TECHNOLOGICAL
RESPONSIBILITY

HANDBOOK ON THE SOCIALISATION OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

A tool for promoting science and technology socialisation policies addressed to policy makers, research and innovation actors and stakeholders

TECHNOLOGICAL RESPONSIBILITY

CITIZENS AND GOVERNANCE IN A KNOWLEDGE-BASED SOCIETY

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FOREWORD

Scientific and technological research is rapidly changing: the ways in which research is produced are changing; science-society relationships are becoming more complex and multifaceted; an expanding and more diversified set of actors and stakeholders is involved in the research process or is able to influence it; increasing emphasis is put on research by governments and national communities to support economic development in their own countries.

These transformations are occurring in an uneven and non linear way and their future trajectories are uncertain. What is certain is that scientific and technological research, in the "knowledge society", is and will be increasingly different – in terms of structures, functioning, meanings, social and political significance, governance, and involved actors – from the so called "Big Science"[1] which contributed to the post-war economic growth of industrial societies.

If the "Big Science" made research similar to an "industrial enterprise", current trends are making research similar to a "social undertaking", in which elements previously underrated now play an important role. We can mention, as examples, the orientation, willingness and capacity of the actors involved in science production to synchronise with each other, the degree of cooperation between scientists belonging to distinct disciplinary communities (often very different from each other as regards contents, interests, languages and culture) or the emergence and consolidation of new professions connected in one way or another with the research process.

The stakes are high. As a matter of fact, these issues are strongly related to the efforts of the European Union to make our continent a dynamic science-based economy. Also to be interpreted in this perspective is the great investment the EU is making to establish a single European Research Area, which should allow Europe to fully express its research and innovation potential.

However, as stressed by the European institutions, it is not enough to increase research funds, support research networks or reinforce research infrastructure in order to implement this strategy. More concrete policies and measures are required, capable of addressing areas which are usually neglected by policy action, such as widespread behavioural models, personal orientations, organisational dynamics, social relationships or professional practices.

[1] de Solla Price, D. J. (1963), *Little Science, Big Science*. New York: Columbia University Press

This Handbook moves in this direction. It is focused on the risk which can derive from poor socialisation of scientific and technological research, understood as an inadequate or even decreasing capacity of science and innovation systems to adapt to a changing society and to manage and steer the transformations affecting them. With time, poorly socialised research is likely to progressively lose productivity, economic significance, social impact and, eventually, and quality. Therefore, it is difficult to conceive first-class research which is not highly socialised.

Therefore, this Handbook can be viewed as an attempt to prevent and contrast these risks, by bringing together in a unitary perspective questions pertaining to innovation, organisation of research institutes, research practices, scientific communication, access to research funds or evaluation, which are still regularly undervalued (sometimes by the scientists themselves) in their overall impact on research and almost always treated separately by different groups of policy makers or experts.

By proposing socialisation as an analytical and policy key, the Handbook provides policy makers, research actors, research institutions and stakeholders with orientations and tools which will support them in quickly recognising the changes occurring, in mapping critical factors and opportunities as well as in devising suitable strategies and taking appropriate decisions. At the same time, the Handbook also aims to raise awareness and to promote a more widespread sense of responsibility about the future of scientific and technological research in Europe, also directed at actors and social sectors that feel they are not involved in science and technology.

To a certain extent, the Handbook represents the final output of an experimental process. The approach adopted in the project has been experimental in nature, characterised by a mix of research and pilot initiatives, which have seen social researchers, natural scientists and engineers work together. Also experimental is the proposed analytical framework, which is therefore flexible and open to both theoretical and empirical contributions.

The hope is that the work carried out, notwithstanding its inevitable limits, could be helpful in acknowledging and enhancing the many experiences in science and technology socialisation already active in Europe and in sustaining new and more effective policies and measures able to ensure a greater degree of embeddedness of research in European society.

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INTRODUCTION

The Handbook on the Socialisation on Scientific and Technological Research is the result of the three-year project "**Social Sciences and European Research Capacities**" **(SS-ERC)**, which was undertaken in order to address some emerging and policy-sensitive issues pertaining to the future of the European Union.

The project was intended as a contribution to the efforts made both at European and national levels to support research systems in coping with the transformation processes which are profoundly affecting them. These transformations are pushing to the forefront the relevance of the social dimension (in a broad sense) in the production of scientific and technological research and the growing complexity of science-society relationships. At the same time, they are showing the need for rendering science and technology more transparent and open to citizens.

This contributes to making research more dynamic, but, at the same time, more difficult to interpret and steer, since at a minimum level it requires a closer cooperation among a broad and diversified range of actors as well as an increased involvement of the social sciences in order to improve the capacities of the research systems in Europe to face these changes. It is easy to understand how this changing scenario has much to do with the possibility for Europe to pursue the objectives established at the Lisbon European Council, held in March 2000, and to speed up the process of creating the European Research Area.

The **SS-ERC project** followed an approach which can be easily described as organised in **four** main steps.

The **first step** was that of **mapping the actual and potential contribution of social sciences** to a deeper understanding of science and technology. In this context, a **literature review** on the empirical and theoretical contributions of the social sciences was undertaken and **a database** of European social research institutions specialised in science and technology was developed.

The **second step** was to **generate new knowledge on the increasing weight of social dynamics** (in a broad sense, including political, economic, relational, cultural, and organisational dynamics) embedded in scientific and technological research and on the changing relations between science and society. For this purpose, **research** involving 5 European Member States (Denmark, Italy, Netherlands, Slovenia and Spain) was carried out.

The **third step** was aimed at producing further knowledge by **testing concrete forms of cooperation between social researchers and research actors** (mainly research groups and universities) in order to improve the capacity of research actors to steer the social dynamics increasingly permeating scientific and technological research. To this end, **five experiments** (one in Denmark, Slovenia and Spain and two in Italy) were undertaken.

The **fourth and final step** was that of drawing out from the previous activities guidelines to devise strategies and deve-

lop policies aimed at enhancing the socialisation levels of science and technology, by increasing the capacity of European research systems to analyse, interpret and steer science-society relationships and the social dynamics embedded into the research process.

It is in this perspective that this Handbook has been conceived. The **document is addressed** to a wide range of actors: primarily, the **policy makers** involved, at different levels (European, national or local), in science, technology and innovation. Moreover, the **actors** who, directly or indirectly, are **engaged in research and innovation**, including scientists, universities, research institutions, science parks, high-tech incubators, technology districts and the like. Finally, the handbook could also be useful for the large number of actual and potential **stakeholders** (enterprises, civil society organisations, science communicators, etc.) concerned with science and technology. The handbook is organised in **three parts**.

Part A, titled "**A new setting for dealing with science and technology**", is intended to provide a picture of the social and political context in which the transformations affecting science and technology are occurring, also in order to better understand what is at stake in the socialisation of scientific and technological research.

In **Part B**, titled "**Orientations for interpreting"**, the dynamics of science and technology socialisation are elaborated from different angles, starting from the current state of science and technology socialisation in Europe up to the proposal of developing specific socialisation policies. In this part, a reflection on "scientific citizenships" and the development of a widespread "technological responsibility" is elaborated.

Finally, **Part C**, titled "**Processes and policies in the six areas of socialisation of science and technology**", is aimed at providing the readers with useful orientations for devising strategies, tools and measures aimed at increasing the level of socialisation of scientific and technological research, in six different socialisation areas (scientific practices, scientific mediation, scientific communication, evaluation, governance, and innovation). Each area is to be understood as both an **analytical category** to identify trends, obstacles, constraints and opportunities, and a specific **domain for action** to develop new socialisation initiatives or reinforce existing ones.

The project has been carried out under the Sixth Framework Programme for Research and Technological Development by a network of six research institutions: Science Park Office of the Tor Vergata University of Rome (project coordinator); the Danish Centre for Studies in Research and Research Policy of the University of Aarhus (Denmark); University of Maastricht (Netherlands); Laboratorio di Scienze della Cittadinanza (Italy); Primorska University of Koper (Slovenia); General Foundation of the La Rioja University (Spain).

The handbook has been edited by Wiebe E.Bijker (University of Maastricht) and Luciano d'Andrea (SS-ERC scientific project coordinator), with the cooperation of Erik Aarden (University of Maastricht) for the linguistic aspects. Special thanks are to be addressed to Sally Wyatt (Virtual Knowledge Studio for the Humanities and Social Sciences, KNAW) for her careful review of the text and valuable suggestions for its improvement.

