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Introduction - technologies and European integrations

Inga Ulnicane

Abstract:

This introductory chapter to the technology section provides an overview of complex relationships between technologies and European integrations. First, it highlights that in European integration literature the term 'technology' is often in multiple ways typically without explicit reflection on its meaning. While the term technology is frequently used in instrumental ways, this chapter emphasizes political, social, and cultural aspects of technology. Second, the chapter outlines three modes of European integration relevant for technology: first, 'hidden integration' of technology as infrastructure; second, integration outside the treaty framework, and, third, integration of technology policy within the EU. Finally, the chapter concludes with some questions for future research on mutual shaping of technologies and European integrations.

> The history of Europe in the 20th century is in no small part a history of big technological projects, within and beyond the nation-state. Such projects have often surpassed their obvious function as technological artefacts or systems, generating a rich array of symbolic meanings, political ramifications, and economical consequences (Trischler and Weinberger, 2005: 49).

Multiple relationships between technologies and European integrations are outlined in a growing but disperse scientific literature on history, politics, society and economics of Europe. Put simply, technologies have shaped European integrations and European integrations have shaped the development and use of technologies (Cramer and Hallonsten, 2020; Kaiser and Schot, 2014; Mitzner, 2020). However, this is a highly complex topic, because in the case of technologies a number of modes of European integration within and outside the European Union (EU) have been present and intertwined. Moreover, what is meant by 'technology' is far from straightforward. In European integration literature the word 'technology' is used in many different ways, often without any explicit reflection on what it does mean. Thus, it is necessary to start this introduction to the section of

technology topics with a review of the term 'technology' before outlining a number of modes of European integration relevant for technology.

Technologies: Multiple meanings

What is technology? It might sound like a simple question, but finding an answer in the scientific literature can turn out to be challenging. In his critical history of this concept, Eric Schatzberg highlights confusion surrounding it admitting that "the definition of *technology* is a mess" (Schatzberg, 2018: 1) and "its multiple meanings are contradictory. In popular discourse, technology is little more than a shorthand for the latest innovation in digital devices" (Schatzberg, 2018: 1). He defines technology as "the set of practices humans use to transform the material world, practices involved in creating and using material things" (Schatzberg, 2018: 2). Importantly, Schatzberg distinguishes between cultural and instrumental understandings of technology, where the former sees technology as a creative expression of human culture, while the latter approaches it as a mere instrument that serves ends defined by others (Schatzberg, 2018: 3). Instrumental approaches to technology can often be seen in public policy, as is the case with an authoritative definition coming from the Organisation for Economic Cooperation and Development's (OECD) Oslo Manual that

> Technology refers to the state of the knowledge on how to convert resources into outputs. This includes the practical use and application to business processes or products of technical methods, systems, devices, skills and practices (OECD/Eurostat, 2018: 254).

However, such instrumental and business-oriented definitions of technology are challenged in social sciences and humanities literature that emphasizes political, social and cultural aspects of technology. Schatzberg believes that a shift from instrumental to cultural approach to technology would "help humans exert more conscious control over their technological futures" (Schatzberg, 2018: 15).

Social and political aspects of technology are important for understanding the mutual shaping of technologies and European integrations. A relevant concept here is that of socio-technical systems

that highlights that technical artefacts do not operate in isolation, but are integrated and interacting with other technical and non-technical elements in society and the economy (Borras and Edler, 2014). Scholars in Science and Technology Studies in particular focus on co-creation of technology and society. Langdon Winner writes that "technologies are not merely aids to human activity, but also powerful forces acting to reshape that activity and its meaning" (Winner, 2020: 6). For him, technologies "are ways of building order in our world […] In that sense technological innovations are similar to legislative acts or political foundings that establish a framework for public order to endure over many generations." (Winner, 2020: 28-29). Similarly, Sheila Jasanoff states that "technological choices, are, as well, intrinsically political: they order society, distribute benefits and burdens, and channel power" (Jasanoff, 2016: 243).

Furthermore, in scientific literature as well as in policy documents, including in the area of European integration, the term 'technology' is often used next to or even interchangeably with related terms such as science, research, innovation, knowledge, and infrastructure (Edgerton, 2017). While traditionally these terms have had predominantly positive connotations and been associated with progress and growth, today it is increasingly recognized that they can have positive as well as negative social consequences (Diercks, Larsen and Steward, 2019).

