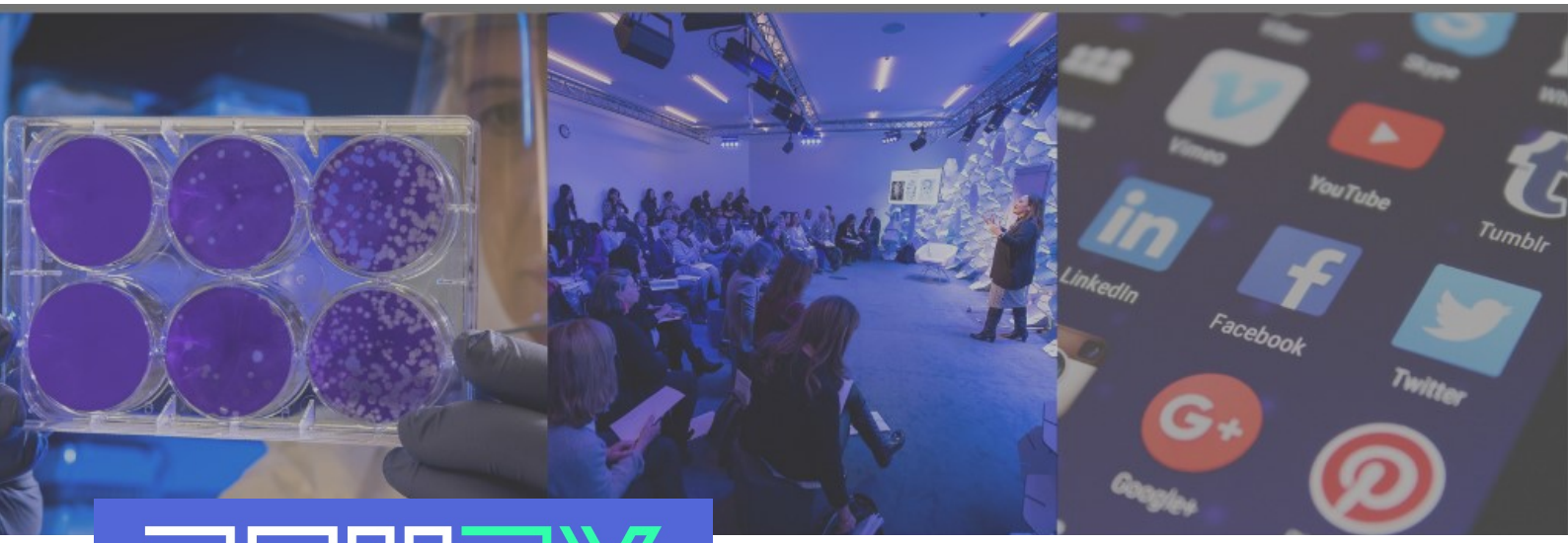

FETFX

OUR FUTURE, TODAY

ASSESSING SCIENCE COMMUNICATION IN THE EUROPEAN UNION'S HIGH-RISK RESEARCH ECOYSTEM

Recommendation Paper 2021

This project has received funding from the European Union's Horizon 2020 FET Programme under grant agreement No. 824753.

Table of Contents

Executive Summary

This paper discusses the practices relating to **Horizon 2020 Future Emerging Technologies** (FET) and **European Innovation Council** (EIC) **Pathfinder Pilot** communication on high-risk, high-gain research from the perspectives of the research and innovation community, science communicators and policy advisers. It includes an overview of obstacles and constraints, and suggestions for communicating the EIC Pathfinder and its breakthrough innovations. It further provides recommendations for **European Commission** (EC) services and the **European Innovation Council and SME Executive Agency** (EISMEA) surrounding the launch of the EIC, and for supporting the effective communication of the EIC and its main instruments to the community at large.

Science Communication: The Current Situation

In the last 10 years, a post-truth-type society with new digital platforms, disseminators and sense-making processes has emerged. While new platforms bring new opportunities for communication, engagement, and dialogue, they also pose challenges by giving voice to interests which can spread misinformation and threaten society's perception of science. High-risk research communication faces several obstacles including the removal of traditional fact checking gatekeepers such as news media; reduced media resources for covering science topics; the freedom of non-experts to mobilise support and engage followers on scientific topics online; gaining attention from disinterested audiences lacking in scientific knowledge; and researchers too busy or untrained to engage in online communication. Furthermore, media, policymakers and politicians favour short-term, concrete results, rather than understanding that, while EIC Pathfinder-type research has huge potential, tangible results lie 10 to 20 years in the future. Finally, the EU is home to several different language groups and national research systems, which might feature different ways of communicating about science. In a similar vein, lack of English fluency prevents many EU citizens from accessing quality science news.

Recommendations & Good Practices for Communicating About High-Risk Research

Given the manifold challenges facing high-risk research communication, as well as the need to rouse public support - and trust - for research aimed at tackling society's grand challenges, effective, targeted, and wide-reaching communication measures are vital. Thus, it is important for EU actors from the high-risk research ecosystem to establish good practices to facilitate the best possible outcomes.