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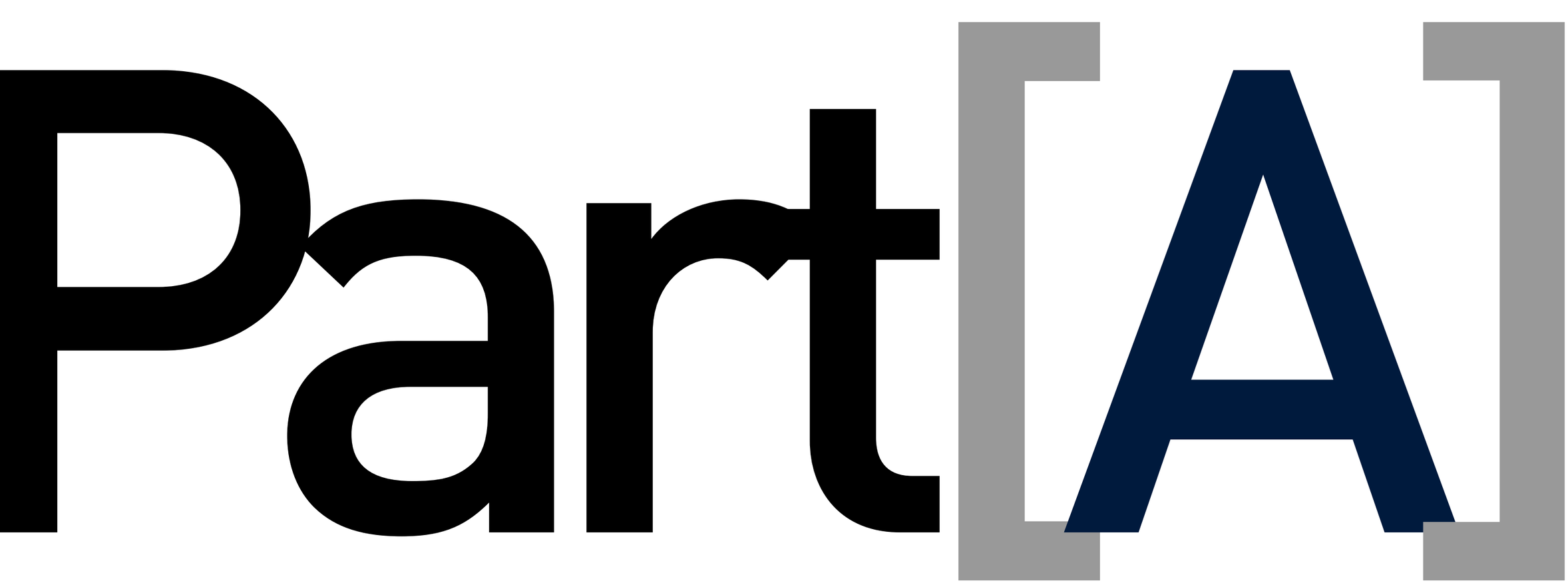
[A]

PART A

A NEW SETTING FOR DEALING
WITH SCIENCE AND TECHNOLOGY



CHAPTER ONE

THE SOCIALISATION OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

[1]

THE CONTRADICTORY CONDITION OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

Science and technology are affected by a **contradictory condition**.

Research is increasingly significant and visible

On the one hand, they are more and more politically, socially and economically **significant and visible**. Science-based innovation is increasingly acknowledged as a pivotal factor of competitiveness in the global market; science and technology are viewed as key elements for successfully coping with global problems (such as sustainable energy, growing mobility needs, food shortage, environmental protection); power and pervasiveness of technologies have increased to the point that they profoundly affect social life and even individuals' biographies.

Science and technology are therefore asked to be increasingly effective, accountable, result-oriented and able to generate benefits for people and firms.

On the other hand, in large sectors of society and political leaderships, there is an increasing **mistrust** towards science and technology and a widespread **indifference** with respect, not so much to scientific discoveries and technological innovations (which arouse interest and curiosity of the public at large), as to the **destiny of the scientific and technological research** and the **problems met by scientists and research institutions**.

A scarce "social mobilisation" around science

This **scarce "social mobilisation"** on scientific and technological research manifests itself in different ways: low appeal of scientific faculties to young people and their families; decreasing social status of scientists (also in terms of salaries) in comparison with other professional groups; increasing obstacles met by young people in accessing scientific careers; low investments on research, mainly by the private sector but, in some European countries, also by the State; a serious gap between science and culture, hindering that the often large implications of scientific research could be culturally developed; scarce attention devoted to research and innovation by large sectors of public administrations and political leaderships; the enduring forms of discrimination experienced by women in scientific careers; diffused, even if not dominant, sense of worry about science-related risks.

In sum, science and technology risk to be more and more socially marginalised and to appear as a "**foreign body**" to the social system, in the very moment in which they are taking a **driving role** for the economic and social development and are establishing closer and multifarious connections with society (box 1.1.).

[Box 1.1] VIEWS OF THE PARADOX

Science is under attack. People are **losing confidence** in its powers. (...) And yet, opinion surveys regularly report large majorities in its favour. (...) Science has **never been so popular or influential**. (John Ziman, *Real Science*, 2000)

Today, science is no longer viewed unquestioningly as the harbinger of better times. Society's view of scientific inquiry has become more sophisticated and nuanced The **gap between the scientific community and society** at large has widened. (European Commission, *Science and Society Action Portfolio,* Brussels, 2005)

Public opinion, the sentiments of voters and the bias of the media debate largely determine the boundaries imposed on scientific practice at the beginning of the 21st century. And, as we have seen, these sentiments are unmistakably **more skeptical and negative** than in the past. (Peter Drenth, President of All European Academies, ALLEA, Bratislava, 2003)

Despite increasing communication there are indications of a **disconnection between science and society**. (...) Research is not seen as an attractive field for young people to pursue as a career. (...) Fewer researchers with less available time to bridge the gap between science and public perception would not alleviate the situation. (European Research Advisory Board, 2007)

[2]

SCIENCE-SOCIETY RELATIONSHIPS

Which **factors** are at the basis of this paradox? And which **effects** does it produce?

In order to deepen these issues, it is necessary to dwell a little upon the **processes of change** that are occurring in the last decades.

Societies are changing

Primarily, **societies themselves have been profoundly changed**; and this process is still at its first steps. We left behind an **industrial society** – with its strong structures and rules, hierarchical relationships, State's centrality, well-defined boundaries between sectors, groups, disciplines and competences – to enter a more fragmented, network-shaped,

Science and technology are changing

Science-society relationships are changing

An intricate puzzle

The notion of socialisation

globalised, more dynamic and disordered "**knowledge society**", where ideas, knowledge, information and therefore science and technology are acquiring a social and economic weight they never had before.

Also, science and technology are radically changing: boundaries among disciplines are weakening, while application fields are rapidly expanding and fragmenting into thousands of research strands; the focus is increasingly put on economic and social results of research programs; organisational ways to produce research are changing. Science appears less and less a unitary, ordered and consistent entity.

Consequently, **science-society relationships are changing too**. At least up to the end of the 60s, science, although important, was not perceived as pivotal for development, as we believe today. Moreover, science was relatively separate from, but at the same time fairly integrated into, society. A limited set of actors (universities, some state agencies, some large companies) was actually involved.

Presently, a **strong intensification** of science-society relationships is occurring, at multiple levels; there are no longer "authorities" or "traffic lights" able to regulate the flows. An increasing number of actors and stakeholders are potentially involved in research production, while the pervasiveness of technology is, to a certain extent, rendering users an active part in technological development. Economic and social interests on scientific and technological research are growing and developing on a global scale. So, science and society are "compelled" to live together under the same roof and to share the same food.

Thus, if in the past, science-society relationships were a puzzle made up of a low number of pieces, relatively easy to combine together, now **the puzzle to be completed is much more intricate**, being made up of an increasing number of pieces which are more difficult to fit together.

Perhaps, the paradox of a **research** playing a central role for development, but also exposed to be socially marginalised can be understood taking into account this complex setting. As a matter of fact, this paradox is not to be seen as a phenomenon in itself, but rather as a **symptom** of broader contradictions characterising present science-society relationships.

[3]

SOCIALISATION AS AN INTERPRETATIVE PERSPECTIVE

All that brings us to the **question at the centre of this handbook**, i.e. the **socialisation of science and technology**. Used in its proper meaning, socialisation refers to the **embeddedness of an individual** – for example, a child or a foreigner – into a given society or a given social environment. Through socialisation, the new member acquires culture, social rules and meanings of society and learns to recognise and assess the expectations that the other members have about him. In this way, the individual develops his/her **personal identity** and learns to find his/her "**place**" within society.

The **application** of the concept of socialisation, not to an individual, but to the set of social institutions and human activities that we call "**scientific and technological research**" is based on this same **idea of embeddedness**.

A difficult embeddedness

As a matter of fact, most of the problems and hindrances met by scientific and technological research can be due to the fact that research is **less embedded** into society than it was in the past. Its **identity** – that is, the capacity of research systems to manage themselves and to steer the transformations which are presently affecting them – seems to be weakened and disarticulated. At the same time, its **degree of adaptation** to a changing society is low and, therefore, its "**place**" within society remains unstable and uncertain[1].

An overall profile of science-society relations

A perspective turning around the idea of socialisation offers the possibility to **overcome the great fragmentation** characterising analysis and management of science-society relationships. Actually, policy makers and social scientists (with some remarkable exceptions) tend to identify and to focus the attention on the **single questions** (the problems in scientific communication, the difficult interactions between universities and enterprises, the poor organisation of research institutions, etc.), as if they were unrelated to each other. On the contrary, the perspective of socialisation helps in understanding that we have to deal with a **single system of relations and transformations** and, consequently, allows us to reassemble an **overall profile of science-society relations**, at least in a given social or institutional context.

Operationally, in order to strengthen and make more visible this **unitary approach to science-society relationships**, socialisation has been organised in **six "socialisation areas"**, that is six large domains where it is easier to identify ongoing socialisation processes as well as those factors which could hinder, foster or drive them. These areas are: scientific practices, scientific mediation, scientific communication, evaluation, governance and innovation.