Modes of European integration of technologies

In many ways and for a long time, technological activities have been highly internationalised and integrated in Europe. At the level of scientific and technological community, scientists, engineers and inventors have collaborated and communicated across national borders for centuries (Kastenhofer and Molyneux-Hodgson, 2021). Such exchanges have been greatly facilitated by common standards and vocabulary developed and diffused through European and international professional societies, meetings, and journals. Thus, in various ways the European integration of technologies precedes and goes beyond traditional political integration that started in the mid-20th century and eventually led to the establishment of the EU. In this introduction, three modes of European integration are discussed:

first, ‘hidden integration’ of technology as infrastructure; second, integration of science and technology outside the Treaty framework; and, third, integration of technology policy within the EU.

‘Hidden integration’ of technology as infrastructure

Historians of technology have studied European integration as a process of linking and delinking infrastructures (Misa and Schot, 2005). For them, technologies are European infrastructures, namely, transnational networks, such as road, rail, telephone, or electricity supply networks, which they also describe as large technical systems and infrastructural Europeanism (Schipper and Schot, 2011; Van Der Vleuten and Kaijser, 2005). They situate technology in a broader social and cultural analysis of Europe and focus on processes of ‘hidden integration’ and ‘hidden fragmentation’, which they make visible by giving attention to the linking and delinking of infrastructures, and to the circulation and appropriation of products, and systems of knowledge (Misa and Schot, 2005: 3).

These analyses of infrastructures show that “the integration of Europe was a historical process that began in the 19th century, that it unfolded unevenly across the 20th century, and that a history of European integration must be placed in a global context, including colonization, decolonization, and transatlantic crossings” (Misa and Schot, 2005: 3). Thus, history and integration of technology in Europe is seen as a part of global diffusion, circulation and exchange of technology including in the former European colonies (Arnold, 2005). Today, focus on the role of infrastructures in European integration is also important when analysing relevant EU policies, such as in the area of transport (Dyrhauge, 2021: in this book).

Integration of science and technology outside the Treaty framework

During the first decades of European integration from the 1950s until the 1970s, most cooperation initiatives in the field of science and technology (see Table 1) emerged outside the initial Treaties establishing the European Communities (Cramer, 2020; Cramer and Hallonsten, 2020; Hallonsten, 2016; Krige, 2003; Papon, 2009; Trischler and Weinberger, 2005). These intergovernmental initiatives were either large-scale research facilities that required international cooperation, such as the

European Organization of Nuclear Research (CERN) and the European Southern Observatory (ESO) or European programmes, such as the European Cooperation in Science and Technology (COST) or the European Science Foundation (ESF) for funding international science and technology projects. Large-scale research facilities include accelerators for particle collisions and reactors for nuclear research known as Big Science initiatives, characterized by big organizations, big machines and big politics (Hallonsten, 2016; Ryan, 2021: in this book). Their establishment and maintenance requires high costs, which is an important motivation for international cooperation.

Year established	*Initiative*
1954	European Organization of Nuclear Research CERN
1962	European Southern Observatory ESO
1964	European Space Research Organization ESRO
1964	European Launcher Development Organization ELDO
1967	Institut Laue-Langevin ILL
1971	European Cooperation in Science and Technology COST
1974	European Science Foundation ESF
1974	European Molecular Biology Laboratory EMBL
1975	European Space Agency ESA
1988	European Synchrotron Radiation Facility ESRF

Table 1 Intergovernmental initiatives in science and technology (adopted from Ulnicane, 2020)

Most of these intergovernmental initiatives were launched on an ad-hoc basis without any coherent policy framework. Some of them like CERN, ESA, ESO and EMBL were established as international organizations, others such as ESRF and ILL came into being as private entities (Papon, 2009). Such ad hoc approach to establishing intergovernmental initiatives provided a lot of flexibility, but also involved lengthy negotiations and created a patchwork of different organizations rather than a systemic approach to scientific and technological cooperation in Europe.

Why did these cooperation initiatives emerge outside the Treaty framework? Firstly, initial Treaties paid little attention to cooperation in science and technology (with some exceptions, see below). Secondly, during this time, the number of Member States was very limited – initially, six, later nine Member States, while majority of these intergovernmental initiatives brought together and required cooperation of a larger number of countries.

Although these initiatives emerged outside the framework of the European Communities (EC), they have complex relationships with the EC/ EU. The Commission and the Council were involved in negotiations leading to the establishment of some initiatives, such as funding programmes like COST and ESF, which then were launched as intergovernmental initiatives preceding the start of the EC Framework Programme for funding research and technological development in 1984 (Mitzner, 2020). Over time, various relationships have evolved between these intergovernmental initiatives and the EU including participation and funding from the EU to some of these initiatives (see e.g. Lieberman, 2021: in this book). Moreover, in recent decades, in some of these areas EU policy frameworks have been developed. For example, that is the case for large-scale research facilities, which are now called European Research Infrastructures, which can apply to become part of the European Strategy Forum on Research Infrastructures (ESFRI) roadmap and use the legal framework of European Research Infrastructure Consortium (ERIC), instead of previously widespread ad hoc arrangements (Ryan, 2021: in this book; Ulnicane, 2020).