The **EIC Pathfinder researcher and innovation community** should define their targets from the project onset, understanding that audiences are not homogenous and require a variety of communication formats, channels, and tones. The effectiveness of outreach and engagement activities should also be assessed regularly by applying a mix of quality and key performance indicators to gain insights into which measures work best and to adjust efforts as needed. Project teams should take advantage of science communication trainings whenever possible to sharpen their skills for communicating with different stakeholders, including using personal social media accounts to build networks. Setting up networking opportunities for projects enables them to learn from each other, to build upon existing know-how and to share best practices. When communicating with **SMEs and industry**, project teams should be aware of different matchmaking-type events which provide an opportunity to present research results in terms of innovation potential to the business community. They should also launch communication and diffusion activities to attract attention in engineering and technology development communities and collaborate with industry R&D to further develop innovative and visionary project ideas. EIC Pathfinder and EIC Transition results should be communicated to industry and early-stage investors by presenting them at conferences with industry and local innovation communities, taking into consideration the EIC Project portfolio whenever relevant. Finally, bringing stakeholders and scientists together though more interactive forms of engagement such as science festivals can encourage two-way dialogue and produce better collaboration.

Policymakers should give prominence to recognised and credible mediators such as scientists and scientific institutions for communicating, as they can interpret and present information in a clear and accurate way. Thus, establishing and supporting communications programmes, trainings and EIC promotional campaigns (e.g. the Future Tech Week) for EIC Pathfinder collaborative research is important, and public funding and support should also be provided for science media. This would be beneficial especially for controversial topics, where it would be useful to create a broadly accessible centralised source of scientifically validated and reliable information gathered from across the EU research and innovation ecosystem. EIC promotional campaigns should support the full range of instruments - **EIC Pathfinder**, **EIC Transition** and **EIC Accelerator,** and **EIC Prizes**, taking into consideration the different perspectives and outcomes that might

be beneficial for the specific community interested by the instrument. The promotional campaigns will support the awareness raising on the specific emerging technological trend, will address misinformation and fake news and will take steps to improve public literacy on EIC breakthrough and disruptive innovations.

Introducing the European Innovation Council

To maximise the innovation potential and future impacts of high-risk research in Europe, **policymakers must find ways to support effective and accessible communication surrounding the launch of the EIC** with its ambitious plans to develop and scale-up breakthrough innovations. The EIC enables Europe to position itself as a global hub for disruptive innovation and high-risk research; it has the potential to bring together investors, corporations and businesses, research intensive R&D and consortia - and to find synergies unexplored and unexploited by different stakeholders thanks to its Europe-level overview.

To establish strong ties with **SMEs and industry,** the EIC should identify the right individuals with which to communicate within its target audience, and tailor activities and messages specifically to this group, while at the same time communicating in an approachable manner. Avoid making difficult to predict promises and be clear about the long timelines associated with frontier research. Also provide researchers with science communication training so they are able to communicate about their work also to potential investors.

To facilitate a smooth transition for **high-risk research**, the EIC should emphasise its consolidation of different calls and activities into one location and disseminate clearly to researchers how to navigate this landscape. This could be achieved by a focus on EIC Pathfinder and EIC Transition results via the EIC official communication channels (website, Social Media, etc.), where evidence on high-risk research and its outstanding results should be given, even by providing information on eligible projects connected to the EIC Transition schemes.

Policymakers should also make themselves more accessible to the research and innovation community, for instance via the EIC Programme Managers as a go-between to ensure a smoother flow of feedback between both sides. The EIC should further promote and support EIC funded projects to disseminate their results and findings - including with the help of professional science communicators and promotional campaigns and initiatives - by providing funding and training sponsored by the EU.

Circulation of Knowledge & Talents

In addition to bridging the gap, and thus facilitating dialogue between the **public** and the **research and innovation community**, communicating about science can also contribute towards fostering the development and circulation of knowledge and talents in the EU. Conveying messages about the importance of high-risk research and its positive impacts for society can inspire and recruit a new generation of science students from across the region, emphasising the consolidation of a European leading capacity on emerging technologies and disruptive innovations. By showcasing the attractiveness of scientific careers to youth, the EU could strengthen potential pools of future talent in **STEM disciplines**, supporting such valuable messages as **Responsible Research and Innovation** and a gender balance approach. Intensifying more interactive forms of science outreach can raise visibility of researchers, research careers, innovation pathways and innovators' perspectives.

By participating in EIC Pathfinder projects at the start of their careers, a new generation of scientists receives interdisciplinary training which enables them to develop multiple research specializations and to expand their individual strengths. At the mid-career stage, researchers with proven track records can use EIC Pathfinder support to explore new directions and pursue high-risk, and highly innovative, projects. EIC Pathfinder's situation between frontier research and engineering allows them the freedom and possibility to experiment in order to achieve unexpected things.