[4]

THE WEAK SOCIALISATION OF RESEARCH IN EUROPE

A mainly European problem

Even though all advanced economies have to deal with problems related to the socialisation of science and technology, in Europe the **question of socialisation is particular-**

[1] See Castells, M. (2000) *The Rise of the Network Society: The Information Age: Economy, Society and Culture*, Volume I (2nd revised edition). Oxford: Blackwell.

ly worrying (see box. 1.2). As we will see below, Europe risks lagging behind other countries (United States, China, India, South-East Asia), not only because of the low level of expenditures on science and technology, but mainly for the **lack of effective mechanisms for integrating research into society**.

[Box 1.2]

VOICES OF RESEARCHERS: THE CONTRADICTORY CONDITION OF SCIENCE AND TECHNOLOGY IN EUROPE

On the one hand researchers and scientific findings are treated with **high esteem**, almost as the carriers of truth and unquestionable knowledge, but on the other hand they are considered to be working far away from the reality of policy and practice and thus **often not taken seriously**. (…) Over-estimation seems to lead to underestimation (Netherlands)

Everybody lives surrounded by technology, [especially] young generations since they live with technology in a very easy way. Reality imposes that you are **using technology more and more frequently**… On the other hand, I think that **social consideration is very low, very insufficient**… (Spain)

I notice this gap: researchers and their institutions, knowledge and technology are generally considered to be **crucial** and **important for society**, but at the same time **researchers' salaries are much lower than that of policy officers of the same level**. In my view, this is an awkward situation (Netherlands)

Perhaps a distinction should be made between science and technology. People are **more open to science**, but **fear technology**, even though they use it extensively. The present trend in science and technology is that of no longer to distinguish between science and technology.(Italy)

(passages drawn from the interviews made in the framework of the SS-ERC project)

The weakness of the "agents of socialisation"

Obviously, also in Europe **processes of science and technology socialisation are occurring**. Actually, there are many actors (researchers, research groups, university administrators, civil society organisations, sometimes governments and local administrations) who – more or less consciously – are acting as "**agents of socialisation**", by creating new links between science and society or managing and driving the existing ones. Acting in this way, these actors allow research to advance anyhow, contrasting inaction, disinterest and resistance of other researchers, research groups, social groups and sometimes of their own government. The point is that in Europe, the "agents of socialisation" seem to be **few**; they often work in a **hostile environment**, where resistances and hindrances limit the "systemic" impact of their action; the **degree of acknowledgment** that they receive from public institutions varies country by country, but overall it appears to be **limited**; they prevalently act in an "**atomised" way,** or create short and scarcely visible co-operation chains.

Hence the urgent need for European governments and research institutions to develop **specific socialisation policies** – subject of this handbook – in support of traditional research policies, in order to sustain the agents of socialisation, to increase their number and to remove as much as possible the constraints limiting them.

Socialisation policies

[K] CHAPTER'S KEY ISSUES

- Science and technology are affected by a **contradictory condition**: on the one side, they are more and more politically, socially and economically **significant and visible,** but, at the same time, they appear to be **relatively marginalised**.
- To understand this paradox, it is necessary to dwell a little upon the **change processes** that are occurring in the last decades: the overall shift from **industrial society** to **knowledge society**; the deep transformations affecting the ways in which **science and technology are produced**; the change occurring in **science-society relationships**.
- These transformations have taken place in a very **short time span** and in a **chaotic** and **contradictory** way, producing **considerable displacement** between changes and suitable "machineries" (social, cultural, political, organisational and so on) for handling them.
- The handbook deals with this set of questions, focusing the attention on the **socialisation** of scientific and technological research, that is its degree of **embeddedness** in society, providing an overall profile of science-society relationships.
- Many authoritative sources and the same European Commission stress how in Europe socialisation processes are particularly **weak** and the actors working in support of research socialisation - the "**agents of socialisation**" – are few, they often work in a hostile environment, where resistances and hindrances limit the "systemic" impact of their action.
- Hence the urgent need for European governments and research institutions to develop **specific socialisation policies** – subject of this handbook – in support of traditional research policies, in order to support the agents of socialisation, to increase their number and to remove as much as possible the constraints limiting them.

CHAPTER TWO

THE SOCIETAL PERSPECTIVE

[1]

BEYOND THE INDUSTRIAL SOCIETY

The growing importance of science and technology is not an isolated fact. Rather, it reflects **broader transformations** that are affecting all contemporary societies. This has mainly started in the 60s of the last century but its pace accelerated in the following decades.

Almost all scholars agree in recognising these transformations as the signs of an overall shift – still in progress and, in some respects, just started – from **industrial society** to a **new type of society**, of which it is difficult to define the present profile and even more tricky to assess future developments.

The interpretations

Different interpretations of this shift (sociological, but also economic and philosophical ones) have been developed (box 2.1.). One follows from the other, they often overlap, but remain well distinguished from each other.

[Box 2.1]
BEYOND THE INDUSTRIAL SOCIETY: DIFFERENT INTERPRETATIONS

Post-industrial society. Developed, among others, by sociologist Daniel Bell[1], this notion refers to the shift in advanced societies from an economy and a social structure built on industrial production to an economy and a social structure turning around services, based on information production and management.

Information society. The expression "information society" has been mainly used to refer to the effects deriving from the technological revolution in the field of the ICTs[2] on economy and social structure (development of networks, impacts on daily life, effects on personal experience, changes in human relations and power distribution, etc[3]).

Knowledge society. The concept of "knowledge society" mainly refers, not to knowledge in itself, but to all the components (social processes, actors, learning processes, cognitive elements such as values, languages or social representations, etc.) involved with its production, storage, manipulation and diffusion.

Risk society. Coined by the German sociologist Ulrich Beck[4], the expression "risk society" put at the forefront the diminishing capacity of contemporary societies to control technological, physical and social dangers, the great majority of which are produced by the same legal, social and organisational mechanisms put in place for controlling risks. These dynamics have profound effects on social structures and individual lives (social fragmentation, uncertainty, etc.).

Reflexive modernity. The concept of "reflexive modernity" (mainly developed by sociologist Anthony Giddens[5]) focuses on the current, further phase of "social individualisation" started with modernity. This process is increasingly weakening traditional social bonds. Hence the need for both individuals and institutions to reinforce their capacity to keep a "reflexive control" over their own choices and over the consequences of their actions, being disappearing any authorities able to provide them with guidance and protection.

Liquid society. Proposed by German sociologist Zygmunt Baumann[6], this notion mainly refers to the process of "liquefaction" of those social structures (social classes, marriage, the state, etc.) which had driven modern societies up to few decades ago. This process has strong effects (instability, uncertainty, weakening of social protection mechanisms, existential precariousness, etc.), faced by individuals and institutions through devising different more or less effective coping strategies.

Post-modern society. The concept of "post-modern society" emerged in the 70s, in the framework of a large and composite philosophical movement, originated in France[7]. The core idea is that modernity, understood as a social organisation and a form of thought pivoted upon both rationality and the unitary explanations of the World (such as those offered by religions, political ideologies or science), failed its objectives. Therefore, we live now in an increasingly fragmented World, in which the authority of political, scientific and religious institutions is decreasing and the boundaries between social spheres, disciplines, categories and worldviews are increasingly blurring.

The processes of change

Although being different, the interpretations given to this overall shift seem to converge in identifying a common **set of change processes**.

The most relevant is probably that of the **modified relationships between social actors** (individuals or groups) **and "social structures"** (which manifest themselves, for

1 Bell, D. (1974) *The Coming of Post-Industrial Society.* New York: Harper Colophon Books.
2 Lash, S. (2002) *Critique of Information*. London: Sage Publications.
3 Castells, M. (2000) *The Rise of the Network Society: The Information Age: Economy, Society and Culture*, Volume I (2nd revised edition). Oxford: Blackwell.
4 Beck, U. (1992) *Risk Society: Towards a New Modernity*. London: Sage Publications.
5 Giddens, A. (1991) *Modernity and Self-Identity: Self and Society in the Late Modern Age.* Stanford: Stanford University Press.
6 Baumann, Z. (2000) *Liquid Society*. Cambridge: Polity Press.
7 Lyotard, J-F. (1984) *The Postmodern Condition*. Manchester: Manchester University Press.

example, through social norms, behavioural models, social roles, values, etc.).

In the industrial society, social structures tended to have a relatively strong control over individuals and social groups. In contemporary societies, however, individuals and groups are endowed with a **stronger subjectivity and a higher strength**. Therefore, they tend to be more autonomous, to enjoy a broader range of socially accepted options and to escape as far as possible from the control of social structures and even, under certain conditions, to modify them.

Linked to this process, there are other **no less important changes** to be mentioned.

Crisis of the institutions of modernity

- **Transformations and crisis of the "institutions of modernity".** The weakening of social structures also entails a crisis of the "institutions of modernity" related to politics, religion, economy, trade-unions or public administrations. All these institutions have lost authority, power and autonomy; they are asked to be more transparent and accountable; in order to be functioning, they are more in need of the support of users and citizens; to manage themselves, they can less and less rely upon hierarchical relationships. Some institutions prove not to be able to stand the impact of the growing and growingly fragmented demands of the public.

Uncertainty and instability

- **Growth of uncertainty and instability**. Instability increases in all sectors of social life (labour, emotional ties, social protection, etc.), because of the weakening of social structures, which, while producing a control over the individuals, also provides the same individuals with social, psychological and physical protection. Therefore, the sense of uncertainty appears to be a dominant character both in the social life and in the biographical dimension.