Integration of technology policy in the EU

Since the 1980s, the EU technology policy has experienced a major expansion in terms of funds, competencies and policy instruments (see Table 2). This policy area, which is established in the Treaty on the Functioning of the European Union (TFEU) as 'research and technological development', but in recent times has been known as 'research and innovation' or simply 'research' policy, is seen as a success story of European integration due to its sustained growth and impact (Mitzner, 2020).

Year	*Initiative*
1957	Euratom (European Atomic Energy Community) Treaty
1967	DG Research at the European Commission established
1973	Scientific and Technical Research Committee CREST established
1984	Launch of the Framework Programme FP
1987	Introduction of legal competence in research in the Single European Act
2000	Launch of the European Research Area
2007	Launch of the European Research Council
2009	Lund Declaration on Grand Challenges
2017	Launch of the European Defence Fund
2021	Launch of the European Innovation Council

Table 2. Key milestones in expansion of EU research policy (based on Chou and Ulnicane, 2015; Mitzner, 2020)

This EU policy area has expanded gradually (Chou and Ulnicane, 2015; Georghiou, 2001; Grande and Peschke, 1999; Kuhlmann, 2001; Mitzner, 2020; Wedlin and Nedeva, 2015). There was hardly any competence in research and technology in the initial Treaties of the 1950s. The main exception was the Euratom Treaty in 1957 on the European Atomic Energy Community which envisaged to promote research in the field of nuclear energy. At this period the European integration mainly focused on economic integration. Accordingly, initial discussions on integration in research and technology focused on their contribution to economic growth and competitiveness. Early integration steps in this area included creation of the General Directorate for Research at the European Commission in 1967 to bring together scattered efforts in research at the time (Mitzner, 2020). In 1973, the Scientific and Technical Research Committee CREST with representatives from the Member States and the Commission was established to provide advice to the Council and the Commission.

A major breakthrough in EU research policy came in 1984 with the establishment of the multiannual Framework Programme (FP) for funding research and technological development. It is the third largest item on the EU budget and amounted to approximately 8% of the EU budget 2013-2020 (Ulnicane 2016a). Over the past 40 years, the funding for the FPs has grown considerably from some 3 billion Euros allocated to the FP1 (1984-1987) to almost 100 billion Euros allocated to the most recent Horizon Europe programme (2021-2027) (European Commission, 2021).

The Treaty basis for research and technological development policy was introduced in the Single European Act in 1987. While initially the Community had only a complementary competence in this area, since the Lisbon Treaty in 2009 it is a shared competence between the EU and Member States. Article 179 of the Treaty on Functioning of the EU envisage that

> The Union shall have the objective of strengthening its scientific and technological bases by achieving a European research area in which researchers, scientific knowledge and technology circulate freely, and encouraging it to become more competitive, including in its industry, while promoting all the research activities deemed necessary by virtue of other Chapters of the Treaties.

This Treaty article mentions the European Research Area (ERA) initiative, which was launched in 2000 to further facilitate integration in the field of research and technological development (Chou and Ulnicane 2015; Ulnicane 2016a). While funding instruments from FPs dominated the EU research policy, the ERA initiative introduced the Open Method of Coordination in this policy area aiming to facilitate coordination of national research policies and investments as well as comparing and learning from good practices. In parallel, new funding instruments have been launched within the FPs. One major innovation was the establishment of the European Research Council (ERC) in 2007 (König, 2017; Nedeva, 2013). If traditionally FPs largely funded collaborative applied research, then the launch of ERC introduced EU level competition for an investigator-led fundamental research. The ERC has been seen as a success story, and a similar model has been applied to the launch of the European Innovation Council in 2021.

An important characteristic of EU research policy is that many of its elements follow the so-called differentiated integration approach (Rabinovych and Pintsch, 2021: in this book), namely, EU policy is neither uniformly nor exclusively valid for all Member States (Chou and Ulnicane, 2015; Ulnicane, 2020). Also known as Europe *à la carte* or variable geometry (Edler, 2012), this model implies that non-members and/ or a selection of members participate in some EU initiatives. A major example is the FP, which also includes a number of associated countries participating. For example, sixteen associated countries participated in the recent Horizon 2020 programme. Some initiatives, such as the European Research Infrastructure Consortia bring together a selection of members and non-members, allowing countries to pick and choose their participation according to their research priorities.