Looking Forward

In order for the newly minted EIC and Europe to forge ahead and maintain competitiveness, wide ranging support for research and innovation remains crucial. To achieve this support, robust two-way communication and engagement with all key audiences is of vital importance. This is true both for researchers, who will need to take a more active role in science communication, and for policymakers, who must determine how best to support researcher and innovation communities and the fact-based communication of science, while at the same time fighting the mistruths, hoaxes and conspiracies which have emerged from the new digital space. The recommendations contained in this paper should provide a good baseline from which to start.

1. Introduction

Research funded by the European Innovation Council (EIC) Pathfinder Pilot and Horizon 2020 Future and Emerging Technologies (FET) programme is integral to Europe's competitiveness and industrial renewal. This high-risk, basic, use inspired research holds the key to solving many of society's grand challenges - but to do so, it requires the support of a wide range of actors, including policymakers and government, research and innovation communities, media, industry and business, and citizens. Under the framework of Horizon 2020's and Horizon Europe's **Responsible Research and Innovation (RRI),** these societal actors must work together throughout the research and innovation process to better align the processes and their outcomes with the values, needs and expectations of European society (Delaney 2020). ***For this reason, effective science communication, which shares not only research results and findings, but also the stories and processes behind, is vitally important.*** With so many non-specialist audiences with different levels of understanding to address, researcher and innovation communities, and science communicators must find engaging ways to present complex topics in formats understandable to their targets - while still reflecting scientific methodology.

While this in itself can be challenging, the situation is compounded by the **shifting landscape of digital communication**. Today's science communication ecosystem is characterized by multiple interfaces featuring new digital platforms and disseminators, and new emerging sense-making processes. It is nothing short of a paradigm shift. On the one hand, digitalization offers exciting new possibilities for scientists and institutions to communicate and engage with a wide range of stakeholders, contributing to a better science-society relationship (Roedema *et al.* 2020). On the other, a post-truth society is rising where the traditional gatekeepers like news media are often absent, giving voice to strategic populist interests; in fact, anyone can produce scientific content. This has led to an uncontrolled spread of mis -or dis-information, also known as 'fake news', especially relating to high-risk research topics such as AI, health and climate change.

This recommendation paper, aimed at **EIC Pathfinder researcher and innovation communities and EC/EIC policymakers**, will discuss the situation in detail, as well as endeavour to outline some possible ways to address the described challenges. First, it provides a snapshot of the current situation surrounding high-risk, high-gain research and science communications in the EU, including an in-depth look at the limitations, obstacles, and constraints faced. It then discusses good practices which EIC projects and policy stakeholders can employ to communicate effectively and gain widespread support among different actors and target audiences in the face of the presented challenges. As a next step, the usefulness of **Key Performance Indicators** (KPIS) as a measurement tool for communication and engagement effectiveness is outlined along with tips on how to implement these at the onset of high-risk research projects. The paper then looks at the **circulation of knowledge and talents** within Europe's high-risk research ecosystem, followed by a close examination of the current situation for the new European Innovation Council and policymakers. It concludes with a short case study, drawn from expert discussion which took place at the November 2020 Signals from the Future workshop, hosted by FETFX in partnership with the QUEST project, about the state of communication surrounding **Artificial Intelligence.**

2. Current Situation: A Brief Overview

The last decade has seen a transformation both in the mediascape and in the way communication occurs. We are in the midst of a **paradigm shift,** out of which a post-truth society with new digital platforms, disseminators and sense-making processes is emerging. Today's **crowded science communication ecosystem** includes university spokespeople, publicists, journalists, propogandists, activists, science deniers, researchers, and many others. On the one hand, this mediatization (Fähnrich 2020) brings new opportunities for communication, offering novel ways and channels over which to deliver messages and interact with target audiences. It enables dialogue and engagement while making communication about science more broadly available. On the other, it poses risks and challenges, giving voices to strategic and populist interests which can spread misinformation or worse, threaten society's perception of science and challenge the expertise of researchers working in high-risk research.

The ability to communicate about science in the digital realm has fundamentally changed the relationship between science and society. Online media is characterized by many content producers; thus, **the dissemination of knowledge is no longer only the domain of scientific institutions or experts**. In fact, research has demonstrated that the decline of science coverage in traditional media coincides with a significant rise in science content on social media from a growing variety of sources (Fähnrich 2020). Because digital media has **blurred the distinction between producers and consumers of content** and

eliminated the role of traditional gatekeepers, many new actors who contribute to the discourse online have emerged. Now scientists, universities, civil society organizations, research centres, funding bodies, publishers, science museums, R&I focused companies, charities and amateurs can share messages, filling the scientific and technological communications void left by resource-starved traditional media. For science communication, it is a brave new world of threats and opportunities.

3. Gaps, Limitations, Obstacles & Constraints in High-Risk Research

The complex, long-term nature of H2020 FET and EIC high-risk research conjures several obstacles and limitations related to communicating about the science itself as well as to creating awareness of the societal and economic benefits and opportunities that emerging technologies can deliver. Against the current backdrop, when examining the constraints which are affecting high-risk research communication in Europe, it is helpful to understand the obstacles faced by a variety of actors in service of creating a well-rounded picture.