Social and cultural diversification

- **Social and cultural diversification**. The modified balance between actors and structures produced a strong social and cultural diversification within society. It is more and more difficult to identify homogeneous social groups or dominant behavioural patterns. Even individuals' identity is more unstable, fragmented and inconsistent. At the same time, diversification feeds a multiplication of ideas, initiatives, behaviours and forms of knowledge, accelerating social changes.

Weakening of social boundaries

- **Weakening of social boundaries**. All the "inner" boundaries within society are weakening: between social spheres, between institutions, between social groups and between cultures. New forms of social and cultural hybridisation and *metissage* constantly arise from within society.

Globalisation and localisation

- **Globalisation and localisation**. Globalisation processes are speeding up and enlarging their scope, affecting all sectors of social life. At the same time, also localisation processes (i.e. a strengthening of the local dimension in economic, social and cultural domains) are also rapidly emerging. Some authors introduced the term "glocalisation"[8], exactly for stressing the co-presence of these two apparently opposite trends.

8 Robertson R. (1995) Glocalization: Time-Space and Homogeneity-Heterogeneity. In Featherstone, M., Lash, S., Robertson, R. (eds), *Global Modernities*. London: Sage Publications.

Increasing importance of the affective-cognitive dimension

- **Increased importance of the affective-cognitive dimension**. The "affective-cognitive dimension" (feelings, expectations, worldviews, knowledge, etc.) of the social actors is getting a prominent role in all spheres of social life (politics, consumption, economy, public administration, social relations, etc.), also thanks to the huge developments in mass communication and ICTs.

The causal factors

There are many **causal factors** that contributed to producing this overall shift in contemporary society. In a sketchy and not exhaustive way, five main factors can be mentioned here.

Demographic factors

- **Demographic factors**. The impetuous population growth that occurred in the 20th century created a "critical mass" of population which produced a social pressure on state structures, administrations and services, progressively weakening them.

Education

- **Education.** Mass education greatly contributed to multiplying individuals' capacity in coping with complex problems, in developing their own interpretations of reality, in interacting with public institutions, in choosing and taking decisions autonomously and in shaping and implementing their own personal orientations.

Access to rights

- **Broadening access to rights**. The increasing recognition of individuals as bearers of rights (civic rights, political rights and, after the Second World War, social rights) previously limited to few social groups allowed all citizens to access "public arenas", public services and provisions which were previously denied to them. This reinforced the identity-building processes of people and increased the presence of citizens in organised forms within the public sphere.

Technology

- **Technology**. The escalating diffusion of powerful technologies at affordable costs hugely improved the capacity of individuals to influence and handle social and physical reality surrounding them. Moreover, technology increased the physical mobility of persons and goods as well as the opportunities to access communication and information. All these elements dramatically enhanced the range of choices and actions potentially available for individuals and groups.

Mass consumption

- **Increase in mass consumption**. The explosion of mass consumption, despite its distortive effects and risks of manipulation, strongly supported the rising of subjectivity of social actors. Actually, consumptions allowed people to concretely practice their own lifestyles and to facilitate the construction of their self-identity.

Processes of change

Collectivisation

Contextualisation

Socially-diffused research

[2]

HOW SCIENCE AND TECHNOLOGY ARE CHANGING

Like all institutions of modernity, **science and technology are profoundly changing**, moving in the same direction as the social system as a whole. Consequently, **science-society relationships** are changing too.

Different models have been developed to **interpret** these transformations, such as the "Mode1/Mode2" model[9], that of post-academic science[10] or the "Triple Helix" model[11].

While they are very different from each other, these models together allow us to shed light on the main trends of change.

- **Diffusion of cooperative practices in scientific production.** Research is increasingly a collective enterprise involving ever-enlarging spirals of scientists. Actually, it is claimed to match more complex research demands requiring, to be coped with, costly and sophisticated equipments which cannot be provided by single research institutions. Interaction among research institutions is practically unconstrained, thanks to ICTs.

- **Contextualisation**. Research is increasingly "context-driven", i.e. "is carried out in a context of application, arising from the very work of problem solving and not governed by the paradigms of traditional disciplines of knowledge"[12]. Consequently, research is more and more "problem-focused": it is no longer initiated by the interest of the scientist, but is aimed at coping with specific problems or exploiting a given opportunity.

- **Socially-diffused research**. There is a much greater diversity of the sites at which knowledge is produced as well as of the types of knowledge produced. University is no longer the unique environment for research production

9 Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S, Scott, P., Trow, M. (1994) *The new production of knowledge: the dynamics of science and research in contemporary societies*. London: Sage Publications; Nowotny, H., Scott, P., Gibbons, M. (2001) Re-*thinking Science: Knowledge and the Public in and Age of Uncertainty*, Cambridge: Polity Press; Nowotny, H., Scott, P., Gibbons, M. (2003) 'Mode 2 Revisited': The New Production of Knowledge. *Minerva*, 41.

10 Ziman, J. (2000) *Real Science. What it is, and what it means*. Cambridge: Cambridge University Press,

11 Etzkowitz, H., Leydesdorff, L. (1998) The Endless Transition: A 'Triple Helix' of University - Industry – Government Relations. *Minerva*, 36; Etzkowitz, H., Leydesdorff, L. (2000) The dynamics of innovation: From National Systems and 'Mode 2' to a triple helix of university–industry–government relations. *Research Policy,* 29.

12 Limoges, C. (1996), *L'université à la croisée des chemins: une mission à affirmer, une gestion à réformer*. Quebec: Actes du colloque ACFAS.CSE.CST, Gouvernement du Québec Ministère de l'Éducation.

- **Trans-disciplinarity**. Research is ever more trans-disciplinary in nature, while in the past it was narrowly carried out in specific disciplinary domains.

- **Quality control enlargement**. Quality control systems are changing, involving other actors beyond peers (knowledge brokers, final users, etc.) and applying multiple assessment criteria.

- **Accountability**. There is an increasing need for making science accountable towards a wide range of actors, with effects such as the proliferation of evaluation exercises and modification of research procedures (for example, disaggregation of trans-disciplinary research in order to allow disciplinary-based evaluation).

- **Utilitarianism**. Research results are expected to have economic impacts. This does not mean only applied research is done, but rather that economic utility is applied as a parameter for any kind of research program. Therefore, a discovery is assessed for its commercial value, even before it is assessed for its scientific value.

- **Political steering**. Policy makers show an increasing desire to lead the research process and to steer research priorities, both at the European (through the framework programs) and the national levels.

- **Competitive access to resources**. Access to public funds is increasingly based on competitive procedures, grounded on multiple criteria.

- **Bureaucratisation.** Research is growingly submitted to bureaucratic and administrative regulations and standardised procedures (related to, for example, work security, application for funds, evaluation and assessment, fraud control, management, etc.)

- **Hybridisation**. Relationships between universities, governments and industries are increasingly closer and co-ordinated. This results in the creation of "hybrid" structures and institutions (such as academic spin-off, high-tech incubators, science and technology parks, etc.).

Overall, these tendencies result in a **closer and complex interaction between science and society.** A pivotal contribution, in this regard, has been given by the so-called "**social-constructionist" approach**, which decisively contributed **to overcoming any deterministic view** of science-society relationships: both the one, largely dominant in the past, understanding science as an autonomous and separate entity able to deterministically inducing changes in the society; and the reverse one, undoubtedly less diffused, understanding science as fully controlled by social processes, forces and actors. Rather, this approach allowed to highlight how science and society are involved in a sort of **"co-construction" process**, since the evolution of the one is increasingly influenced by that of the other, even if not without tensions, conflicts and contradictions.

On the basis of the interpretations presented so far, some points deserving particular attention can be singled out.

Trans-disciplinarity

Quality control enlargement

Accountability

Utilitarianism

Political steering

Competitive access to resources

Bureaucratisation

Hybridisation

Co-construction of science and society

Emerging trends

The deepness of transformations

Firstly, all interpretations show that transformations presently affecting science and technology are not partial or marginal, but **deep** and "**systemic**" in nature, radically altering the way in which research is done and modifying the same social meaning of science.

"Techno-sciences"

One of the most significant effects of these transformations is that, in the new context, science and technology have become inextricably intermingled or hybridised in some sense, giving birth to a unique "**techno-scientific" system**. Science is increasingly aimed at the technological product, while technology is increasingly based on scientific procedures and technology plays an increasing role in doing research. The shift from science to technology is no longer the output of a linear process proceeding from basic research to industrial development, allowing to mark the boundary where science ends and technology starts.

Science-society co-evolution

At the same time, these transformations have made **science-society relationships much more intense and complex**. While, in the context of industrial society, science and society had few relations, being limited by social and institutional mechanisms (it is not by chance that university were viewed as an "ivory tower"), today, in the context of post-industrial society, they continuously interact at different levels, producing widespread phenomena of **overlapping** and **hybridisation**, but also **conflicts** and **mutual rejection**. Pursuing a harmonious **science-society co-evolution**, therefore, becomes particularly **difficult**, even though increasingly **necessary**, since science more and more needs society and society, to develop, more and more needs science.