What has been driving the emergence and expansion of EU research and technological development policy? Since the early years of European integration, concerns about a 'technological gap' between Europe and other major powers have been a key driving force for establishing and expanding EU research policy. Historically, these were concerns that the EU is lagging in its investments and development of new technologies behind the United States, later – also Japan, and more recently – China (Mitzner, 2020; Sandholtz, 1992; Ulnicane, 2016a). In this context, EU research policy is seen as a way for European countries to avoid fragmentation, joining forces and improving Europe's competitive position. In recent years, this discourse that the EU should do things together to stand its ground in global technological race has played a prominent role in discussions about new digital technologies, including Artificial Intelligence (Bakardijeva Engelbrekt et al, 2021; Ulnicane, 2021: in this book). While international competitiveness discourse remains an important driving force for EU research policy, concerns about cohesion among EU countries are relevant as well and are addressed through major funding allocations for research from of EU Structural Funds in particular for Southern and Eastern Member States (Sharp, 1998; Ulnicane, 2016a).

Next to the economic competitiveness discourse, recently a new technology policy paradigm has emerged that sees addressing societal challenges in areas, such as health, environment and energy as a key objective of technology policy (Diercks et al, 2019). While this paradigm of tackling Grand

societal challenges has gained popularity in many countries, a unique feature of EU research policy is that here European cooperation is seen as crucial for addressing these challenges (Ulnicane, 2016b). The EU started to fund research on societal challenges, such as food security and climate action in its Horizon 2020 programme where societal challenges were one of the three priorities along with scientific excellence and industrial leadership. In the current Horizon Europe programme the societal challenges paradigm has been implemented by focusing on achieving the United Nations' Sustainable Development Goals and allocating part of the funding to the so-called 'missions' addressing areas, such as cancer, adaptation to climate change, and smart cities (European Commission, 2021).

This new paradigm of technology policy entails a changing understanding of the role of state and public sector. If traditionally the role of the public sector in technology policy was largely limited to market correction in facilitating economic growth, then in a new paradigm the public sector is seen as co-shaping the development and the use of technologies for public purposes, such as health and sustainability (Mazzucato, 2021). To fulfil this role, the public sector is expected to take risks and experiment in collaboration with a broad range of stakeholders, including citizens. These ideas are underpinning current investments in mission research as one of the key priorities in the Horizon Europe programme, in which different paradigms of economic competitiveness and societal challenges co-exist next to each other.

In addition to continuous expansion and diversification of EU research policy, technology increasingly becomes part of other EU policies as well. Security and defence policies are examples of EU policy areas where growing attention is given to regulating and funding technology development and use including through the recently established European Defence Fund (Calcara, Csernatoni and Lavalée, 2020; Fahey, 2021: in this book; Karampekios and Oikonomou, 2021: in this book). While these new initiatives confirm the increasing role of technologies in European integration, they also raise new questions and challenges about relationships, overlaps, and potential tensions between different EU initiatives, for example, technologies funded by Framework Programmes with their

exclusive focus on civil applications and those supported by the European Defence Fund for military purposes.

Future research directions: Mutual shaping of technologies and European integrations

As this introduction demonstrates, growing but disperse scientific literature suggests multiple ways of mutual shaping of technologies and European integrations. However, this mutual shaping often is under-conceptualized taking technologies for granted and focusing mainly on their economic and instrumental aspects. To deepen our understanding of diverse interactions between technologies and European integrations, a more reflexive engagement with the topic of technologies and their political, societal and cultural aspects in European integrations is needed. How do technologies shape European societies and cultures and vice versa? How are novel technologies and European identities co-produced (Mager, 2017)? And how do debates about technologies serve as sites of contestation over social and political futures of Europe (Mahfoud, 2021)? Moreover, it is important to examine not only the ways in which technologies facilitate European integrations, but also reflect on more problematic aspects of their roles in reinforcing old and creating new gaps and divisions within and across European societies.

Due to multiple understandings of technologies, it can be challenging to identify common features across their different manifestations from networks of infrastructures to large projects and new tools. Moreover, it is difficult to set the boundaries of this topic, because technologies are also closely intertwined and present in many areas, domains and sectoral policies, such as culture, governance, security, and sustainability. Thus, in addition to mutual shaping of technologies and European integrations, technologies are also increasingly shaping almost every area of European integration from culture and security to energy and sustainability. This raises a range of exciting scientific questions for future research on diverse, contradictory and contested roles that technologies play in European integrations.

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