The Rise of Digital Media & Digital Transformation

A significant challenge faced by science communicators across the board is the **rise of the aforementioned post-truth society**, one in which traditional gatekeepers like news media - with its fact-checking practices and editorial oversight - are often absent. Digital media has disrupted and fragmented the traditional system; its ubiquity has blurred once clear boundaries between science and society and increased prospects for public participation. The rapid diffusion of open access publications and science-related content over social media has created opportunities for all matter of groups to reach large-scale audiences about scientific issues, granting non-experts the freedom to mobilise support and engage followers online (Delaney 2020). In short, **new media has revolutionized the way that information is produced, shared, and consumed**.

The diversity of actors and sheer magnitude of information sources online, with their potential for bias, incompleteness or even inaccuracy, makes it difficult for layperson audiences to differentiate between facts and opinions and thus to understand and evaluate situations. While on the one hand, citizens participating in discussions on such platforms as news sites, blogs, forums, and social media could be seen as 'democratic deliberation' (Fähnrich 2020, 5), on the other, it can galvanize counter-publics which express opinions and ideas not backed by scientific facts. In this new reality, anyone can produce and disseminate content about science. The result is a communications minefield for the research and innovation community; it has led to the uncontrolled spread of misinformation, especially relating to high-risk research topics such as AI or climate change, which can attract controversy.

Science communicators are faced with a 'double flow' at the interface of science and society (Bezzi 2019); they are presented with **expanded opportunities to communicate** and increased openness in scientific processes, but also with challenges for maintaining **scientific standards** and intensified exchanges with non-specialists. This has placed emphasis on questions of expertise and legitimacy and led to an increasing need for the scientific community to defend its authority while scrambling to make clear differences between quality science communication and tabloid-like communication (Olesk *et al.* 2020). The outcome is a radically altered relationship and exchange between actors, and a situation where confusion and **misunderstanding regarding roles and perimeters** has become commonplace. Conversely, according to a policy brief from Horizon 2020-funded project CONCISE entitled '**Communication role on perception and beliefs of EU citizens about science**' (Moreno *et al.* 2020), this backdrop has led citizens to become critical of the quality of science information in the public sphere, with many citing sensationalism, bias, superficiality, contradictions, politicisation and fake news as overriding concerns. The Horizon 2020-funded FET Traces project report '**Visionary and Collaborative Research in Europe. Impacts of Use-Inspired Basic Research**' (Beckert *et al.* 2018) found that digital media is often perceived as the channel with **less reliable scientific information** in comparison with traditional media.

Thus, to secure public support for high-risk research, **scientists must build trust through clear and effective communication**. Managing a dialogue between expert and non-expert knowledge and finding ways to bridge different knowledge systems remains one of the greatest challenges for the R&I community (Delaney 2020).

Mis- & Dis-information & Facts

Regarding mis-and dis-information, the Horizon 2020-funded project RETHINK (Roedema *et al.* 2020) found that perceptions of facts, or what individuals consider as true, are influenced by values, ideologies, attitudes, and interests. **Media consumers seek content which confirms what they already know.** Thus, the same messages can be interpreted in

opposite ways, and evidence that runs counter is distrusted. In the new media context, scientific proof can be regarded as just another opinion rather than an evidence-based fact. This combined with the sheer volume of reliably and unreliably sourced content to which non-experts are exposed online can lead to confusion, flawed decision making and incorrect interpretations from which counter-scientific conspiracy theories might arise.

Photo: Pexels—Joshua Miranda

These factors have created a situation in which it is difficult for science communicators to gain traction and have their material seen by those with differing perspectives, and **complicated public discussions on science** (Milani *et al.* 2020a). Among researchers, the fear exists that too much fake news is accumulating on platforms, where focal topics are often sensational, and the **presented information lacks depth**. This current situation shines a spotlight on the critical importance of finding a way to establish and build trust between scientists and the public.

Conveying Complexity

As scientific and social realities merge, another challenge faced by the high-risk research community is communicating **clearly and comprehensibly** about fundamental research and its social relevance to a multitude of audiences with different backgrounds.

Often, the public is unaware of the **paradigm shifting character of frontier research and emerging technologies** and given that H2020 FET-like research (now embraced under EIC Pathfinder) is based on deeply complex technological and scientific topics, it can be both difficult to find messages or results easily understood by non-expert audiences, and to shape these messages for the short spaces or time frames allotted by media. While researchers favour specificity, those communicating must find the **necessary level of simplification** according to the intended target's level of understanding. In addition, researchers must find ways to overcome the public's lack of interest or apathy towards complex topics (Milani *et al.* 2020a). Communicators should keep in mind that for much of the population, **studies of science or technology subjects end in high school**. From that point forward, scientific-or technological knowledge will likely be acquired through (often) unregulated online information sources (Llorente *et al.* 2020b). This lack of scientific knowledge is a barrier that must considered when planning outreach strategies.