Scientisation of society

This enlarged and intensified interaction between science and society is reflected in the augmenting presence of science and technology in all sectors of society. It seems that a "**scientisation of society**"[13] is occurring, that is a massive diffusion within society of ever more powerful and low-cost technological products as well as a large penetration in the daily life of the universal principles and logics on which science is based. However, this process is also occurring in a contradictory way, producing conflicts, resistances and unbalances which heavily influence the way in which science and technology are socially managed.

Research as social enterprise

This large array of processes makes research a matter which no longer involves only scientists or public agencies. Actually, scientific and technological research is becoming a complex **social enterprise** requiring to a greater extent **close cooperation** and **free-flowing communication** among many different social actors (researchers, decision-makers, financing institutions, research technicians, evaluators, research managers, enterprises, local administrations, scientific communicators, civil society bodies, ordinary citizens), each of them bearing specific interests, culture and representations of reality.

[13] Schofer, E. (1999) The Rationalization of Science and the Scientization of Society: International Science Organizations, 1870-1995. In Boli, J., Thomas, G. (Eds.), *Constructing World Culture: International Nongovernmental Organizations Since 1875.* Stanford: Stanford University Press.

[K] CHAPTER'S KEY ISSUES

- The growing importance of research reflects **broader transformations** which, mainly since the 60s of the last century but with accelerating pace in the following decades, are affecting all contemporary societies.

- Almost all the scholars agree in recognising weight and size of these transformations, even though it is **still open the debate** on whether they are the signs of an overall **overcoming of the industrial society** towards a **new type of society**. About this shift, **different interpretations** have been developed (post-industrial society, information society, knowledge society, risk society, reflexive modernity, liquid society, post-modern society).

- Notwithstanding the strong differences among them, these interpretations allow identifying a **set of change processes**, relatively unequivocal and well-defined in their core features. The most relevant of them is probably that of the **modified relationships between social actors** (individuals or groups) **and "social structures"** (which they manifest themselves, for example, through social norms, behavioural models, social roles, values, etc.), producing a weakening and crisis of the "**institutions of modernity**"

- Like all institutions of modernity, **science is profoundly changing**, moving in the same direction as the social system as a whole. Consequently, **science-society relationships** are changing too.

- To account for these transformations, different **interpretative models** have been developed, allowing to single out **some overall trends** of change within science and in science-society relations.

- These models show how **deep and systemic these transformations are**. They are leading to new ways of scientific production, an increasing co-penetration between science and technology (techno-sciences), a profound modification of the social meanings attributed to scientific and technological research and more intense and often problematic relationships between science and society.

- This large array of processes increasingly makes scientific and technological research a complex **social enterprise** requiring to a greater extent close cooperation and free-flowing communication among many different social actors.

CHAPTER THREE

TOWARDS A NEW AWARENESS
OF RISKS INVOLVING SCIENCE

As we already stressed, current transformations can put scientific and technological research at risk. In this chapter, this aspect is elaborated, focusing the attention on the **risks** that could derive from **a poor or wrong management of these changes**; risks that could affect both science and society.

Two main critical areas can be identified here:

- the **first** area is that of the **"identity"** of the scientific and technological research, that is the way in which research system controls and steers itself;
- the **second** area is that of the **adaptation** of science to society.

[1]

THE IDENTITY OF RESEARCH

The **first critical area** is that of **identity**. This concept is used here to refer to the capacity of research, so to say, to get a control over the transformations which modify it from inside and to steer them towards specific desirable aims.

As shown above, while traditional structures of research (its specific culture, operational procedures, social position, sources of authority, etc.) are weakening and even disappearing, the new ones find it hard to emerge.

Therefore, **steering the research processes** appears even more difficult, at all levels (from the management of the smallest research groups up to the development of long-term European research policies). There are several factors that come into play.

Patchy changes

First of all, transformations affecting science and technology are **not occurring everywhere** nor with the **same intensity**, they are not producing the **same effects** and their final **outputs are not really predictable.**

For this reason, **research less and less seems to be a unitary social institution**, characterised by a high level of uniformity and, therefore, by a consistent identity. On the contrary, it appears to be a multifaceted entity, where diverging rules and social practices can coexist. Scientists, too, are no longer a relatively homogeneous social group as they were in the past and the ways in which they fulfil and view their role is now extremely variable. This means that pre-defined recipes for successful support of scientific and technological research do not exist; therefore, intervening in it requires to continuously combine action and analysis.

National differentiations

In **Europe**, this picture is further complicated by the presence of **strong differences** among **member states** in the ways these transformations are interpreted and managed, even though, thanks to European institutions, important convergences are arising. These differences – which are, at the same time, a richness but also a risk for European research - are due to different factors, such as diverging scientific traditions, different structures of national research systems, diverse attitudes of people towards innovation, varied features of national economies and specific research policies devised at national or local levels.

Poor awareness by the actors of research and policy makers

It should also be remarked that the **actors involved in the research processes** (research institutions, scientists, research managers, etc.) **are usually not fully aware** of the changes affecting science and technology and of their short-term and long-term implications. Moreover, actors' reactions to change are diverging (ignoring it, resisting it, accepting it selectively, etc.). The same can be said about **policy makers.** Most of them ignore the current evolutionary trends of research; their attitudes and strategies are often diverging and not so rarely inconsistent. This appears to be particularly serious since – as already highlighted – policy makers increasingly show a desire to directly steer the research process.

Expert knowledge and post-normal science

Another factor influencing the "identity" of research is the **growing pressure on research institutions** (primarily enacted by governments and international institutions, but also by important sectors of the public and of civil society) to **address complex high-impact problems** (related to health, environment, energy, and the like) and to be **more committed to policy making processes**. Consequently, increasing attention is devoted to the nature and role of "**expert knowledge**" in social life and in policy making, with special reference to its actual use in the different sectors and its relationships with "ordinary knowledge". In this same framework the large debate on so-called "**post-normal science**" can be understood as well. This is on the epistemological ground, procedures and rules characterising research in cases where "facts are uncertain, values in dispute, stakes high and decisions urgent"[1].

Mis-steering

Beyond these overall considerations, there are **some specific risks** deserving particular attention[2].

The main risk is that of "**mis-steering**", i.e. the scarce capacity of decision makers (be they scientists or not) to adequately lead the research sector (box 3.1.). This is due to, e.g. an inadequate knowledge of research dynamics and mechanisms, wrong choices among conflicting priorities, under- or over-estimation of given research sectors in terms of economic potential, lack of scientific culture or failures in identifying or mobilising key actors.

Shortage of adequate skills and expertise

This kind of risk is worsened by the shortage and bad use of professional figures increasingly necessary in the research process. In the European research base, for example, there are problems with the presence and effective use of professionals with **skills and**

1 Funtowicz, S., Ravetz, J.R., Post-normal Science. *The Encyclopedia of Earth*, (www.eoearth.org/article/Post-Normal_ Science)

2 See SS-ERC Project (2007) *Final Research Report*, (http://www.techresp.eu)

expertise on, e.g. research management, university-enterprise relationships, European funding process, scientific communication, management of large research networks, high-tech incubators, technology screening or academic spin-off. In this way, on the one side, scientists risk to be damaged in their research activities (since they have to take an overload of work) and, on the other side, there is an increase in research costs as well as waste of time and resources.

[Box 3.1]
VOICES OF RESEARCHERS:
MIS-STEEERING

Many people here are stressing the extreme power of politics on research. I do not see it. Rather, I see **the weakness of politics**. There is a **gap in the policy makers' capacity** in guiding the research sector, in assessing the weight and potentials of the research projects, in embedding research within policy programs (Italy)

It's a problem that the government doesn't know the inside of research problems, so **they aren't capable of asking the right questions** and they can only stick to their (different) perspective (Netherlands)

(Policymakers) still think in **linear models and input-output models**. Policymakers have expectations that are often unrealistic, in particular to some fields of science (Denmark)

Other risks are **wrong prioritisation of research areas** and **waste of resources** – narrow prioritisation that may have consequences for future research, or funding allocated only to areas which are "in" (example: nano-technology). (Denmark).

Because of a lack of goals, (at the European level) there are no choices made. They are trying to satisfy all parties and not society in general. **There's a lack of decisions and learning from mistakes**. Too many countries and inadequate skills prevent learning and advancement (Netherlands)

Political leaders are unprepared. They still continue "to think analogically"; therefore, they cannot imagine the future in a "digital way" (Italy)

(passages drawn from the interviews conducted in the framework of the SS-ERC project)

Over-steering

Another risk is the tendency by policy makers to **over-steer research**. This could result in different kinds of negative effects such as conflicts, forms of subordination of researchers to policy makers, useless and/or uncoordinated evaluation exercises, psychological stress among researchers. This phenomena have been already recorded in different national contexts (e.g., Denmark, the Netherlands), also with reference to the European research policies.

Rhetorical steering

There is also the risk that policy makers could use the increasing significance of science as a **symbolic tool** to be used in the political arena and in public debate. There is a "rhetoric" about the centrality of science and innovation which sometimes generates a "**rhetorical steering**" of research, that is an action aimed at increasing the political control on research but not interested in supporting research or in pursuing specific objectives. This often results in measures and programs carried out without following precise strategies and even without investing the necessary resources.

