their spheres of production and leisure in order to incorporate robots, can make the necessary investments in those spheres, have developed and have at their disposal advanced robots in the military and aerospace field and the Internet, and those individuals, companies and states that do not have these resources.* This distance or separation implies higher levels of economic, military, and technological power for those individuals, companies, and states that possess robotics technology and especially in critical areas such as aerospace programs or military combat robots that could gain a competitive advantage which would significantly alter the balance of power between one country and another. As a result, military robotics and aerospace robotics, along with developments in robots for the Internet, will become a strategic issue affecting competition between countries, especially between those that are set to play a leading role in the twenty-first century such as the United States, China, India, and Russia.

In leisure and domestic life, as well as health care and the care for disabled or dependent individuals, new service robots will provide a competitive advantage and could have a significant impact by reducing the need for immigrant workers (spheres of activity which are currently very labor intensive). To a certain extent, the robotics divide could introduce a new actor into our social life, the robot, which could become an assistant, a romantic partner (Levy 2007) or even a warrior, and while robots may not alter job creation in absolute terms, they could have a significant impact on some labor-intensive sectors (i.e., the immigrant workforce in the Western countries). New technologies, in particular robotics, could become a new factor to take into account when analyzing immigration flows (López and Krux 2003). In a more personal context, and to some extent one that runs parallel to the so-called digital divide as noted in some of the chapters in this book, service robotics could become a crucial technology in terms of both access and user requirements. The difference between having and not having a robot may become not only a visible sign of socioeconomic status, but also a symbol of power and wealth, thus creating a gap between the technology "haves" and "have nots" in the sense of Bourdieu. Limited access to robots could also be a clear predictor of social exclusion as they could perform many tasks that would greatly ease the burdens of daily life (not only in terms of mobility or cleaning, but also in terms of emotions and relationships). Table 2.1 summarizes some of the features of the emerging robotics divide at three different levels: states, companies, and individuals.

Table 2.1 Consequences of the robotics divide in the twenty-first century

States	Access to advanced robotics technology	Economic growth and enhanced productivity
		Greater military power
		Border control
		Technological innovation
		Conquer space
	No access to advanced robotics technology	Lower economic growth and productivity
		Less military power
		Less border control
		Lower level of technological innovation
		Increasingly distanced from the space race
Companies	Access to advanced robotics technology	Higher productivity
		Higher levels of automation
		New business niches
	No access to advanced robotics technology	Lower productivity
		Lower levels of automation
		Lower competitiveness in new business niches such as aerospace
Individuals	Access to advanced robotics technology	Automation of domestic chores
		New forms of leisure and services
		Better employment opportunities
		More educational resources associated with robots in the classroom and at home
	No access to advanced robotics technology	Greater difficulties for the disabled
		More activities related to domestic chores
		Less educational resources

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