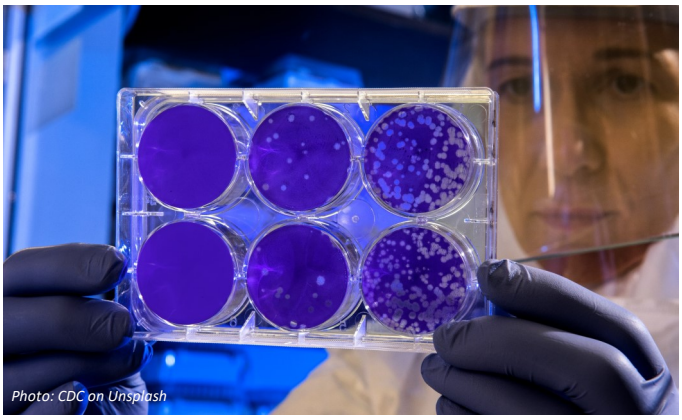
Photo: CDC on Unsplash

The topical complexity can also challenge **professional communicators**, who are not necessarily scientists, working with research projects and institutions: In addition to understanding the social relevance of high-risk research and having the ability to efficiently develop and evaluate scientific outreach, specialised scientific knowledge for dealing with complex topics is essential (Moreno *et al.* 2020).

Attracting Public Interest in a Crowded Arena & Creating Dialogue

Digital communication channels reach a broad range of audiences, but in practice, capturing attention in the crowded online space is another obstacle facing high-risk research communication. According to Milani *et al.* (2020a), this is in part because the Internet is a pull medium where users must actively seek out content, which they do **in accordance with their existing beliefs**. Moreover, many users do not search or follow *any* science news. Thus, **it is difficult for scientists to reach audiences with disinterested or differing viewpoints**. Another factor at play is that disciplines receive differing levels of representation. According to Davies *et al.* (2019), medicine, health and biology currently dominate media coverage while other topics receive less attention. Given the above, it follows that dissemination by the research and innovation community only reaches a fraction of online audiences and not the wider population (Schmid *et al.* 2017a).

Of course, **researchers are keen to broaden their range of audiences** beyond those already interested in science, but without guidance from professional communicators or training, do not know how. Public engagement activities attract the fraction of society already following science and which is reached over digital media. Even among followers, when considering what content appeals to which target demographics and how to design outreach accordingly, it can be difficult for projects to discover who their online audience is. While **analytics** can

determine statistics like website visitors, knowing more about **'who'** is consuming your content is impossible without dedicating further research such as audience surveys (Milani *et al.* 2020a).

Since the **Responsible Research and Innovation** approach calls for **public engagement** in research and innovation to align the process and outcomes with the values, needs and expectations of society, finding ways to connect and interact with new audiences is important. Thus, generating **two-way dialogues** and creating a **healthy exchange** between science and society remains a challenge for those communicating about high-risk research (Milani *et al.* 2020a).

Making the Long-Term Newsworthy

Horizon Europe EIC Pathfinder and **H2020 FET** is unique because it enables for the development of original ideas requiring exceptional, use-inspired basic research to understand and realize their potential applications. While this research broadens the options for future technologies with **potentially wide societal impacts**, what these will be is difficult to determine during early phases because usually it takes between 10 and 20 years until the stage of application in industry, or for the given challenges to be addressed directly (Schaper-Rinkel 2017). The uncertainty of tangible results and this time lag between the basic research taking place and its societal impacts coming to pass, means that communicating about EIC Pathfinder – H2020 FET requires a projection into the future so that audiences can better understand the impact of current research rather than simply focusing on late-stage results (Martiarena 2017). The challenge here is that media focuses on **timeliness and novelty** when assessing the newsworthiness of topics because they generate clicks (Davies *et al.* 2019). They look to cover **concrete results**, not the road to them or the **visions** behind the research. More concerning, according to Professor Emerita of Science and Technology Studies at ETH Zurich and European Research Council founding member and former president Helga Nowotny (FETFX 2020a), is that not only the news media and public are looking for results in the short term: Policymakers and politicians too want to see fast results and can lack understanding of the uncertainties and timelines involved in research and innovation. Most troubling from the researcher perspective, is that the **long-term uncertainty** associated with basic, high-risk research can make them reluctant to dedicate money towards it.

Researchers, Universities & Institutions: Embracing New Priorities & Facing Fears

Historically, universities and research institutes have emphasized **scientific output** and indicators like citations, peer-reviewed publications and journals, and conference attendance as **measures of scientific excellence**. Scientists are pressured to achieve these **prescribed benchmarks** over engaging in science communication, an activity not particularly promoted by research institutions, funding bodies or governments. Even in cases where resources might be allotted towards outreach, the budget might be too little to properly execute tasks (Llorente *et al.* 2020b). To many scientists and the institutions which employ them, their **priority is to provide excellent research**; online communication is a fringe or even voluntary activity which lies outside their job description (Roedema *et al.* 2020).