[Box 3.2]
VOICES OF RESEARCHERS:
OVER-STEERING AND RHETORICAL STEERING

Another central risk is the **growing wish/need among politicians to manage and control research**. Of course there is a legitimate demand for knowledge - the return of the investment from the taxpayers, but there is a need to understand that research and new findings - to a certain extent - cannot be planned and orchestrated top-down (Denmark)

Thus, there is quite a wide **gap** between the **bureaucrats** who have **to 'score' short-term**, and the **scientists** who are more driven by the **progress of science** and try to adept just enough to qualify for the funding (Netherlands)

A central risk is that related to mercerisation of the research – because it represents a threat to the creativity and independency of the research communities and **in the long run could produce less fruitful results** (in spite of the growing investments and societal interest in research) (Denmark)

The problem which we encounter in practice arises from the fact that in everyday life **the need for science is mainly declarative**: more science is needed, more information is needed and this is what will make Slovenia more competitive. In practice, concretely, i.e. in the operative sense, it is much harder (Slovenia)

There is the danger of **over steering of research in both industry and academic settings** (…) One should not depart from the principle of trust: one should trust the intelligence of science and the ability of scientists to think reasonably, to not push them and make them obey politicians and bureaucrats (Netherlands)

In this context (of political centralisation of research), the researchers are asked only to implement **what is required by the economic intelligence** (Italy)

European laws and regulations in any area are too much. Too many rules, too much red tape, and this hinders innovation. The huge amount of bureaucracy takes time and also decreases creativity. (Netherlands)

While we are debating on the centrality of the research, **we are cutting the public investments on research** (Italy)

(passages drawn from the interviews conducted in the framework of the SS-ERC project)

Free-riding by private firms

Also the **orientations of the private sector** could carry some risks (box 3.3.). The most relevant of them is that enterprises, especially small and medium-size ones, although the context may be favourable to them, still face great difficulties in investing in research and in linking up with the research sector. This sometimes generates a real tendency to **free-riding**: companies try not to take the risks linked to scientific research (necessarily high) waiting or actively acting for transferring these risks on the shoulders of public actors (through public incentives to innovation, public funded initiatives to facilitate university-industry relations, forms of knowledge spill-overs from public research institutions, etc.).

[Box 3.3]
VOICES OF RESEARCHERS:
ENTERPRISES AND RESEARCH

Smaller companies do not realise the benefits good knowledge management brings. The **absorptive capacity of companies is limited** but they do not think this is a real problem (Netherlands).

The **interest of enterprises is only utilitarian** (…). They are not involved with research but mainly with the technological development in the short run (Italy)

(There are) few initiatives of private companies to increase R&D.(Spain)

There is a poor sharing of **responsibility**, mostly on the part of the **private sector**. Companies in the Netherlands do not keep up with their R&D expenditure (Netherlands)

I do not see enterprises which are particularly mobilised on research issues. This is mainly a problem of the lack of scientific culture (Italy).

(passages drawn from the interviews conducted in the framework of the SS-ERC project)

Therefore, as far as this first critical area is concerned, the overall question to be coped with is that of **endowing scientific and technological research with adequate tools to "control itself"**. Scientific and technological research needs qualified human resources, knowledge, procedures and means allowing those who are involved in the research process to timely recognise and interpret change processes and to drive them towards desired objectives, by supporting or, when necessary, countervailing them.

Increasing the capacity of scientific and technological research to control itself

[2]

THE ADAPTATION OF RESEARCH TO SOCIETY

The **second critical area** is that of **science-society relationships**.

Intensifying science-society relationships

As already underlined, these relationships are **increasingly intense and complex**. Because of the weakening of the traditional structures of modernity, which tended to keep science relatively isolated from other social spheres, and as a consequence of the diversification of science and technology production sites, today science constantly interacts with society at different levels, in many ways and through multiple channels. There are no longer gatekeepers or recognised authorities able to regulate this intense traffic of exchanges.

Reaching a state of equilibrium, even though a dynamic one, between science and society appears to be more difficult and the **risks** that could arise are of different nature.

The closest and perhaps the most serious risks are those of a progressive **delegitimation** and **social marginalisation** of research (box 3.4.).

Delegitimation and social marginalisation of science and technology

This is a **contradictory phenomenon**. According to Eurobarometer pools, 9 Europeans out of 10 think that scientists are giving a great contribution to the development of society; science museums and science centres are increasingly popular and attractive; popular magazines specialised in science and technology are increasing in number and diffusion. And yet, according to many sources (including various European institutions[3]), relationships between scientific and technological research and the different social spheres remain problematic. For example: the social status of European scientists seems to be declining; young people remain scarcely interested in scientific careers; research institutions in Europe are poorly attractive for young talents; people's distrust and indifference

[3] See, for example: EURAB (2007), *Research and Societal Engagement*. Brussels; Grablowitz, A., Delicado, A., Laget, P. (2007) *Business R&D in Europe; Trends in Expenditures, Researcher Numbers and Related Policies*. JRC/IPT/Erawatch, Brussels; European Commission (2007) *Towards a European Research Area. Science, Technology and Innovation. Key Figures 2007*. Brussels; European Commission (2008) *Reports of the ERA Expert Groups. Executive sommaries.* Brussels.

in science and technology is diffused, even though there are broad social areas where they are accepted and supported; very few civil society organisations and universities are engaged in working together; the interest of enterprises towards research is still limited.

[Box 3.4]
VOICES OF RESEARCHERS: RISKS OF SOCIAL MARGINALISATION OF SCIENCE AND TECHNOLOGY

When there is **insufficient communication**, the distance between scientists and citizens increases, which relates to the perceived legitimacy of science (Netherlands)

Local communities are not really interested in "rocket science", but rather in using research results in practice in order to help the development of their own community (Slovenia)

What is in danger is the legitimacy of technology: In the example Nanotechnology and GMOs you see that these technologies are in danger of losing their legitimacy because the public **does not trust the organisations [companies] working with these technologies** (Netherlands)

The risk of a **delegitimation of research in Italy is a real danger**. Result? We will be a country of technological consumers but not of technological producers, even though we will continue to generate new ideas that others will exploit (Italy)

(There is the need for) **mechanisms of social legitimisation** (…). In a, so to say, "technified" or "technocratic" society, I believe that places for a social debate and evaluation of the impact of science and technology are lacking (Spain)

People got to a point when they said "this (the science) is going very, very fast, **I can't understand it** and **I am afraid** that something will happen which I cannot control anymore." Saying that, they saw they couldn't stop the process. (Netherlands)

(passages drawn from the interviews conducted in the framework of the SS-ERC project)

Self-isolation

On the opposite side, there is also the risk of a progressive **self-isolation of research actors towards society**. Many scientists and research institutions are still working nearly as if nothing were changed in science-society relationships and within scientific and technological research. Other researchers and institutions see the claims for accountability and the criticisms moved toward science and technology by different sectors of society as unacceptable forms of interference. Initiatives for scientific communication and social dialogue on science and technology remain few, scattered, occasional and sometimes of

a pure symbolic value. All in all, there is a sort of "**viscosity**" or a **resistance** by research actors to modify their own procedures, orientations and attitudes, even though they are increasingly under pressure to dialogue with society. In this way, the main risk is that changes occur through a chain of unintended and poorly managed "landslides".

A responsibility gap

The combination of these two trends – social marginalisation of science and self-isolation of the research actors – may result in a third risk, that of the emerging of a **responsibility gap** in research (box 3.5.). This gap, or, better, a lack of diffused "**technological responsibility**"[4], is generated both by the lack of involvement of many social actors and the public at large with science and technology and by the poor commitment of many research actors in driving transformation processes affecting science and technology. Hence, the risk that narrow and even isolated groups of experts could have a large influence the research as a whole.

Scientific communication

This responsibility gap is facilitated by the poor development of **scientific communication** focused not only upon "*science in the book*" (e.g., on past discoveries, on great scientists, etc.), but also on "*science in action*" (e.g., on the activities of research institutions, on the research strategies they are devising, on the obstacles they are dealing with, etc). The risk is that people know everything about Newton or Galileo, but nothing about the research programs carried out by their city's university and research centres.

Citizens' participation

At the same time, the limited diffusion of effective participatory mechanisms keeps citizens out of decision making processes on science and technology. In this way, a responsibility gap may result in a real **democracy gap**, at least about the steering processes of research and innovation.

[Box 3.5]
VOICES OF RESEARCHERS: THE RESPONSIBILITY GAP

Responsibility for S&T is increasingly being institutionalised or 'professionalised', and to a certain extent, Denmark witnesses a **concentration of power on the hands of professional administrators**. This also means that the social distribution of responsibility is narrowing down (Denmark).

In Spain **we are really very underdeveloped** [in the issue of citizen participation in S&T]. (...) Citizens are exposed to different news and signals from the scientific system, but they never can give an opinion about what to investigate (...) There are no channels for the citizens, communities, local governments, neighbourhood associations, consumers' associations, workers' unions and organisations of businesspeople, to express their demands of research and to discuss priorities and to influence policies (Spain).

[4] Quaranta, G., (2007) Knowledge, responsibility and culture: food for thought on science communication. *JCOM. Journal of Science Communication*, 6 (4).

The question of citizens' involvement is a **tricky one**. How do you imagine citizens to participate fully? They can never participate on an equal ground. However it is important to involve citizens in an early stage of development, and not just economically before the endstage (Netherlands).

Many participatory exercises are really just 'tokenism' at worst or 'consultation' at best but not sufficiently connected to decision-making to be considered real participation. (Denmark)

People are interested in science, but it is difficult (for them) to **obtain information** that someone with a general education could process (Slovenia)

When a problem arises, there is an overdose in communication which makes the problem scaling up towards a given direction. People start worrying and mobilising, without understanding what is really happening. (…) This situation is to be prevented, through a practice of **permanent communication, making consultation with citizens possible** (Italy)

(passages drawn from the interviews made in the framework of the SS-ERC project)

Increasing the capacity of research to adjust to society

Therefore, the key problem in this **second critical area** is that of increasing the capacity of scientific and technological research **to adjust** to a more complex, contradictory, demanding and sometimes hostile society. This means both developing more effective tools of dialogue and bringing science and technology to come into terms with the **big trends** affecting contemporary societies (multi-culturalism, social fragmentation, gender dynamics, high speed communication, etc.) which, in different ways, influence research and its social and economic impact.

[3]

TECHNOLOGICAL DRIFT

As already underlined, the elements presented so far seem to show that, at least in Europe, science and technology are **in danger**.

We are not discussing about the success and positive impacts of science and technology, which are clearly visible. The pivotal question is that, despite its undisputed success, **scientific and technological research increasingly** risks to be socially undervalued, and this may lead research to produce low quality results, from the scientific perspective, and poor impacts in term of innovation.

If **research is in danger**, **society is in danger as well**.

In 2005, the European Research Advisory Board (EURAB) - an expert commission supporting the European Union in the field of research policies - tried to assess the possible consequences of a crisis of the European research systems. In particular, EURAB identified **six great challenges** (box. 3.6.) requiring high-quality and high-impact research. These challenges are putting into question the future wellbeing of European citizens and the possibility for Europe to safeguard the core elements of its own identity.

Six challenges for Europe

[Box 3.6]
SIX CHALLENGES FOR THE RESEARCH IN EUROPE

"The economic challenge - The most important priority of Europe must be growth as the sine qua non condition for the sustainability of the social model, the success of enlargement, and the cohesion and the stability of Europe. The basis for growth is investment in research & development, education and infrastructure.

The global challenge - Today's challenges are global and not restricted to the national level. Problems related to climate, energy and environment cross national borders (…) and threats to health and life quality cannot any longer be seen from a purely national perspective. (…) The creation of new knowledge to address the global challenges will require a multi-facetted expertise and competence not often found in one single institution or country.

The demographic challenge - Europe has a problematic demographic profile in which a decreasing working generation has to sustain an increasing ageing population. (…) As a consequence, European innovation and efficiency needs to be at a higher level than those in other parts of the world, including the USA, to maintain economic competitiveness and to meet the demands of the health care system. Thus, Europe should not only aspire to reach the level of US research funding, but even try to exceed it.

The health challenge - With an aging population comes also an increased demand for extended medical care. With the completion of the Human Genome Project, medicine is about to enter a new era of earlier diagnosis, more individual treatment, better prevention of diseases and maybe new types of treatment.

The European cohesion challenge - A condition for increasing the European com-

petitiveness is a stronger cohesion between countries, regions, and also within our societies. In particular with the expansion of the EU, an upgrading will be necessary of national knowledge and levels of research infrastructure for newly accessed member states in synergy with the structural funds to enhance growth and employment and to guarantee the European cohesion.

The European culture challenge - The concept of European Cultural Heritage in the context of the enlarged European Union could also be a key focus for a new research effort to explore its meaning in Europe's growing and diversified multi-ethnic societies.(…) Understanding culture, language and society is a key factor for more security and to solve religious, cultural and social conflicts."

(Excerpt from EURAB (2005) *The Financial Perspective for Framework Programme 7 and Criteria for the Selection of Topics for the Work Programmes.* Brussels)

Technological drift

Moreover, the limited capacity of scientific and technological research system to control itself and to adjust to a changing society could trigger widespread and serious process of "**technological drift**", which could lead into an overall deterioration of the social and economic system.

We can speak about a "drift", since science should be produced anyway, but in the absence of any effective social and political orientation and public interest. Consequently, research could become ever less important in both economic and social terms.

Scarce or bad connections between research and society at different levels could produce **different effects**.

Researchers' and research institutions' motivations, strategic orientations and aims would progressively weaken and even fade, up to the point of losing the capacity to collect and mobilise "**human agency**" and resources needed for carrying out high quality research.

Science and technology would keep a pivotal role in the social life. However, national and local communities would be increasingly dependent from technology produced elsewhere, no longer being able to manage, adapt, modify, develop and use it. Forms of "**technological dependentism**" could arise, exposing European countries or some of them to economic subordination, brain drain and cultural colonisation from abroad.

The "**drift effect**" could be further worsened by the **shortage of high quality researchers and experts** and the lack of good **research infrastructures.** This could reduce the capacity of European societies to govern themselves and to cope with the complex economic, social, environmental and technological problems challenging them. They would be less capable to master themselves; they would increasingly develop by imitating and applying external models; finally, they would no longer have the cultural tools and the "social force" needed to build up their own future.

[K] CHAPTER'S KEY ISSUES

- **Two main critical areas** for research could be identified.
- The **first area** is that of the "**identity" of scientific and technological research**, which is the capacity of research, so to say, to get a control over the transformations which modify it from inside and to steer them towards specific desirable aims.
- The **second critical area** is that of **science-society relationships.** These relationships are **increasingly intense and complex:** science and technology constantly interact with society at different levels, in many ways, and through multiple channels. There are no longer gatekeepers or recognised authorities able to regulate this intense traffic of exchanges.
- These two critical areas required to be coped with reinforcing the capacity of European research systems both to **steer themselves** and **to adjust** to a more complex, multifold, contradictory, demanding and sometimes hostile society.
- The elements presented so far seem to show that, at least in Europe, research is **in danger**. Despite their undisputed success, **research increasingly** risks to be socially marginalised, to lose in weight and visibility, to be addressed toward wrong goals, to be far from the needs of society. In the middle run, this may lead research to produce low quality results, from the scientific perspective, and poor impacts in term of innovation.
- In this framework, the capacity of Europe to cope with the **big challenges** putting into question its future would be reduced. In particular, widespread processes of "**technological drift**" could arise, leading to an overall deterioration of the social and economic system and an increasing dependence from technology produced elsewhere.

CHAPTER FOUR

THE POLICY GAP

This first part of the handbook has been aimed at outlining **the main themes** revolving around science and technology in contemporary societies.

Even though in a sketchy way, the main changes affecting societies as a whole and in particular those involving scientific and technological research have been examined. This allowed us to highlight how profoundly are the transformations that have been occurring in the last decades in the ways of production of science and technology as well as in science-society relationships.

As we saw above, these changes encouraged **positive tendencies** towards a more productive, accountable, open and problem-oriented research. However, many **problems** are arising in the way in which these transformations are perceived, welcomed, interpreted, managed, supported and driven by the many actors today concerned in science and technology production, by the stakeholders and by the public at large.

To complete the picture of the main themes connected with science, technology and society, one aspect remains to address, i.e. which policies have been devised to deal with these changes, which are their objectives and what are their results so far. Therefore, in the next secton, a short presentation of the policies developed by the European Union to cope with the transformations involving science and technology in the context of the "knowledge society" will be offered.

[1]

EUROPE AND ITS COMPETITORS

The Lisbon Strategy

In Europe, in the last decades, a new vision of science and technology has been progressively emerged. This vision sees science and technology as the **structural backbone** of and the **fuel** for a broader transformation radically affecting contemporary societies as a whole, to be strategically driven.

This vision found its utmost expression in the so-called "**Lisbon Strategy**" (box 4.1.). Established in 2000, the Strategy is aimed at favouring the convergence between research and other key-sectors for the European economic and social development. Therefore, the Lisbon Strategy can be understood as the European "**global strategy**" for the beginning of this century.

[Box 4.1]
THE LISBON STRATEGY AT A GLANCE

The Lisbon strategy is aimed at achieving results in three domains: economy, social protection and environment.

As for the **economy**, the strategy was intended to enhance ICTs, to promote a strong co-ordination of research at the European level, by creating a common European Area of Research and Innovation (ERA), to promote a more friendly environment for business (and mainly for SMEs) and to improve the circulation of goods, persons, services and capital within Europe.

As far as **social protection** is concerned, the Strategy is based on the assumption that creating a knowledge economy requires the enhancement of the working and living conditions, promoting a more flexible social protection system. This requires reorganising the education system, enlarging the presence of women in the labour market, the adoption of an active employment policy and the adoption of new measures against poverty and social exclusion.

Finally, as for the **environment**, the objective is that of promoting an environmentally sustainable economic growth, starting from some priority sectors (climate change, viable ecological transport, health security, sustainable use of natural resources, clean technology, greenhouse effect).

Since its establishment, the Lisbon Strategy **met many obstacles in its implementation** to the point that a complex process of revision and re-launch was started.

The Revised Lisbon Strategy

On the basis of the results of a specific commission – led by the Dutch former prime minister Wim Kok – in charge of assessing the implementation of the Strategy, in 2005 the so called "**revised Lisbon Strategy**" was established, introducing both substantive changes (narrow focus on the economic dimension, with respect to environmental issues and social protection) and methodological ones (definition of new "integrated guidelines for the Strategy implementation"; reform of governance and monitoring mechanisms, by establishing two 3-year cycles of implementation; production of an annual report on the Strategy implementation stage by each Member State).