Researchers might avoid communicating about their research for several additional reasons, chief among them being the **lack of reward** or formal - or even informal - recognition for doing so (Moreno *et al.* 2020). While scientists excel at what they have been trained in and are assessed on performance-wise, namely research and publishing papers, communication is not currently included in **formal evaluations of scientific careers** (Delaney 2020). In a similar vein, researchers are subject to **competing pressures**, which add yet another layer to the communication barrier. In addition to their research, they face an excessive, and time consuming, **bureaucratic burden** to find funding, grants and projects in a very **competitive environment** - which once again leads to a focus on publishing in journals and historic measures of scientific excellence (Llorente *et al.* 2020b). The common result is a lack of time to communicate about science and findings to non-academic audiences, a barrier which transcends actors and EU countries (Milani *et al.* 2020a). This, in turn, limits the capacity of science to produce a positive effect on society.

Photo: Pixabay on Pexels

Some scientists fear that **engaging online might damage their reputations** and thus lack the confidence to do so. According to Roedema *et al.* (2020) concerns include being discredited or attracting criticism or negative feedback from peers, colleagues, supervisors, or the public; being considered less scientific because they are engaging in promotion; or misrepresenting the high-risk research community and contributing to the distrust of science in post-truth society - thus **shaping public**

opinion in a way detrimental to science policy and funding. Posting about science to private accounts raises a deeper fear that negative comments might become personal. Employers often cannot find consensus, nor **provide etiquette or** guidelines for researchers on how best to interact with critics or online audiences, which leads to an **uncoordinated approach** and **perceived lack of support** (Roedema *et al.* 2020).

Further exacerbating the situation is the general **dearth of formal science communication training** found in the curricula of research degrees. Without instruction, researchers may lack the skills to formulate messages about complex research concepts in the simplified language suitable for non-academic audiences (Roedema *et al.* 2020). Lack of training also contributes to a **fear of being misunderstood**, misquoted, or of findings being misused or taken out of context by other actors (Llorente *et al.* 2020b). Furthermore, without instruction, researchers might not be able to develop their audience segmentation and design differentiated strategies and activities according to target groups, nor to implement **meaningful methods of evaluation** (Milani *et al.* 2020a).

Language & Location

During the Signals from the Future workshop, Helga Nowotny (FETFX 2020a) noted that Europe is very **diverse** and while researchers may face many similar challenges across the continent, **national research systems still have an important way of shaping what happens** in all facets of the work. Indeed, different cultures and language groups, have distinct ways of undertaking science communication, which can prove challenging in EIC Pathfinder-FET projects comprising multidisciplinary teams from across Europe (Davies *et al.* 2019). For instance, among German, English or Spanish speakers, each group might have its own **unique discussions about science**, without necessarily strong connections between them.

An additional barrier for many in the high-risk research community is that the potentially large-scale, disruptive impacts of the research mean they are trying to disseminate to **international audiences**. This entails communicating about complex science using languages other than their mother tongue. Attempting to reach a variety of actors, each requiring messaging tailored to their age, education level, and profession adds an additional layer of complexity (Milani *et al.* 2020b). It is also important to note that a **lack of English fluency** prevents many EU citizens from accessing quality science news (Moreno *et al.* 2020). In general, these language barriers have implications for creating an open dialogue between science and society.

The Changing Face of News Media

A key target for the high-risk research community is the **news media**; often, it is the first intermediary in communicating research results to wider audiences, turning them into **stories for public consumption**. For this reason, it is important to understand the challenges journalists face in a system disruptively altered and fragmented by digitalisation.

Over the last decade, most outlets have **reduced resources dedicated to covering scientific and technological issues**. Circulation of newspapers and magazines has declined, and money that would traditionally have been earned from advertising is now redirected towards **digital platforms** (Llorente *et al.* 2020b). Reduced revenues lead to staff cuts, which in turn lead to a decrease of science reporters and editors, and thus **less critical assessment** and reporting of science. These cuts leave media ill-equipped to cover science stories and create a situation in which journalists are forced to increasingly curate news content produced by others (Milani *et al.* 2019). To do so, they progressively rely on a small number of **influential scientific journals** - often from larger research institutes in bigger countries - which do the quality selection process for them via peer review (Davies *et al.* 2019). This can make it harder for H2020 FET and EIC Pathfinder, as well as EIC Transition related teams, especially those from smaller countries, to reach media with their results. At the Signals from the Future workshop, Chair of Science Communication at Rhein-Waal University, Professor Alexander Gerber (FETFX 2020b) stressed the importance of a robust, **independent media**, to 'ask the uncomfortable questions that no one wants to answer' relating to science.

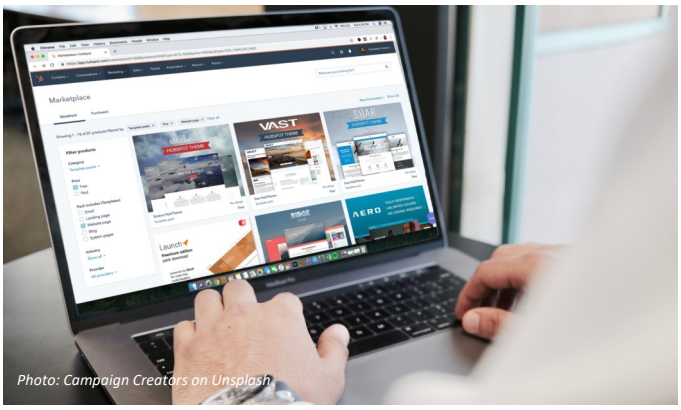

Photo: Campaign Creators on Unsplash

When working with media, researcher and innovation communities must understand and accommodate that science journalists are working on **tight deadlines** and cannot specialize in all areas of science and technology. Information about high-risk research can also be intimidating - and difficult - for journalists to understand. It is unlikely that journalists would have the same level of science education as researchers, and thus EIC communicators must **strike a balance**

in their outreach efforts (Davies *et al.* 2019).

The **proliferation of non-journalistic and non-specialist media** online has led to a further decline, with its amplification of clickbait, sensationalist headlines and superficial content. The public often ingests information about science from sources lacking editorial oversight, verification, and scientific expertise. To compete, journalists can face **pressure** to attract attention in a similar way, by producing quick, entertaining stories rather than the lengthy, investigative pieces that high-risk research might necessitate (Llorente *et al.* 2020a). **Politicization of topics** such as **climate change** or **energy**, and the way they are presented in mainstream media creates an atmosphere of distrust and leads to audiences wanting **clear and fast answers** to complicated issues which can be time consuming for scientists to explain (Milani *et al.* 2020a).

Media also voice concern about the growing influence of **public relations** in contrast to the shrinking pool of science journalism. Many organisations, from universities to research and innovation businesses, have increased resources dedicated to science communication, which increasingly takes the form of **advertising**, **PR**, or **institutional marketing**. Science journalists receive an overwhelming amount of outreach from press officers. This can negatively impact the ability of science journalists to interrogate science policy and research results critically and independently (Davies *et al.* 2019), and lead to increased coverage of stories backed by strong PR, or the **presence of agendas** in reporting.

A final point of concern, raised by science journalist István Palugyai at Signals from the Future (FETFX 2020a) is that EU-funded research projects remain encumbered by **bureaucratic obstacles** when it comes to communicating with journalists - citing that in some EU countries, researchers require too much permission to make statements to the media.

4. Communicating High-Risk Research Effectively: Good Practices for Good Results

Science communication done well not only serves to **attract public support**, **build trust**, and **counter misinformation**; it can also inspire and attract future generations of talent, opening the field to wider diversity and **making Europe more competitive**.

Given the manifold challenges facing high-risk research communication in the current post-truth mediascape, as well as the need to rouse public support - and trust - for research aimed at tackling the grand, and many, challenges society faces, effective, targeted, and wide-reaching communication measures are vital. To achieve this, it is important for actors from across Europe's high-risk research ecosystem to incorporate a **series of good practices** to facilitate the best possible outcome. Through accessible public communication, awareness can be increased, and when this is combined with engagement activities, the social acceptance of innovation can be raised. This represents a necessary precondition of the market uptake of breakthrough scientific and technological results (Schmid *et al.* 2017).

EIC Researcher & Innovation Communities

To attract public support during a time when misinformation runs rife, it is crucial to build trust through clear and effective communication. Scientists should thus consider it part of their responsibility to communicate research outcomes beyond their peers, finding ways to explain complex underlying concepts to inform the public about the role of science (Delaney 2020). There are several good practices EIC R&I communities and project communicators can incorporate to enhance their outreach potential and have their voices heard within the crowded digital media space - they include the following:

Good practice #1: Define your audiences

When designing outreach and engagement for high-risk research results and projects, it is never a case of one size fits all. There are **many different target audiences**; some will be more affected by the outcomes of the research, while others may benefit indirectly in the future. According to Lusuan *et al.* (2020), these include: The **public** (who pay for your research), **governments** (who pay for your research) and **policymakers**, **companies/business/industry** (who might pay for your research), other **scientists** (who you could collaborate with), **media** (who may or may not support further work), and **other stakeholders** (who might fund/support your work). Each has unique interests, needs and values.

Thus, as a first step towards creating effective communication the project team should define the target audiences. It is useful to consider such factors as age, location, education level and professions within each group as these will then help determine appropriate messaging, formats, and communication channels. For example, the public need to understand the **big picture** - how scientific research could shape future life and society, whereas other scientists might be interested to explore investigation lines, which requires far greater precision in communication. Policymakers will be searching for information on the benefits and impacts of the research, while investors and entrepreneurs are interested to bring innovative

tech developments to the market (Milani *et al.* 2020b). The **more targets you reach, the more awareness and understanding of scientific topics will be generated** which in turn increases society's acceptance of research results once they turn into innovation and market applications (FETFX 2019).

Good practice #2: Use the right formats & channels / social media platforms for your targets

There are a variety of **formats** for project communication, from **written** (press releases, journalistic articles, newsletters) to **images** (photos, infographics) to **audio/audiovisual** (video interviews, videos, podcasts). When choosing the right format for your communication, considerations must include available resources and skills; whether you have visually appealing content that would translate well to video or is better presented as a written article; and which **distributions channels** you would like to use to reach the target audience(s). The FETFX Best Practice Communication Kit (FETFX 2019) contains comprehensive tips and advice for how to determine the best formats for your project.