The European Research Area

Although its overall results are still disappointing, the Lisbon Strategy made a deep transformation of the European research policies possible, mainly by establishing, as their common objective, the creation of the so-called **European Research Area (ERA)** (box 4.2.).

[Box 4.2]
THE EUROPEAN RESEARCH AREA: ESSENTIAL FACTS

In 2000, in the framework of the Lisbon Strategy, the EU decided to create the European Research Area (ERA), that is a unified research area all across Europe based on **six main principles**:

[a] An adequate flow of competent researchers – The ERA could enable researchers to move and interact seamlessly within Europe, by creating a single labour market with attractive working conditions for both men and women.

[b] World-class research infrastructures – The ERA could allow the building of research infrastructures which should be integrated, networked and accessed through the concomitant development of new generations of electronic communication infrastructures, both in Europe and globally.

[c] Excellent research institutions – The ERA could progressively structure itself along the lines of a powerful web of research and innovation clusters, mostly interdisciplinary, able to interact routinely with the world of business as well as to engage in durable public/private partnerships.

[d] Effective knowledge sharing – The ERA could make possible: an open and easy access to the public knowledge base; a simple and harmonised regime for Intellectual Property Rights, including a cost-efficient patenting system and shared principles for knowledge transfer and cooperation between public research and industry; innovative communication channels to give the public at large access to scientific knowledge, the means to discuss research agendas and the curiosity to learn more about science.

[e] Well-coordinated research programs and priorities - The ERA could allow the identification of research priorities for Europe through joint foresight, involving the scientific community, society and industry, and jointly decided and acted upon joint programming, implementation and evaluation of public research investments at European level on issues that go beyond the capacities of individual countries.

[f] A wide opening of the European Research Area to the world – The ERA could feeding the participation of neighbouring regions of the EU, as well as on developing multilateral initiatives to address global challenges with EU's partners.

Like the entire Lisbon Strategy, the process of creation of the ERA has been **submitted to a revision**. In 2007, the European Commission published a Green paper[1], on the basis of the work done by a set of expert groups, on the state of implementation of the ERA. The evaluation allowed to identify some important advancements as well as some serious hindering factors

[1] European Commission (2007) *Green Paper. The European Research Area: New Perspectives.* Brussels.

The advancements...

The most **important advancements**, according to the Green paper, have been:

- the substantial increase in the European research funds starting with the launch of the 7th EU Research Framework Programme;
- the launch of initiatives (European Technology Platform, ERA-Net) geared to improve the co-ordination of research activities and programs;
- the more extensive use of the "open method of co-ordination", which supported the convergence of the Member States on common objectives (such as that of reaching the target of 3% of the GDP on research and development);
- the establishment of a "broad-based innovation strategy";
- the increasing importance recognised to "the development of research and innovation capacities, particularly in less developed regions" in the framework of the cohesion policies.

...and two critical points

The document stresses also **two main critical points** in the creation of the ERA.

The **first** is the **high fragmentation of the public research base**. Among the main factors producing this situation, the experts highlighted: the existence of legal and practical barriers hampering the mobility of researchers among institutions, between public and private sectors and among countries; the problems met by enterprises in co-operating with research institutions; the limited co-ordination among national and European research funds; the limited attention given to the European perspective in reforming the national research systems.

The **second** critical point is the poor capacity of the European research base to be competitive enough **to attract private investments on science and technology**. This impedes to overcome the present 1.9% of GDP devoted to R&D.

European Science and Society Action Plan

Another European policy worth mentioning is the strategy geared to **improve science-society relationships**, launched in 2001 and embodied in a specific **Action Plan** revolving around three main axes:

- promoting scientific and education culture in Europe;
- bringing science policies closer to citizens
- put responsible science at the heart of policy making, strengthening the ethical basis of scientific and technological activities, detecting and assessing the risks inherent in progress, and managing them responsibly on the basis of past experience

The competitors

These growing efforts made by European institutions are justified by the fear that

Europe, losing ground in the domain of research, **could not keep pace** with other more dynamic economies.

These worries are not ill-founded (box 4.3.). Actually, main indicators show that **European research is decreasing in weight and quality** in the global scale, with respect to both the traditional competitors (USA, Japan) and the new Asian emerging countries (China, India).

[Box 4.3]
THE COMPETITORS OF THE EUROPEAN RESEARCH

R&D Expenditures. "Europe's R&D intensity remains at a lower level than the R&D intensities of most of the other major world economies such as the US, Japan and South Korea. (….) In 2005, only 1.84 % of GDP was spent on R&D in EU-27. In Japan, the US and South Korea (…) the trend over the past decade has been much more positive, outpacing Europe's performance in R&D intensity growth (….) China will have caught up with the EU by 2010 in terms of R&D intensity."

Human Resources. "Asian countries that have been a major source of mobile human resources in S&T for both Europe and the US are developing their own S&T infrastructures. During the past two decades, two-thirds of foreign students earning a US S&E PhD were from Asia (…) China already surpassed the EU with 4.4 million graduates from tertiary education compared with 2.5 million in the EU."

Private sector. "The private sector contribution to the financing of R&D in the EU has not progressed substantially over the past 10 years. R&D financed by the business sector remained at about 1 % of GDP in the EU, without any noticeable variation over the decade. In 2004, the private sector financed 64 % of total R&D in the US, 67 % in China and 75 % in both Japan and South Korea, compared to only 55 % in the EU."

Scientific Outputs. "The EU is the world's largest producer of scientific output, as measured by its share in the world total of peer reviewed scientific articles: in 2004, the Union represented 38 % of world scientific output, compared with 33% for the US and 9 % for Japan. (….) However, the shares of both the EU and the US have been declining in recent years, because of the rise of new global actors such as China and India. The total number of scientific publications produced each year grew by less than 10% in the advanced economies between 1997 and 2004 (by 6-7 % in both the EU and the US) while, in the emerging countries, it rose by more than 40 %. Chinese annual scientific output almost doubled between 1997 and 2004."

(Excerpts from European Commission [2007] *Towards a European Research Area. Science, Technology and Innovation. Key Figures 2007*, Brussels).

[2]

DEVELOPING SCIENCE AND TECHNOLOGY SOCIALISATION POLICIES

The European engagement in the field of scientific and technological research has been and still is **steady** and **strong**. This allowed to make important steps toward the construction of the European Research Area. However – as stressed by the same European institutions – the difficulties to cope with are still many.

Only part of them can be brought back to e.g. research funds, research infrastructures, number of researchers, legislation or the institutional structure of the European research systems. Actually, with the same investment levels, scientific and technological research in Europe could be more effective and performing if social dynamics, in a broad sense, connected with research were successfully handled.

These dynamics, when ignored or poorly managed, may manifest themselves as constrains and obstacles of different nature (e.g. conflicts, tensions, tendencies to resist changes, lack of co-ordination and communication, lack of skills and capacities, lack of transparent behaviours, etc.) affecting various areas of the research process (research practices, innovation, communication, etc.). The picture is further puzzled by the high fragmentation characterising the 27 member states, each of them displaying different combinations of problems and potentials to be approached through specific strategies.

In this framework, it appears to be appropriate to speak of a **gap** in the capacity of the European and national policies to handle social dynamics embedded in science and technology. This results, in turn, in a decreasing effectiveness of research actors to implement research policies as a whole. It is to be noticed the effort made by European institutions also in devising new policies specifically addressing these issues (e.g. scientific communication, scientific evaluation, university-industry relationships). However, the picture is still fragmented and incomplete. In many cases, what is lacking is a more co-ordinated action able to have impacts on the primary social mechanisms, personal orientations, diffused behavioural patterns, social relationships which day by day contribute in shaping the research process.

As we already anticipated, in this handbook, we are proposing to cope with this broad range of phenomena and processes in a single perspective, that of the **socialisation of scientific and technological research**. This choice should be helpful in mapping up the obstacles to overcome, but above all in developing, at the appropriate level (department, research institution, local level, etc.), effective measures to fill this policy gap.

In this perspective, in Part B, an **interpretative perspective** hinged upon the concept of science and technology socialisation will be elaborated. In Part C, a set of orientations

aimed at developing **policies and measures** in support of the socialisation of scientific and technological research will be proposed.

[K] CHAPTER'S KEY ISSUES

- The last issue to deal with in this part of the handbook is that of the **policies** devised for coping the problems connected with the transformations occurring in science and technology.

- In Europe, the effort in support of science and technology found its utmost expression in the so-called "**Lisbon Strategy**", launched in 2000. Particularly relevant, in this framework, is the objective of creating a single **European Research Area** (ERA). At the same time, the European Union, in 2001, established an **Action Plan** aimed at improving science-society relationships.

- The implementation process of the Lisbon Strategy, as well as that of the creation of ERA, up to now met a set of **serious hindrances**, rendering **European research base** still **highly fragmented** and **not competitive enough** to attract private investments.

- European institutions have tried to cope with these problems by **revising the measures** taken and by **establishing** a series of **new implementation and monitoring procedures**.

- The worries of European institutions about the delay of research seem not to be ill-founded. Actually, main science and technology indicators show that **research in Europe is decreasing in weight and quality** on the global scale, with respect to both the traditional competitors (USA, Japan) and the new Asian emerging countries (China, India).

- In this regard, it appears to be appropriate to speak of a **gap** in policy making exactly concerning science and technology socialisation, to be overcome as soon and effective as possible.