The selection of offline and online communication **channels** over which to convey content to audiences is wide. **Offline channels** include print media and events, both hosted by projects and external, which offer the possibility to establish stronger connections with targets. **Online channels** include project websites, blogs, webinars, external channels such as independent news portals and European Commission websites, and a vast array of social media.

Each **social media platform** has its own social environment and dynamics and thus attracts and appeals to different audience demographics. Further, in different EU member states, different platforms can be less or more dominant. For example, in Italy Facebook is more popular, while in the UK Twitter is preferred. For this reason, effective communication also requires a series of different, **platform-specific**, and often **geographically specific strategies** (Milani *et al.* 2019). Project communicators should establish a good understanding of social media options, both in general and within the context of their region and the larger EU, at the onset. In general, however, the following applies: **Facebook** tends to be used more for leisure and in a personal capacity; **Twitter** is widely used to communicate about science but requires regular posting; **LinkedIn** is oriented to professional content and can be used for engaging with discussion groups related to your research topics; and **Instagram** is very popular but strongly dependent on images, pictures, and videos (FETFX 2019).

Also, worth noting: **Blogs** are useful for sharing features, comments, and news, but require regular upkeep and interaction. **Podcasts** and **YouTube** are best suited for explanations, narratives, and tutorials - on the one hand this is helpful for explaining complex science in an easy-to-understand way, on the other they can be time consuming and resource intensive to produce. Alternately, a Twitter post can be made quickly and with far less effort.

Good practice #3: Maximise your project's social media

Social media is essential for **maximising outreach** to multi-stakeholder groups. Utilising a mix of platforms will boost project visibility, expand networks, and

enable engagement with an online community which can easily be kept up to date. The following tips and practices will help your project to make the most of its **social media** presence (Davies *et al.* 2019):

- To increase your community and interest, content on social media must be **updated frequently**. Tweet new content daily, incorporating a mix or original content and retweets from EC organisations or other projects in a related field.
- Practice social media **tagging** (and mentions) of related organisations - including larger EU entities such as the EIC - and other relevant stakeholders you would like to notice or share your posts.
- Incorporate a targeted use of **hashtags**, especially those used by the larger EC official accounts on Twitter to generate referrals and increase attention for your posts.
- To increase reach, make sure that all consortium partners **share** project social media posts over their social media accounts. This also applies for individuals working within the project.
- Interact with your community by **sharing**, **liking**, **or commenting** on their content - this will encourage them to do the same with yours.
- Social media posts can have a long-life duration - this means over time more and more people encounter them through retweets, shares etc. Thus, **wait to measure impact** statistics.
- To **extend the lifespan** of news, articles, and videos, consider creating several posts relating to each item, focusing on different angles, quotes etc. In the case of videos, short GIFs could even be extracted from the footage and used ie, on Twitter. This provides the possibility for more people to encounter it over an extended period.
- For **events** projects are either hosting or participating in, social media can be a powerful tool. Facebook and YouTube can be used for

l**ivestreaming**, while Twitter can be used first to **promote** the event, and then to **live tweet** during the event itself, by sharing images and updates. This will stimulate dialogue and increase the visibility of the channel, ultimately attracting additional followers.

- Join EU and international social media **campaigns** on similar topics to your research area, or where your project has relevance, ie for International Women's Day, post about women on your team.
- Vary the **format** of your posts - use a mix of text, links, photos, and videos.

Good practice #4: Communicate at the level of your audiences & capture their interest

When it comes to long-term, high-risk basic research, it can be difficult to identify messages widely understandable by general audiences. Communication should be **purposeful and targeted**: coherent in its objective and style and having a clear idea to whom and what it wants to communicate, using chosen formats, style, and tone to reach the target groups (Lusuan *et al.* 2020). Thus, it is important to **customize messages and outreach**, using language adjusted to the audience in question.

Projects should define two to three **key messages** aligned with research objectives and expectations, which can then be tailored to each target audience in such a way they will remember and react to them. Developing a **positioning statement** for each target explaining the value and benefits of your research relating to their expectations, needs and perspectives will help to sharpen the messages (FETFX 2019).

Make sure communications have a **clear focus** and always include the identified key messages. To help the audience understand complex topics, explain core concepts, and use clear, accessible, straightforward **language**, particularly when providing scientific information. At the same time, **avoid trivialization and oversimplification**. Make the communication relatable - address real life questions and problems, or everyday phenomena that people can relate to and make a connection between these and scientific results. Include **sufficient context** so the audience can grasp the relevance of the research results by including the scientific and social history of the topic, also discussing research limitations, and investigating the societal implications of potential applications and the wider context of public concerns, interests, and motivations (Lusuan *et al.* 2020).

Incorporate **storytelling** based on **research outcomes** and **potential market uptake** for the benefit of society as this will stimulate interest and emotional engagement from different audiences (Lusuan *et al.* 2020); including metaphors and comparisons can be helpful in explaining how scientific results can impact our lives. There are several different storytelling strategies that can be incorporated for presenting information - consider such angles as relevance to society, scientific merit, human interest, or relevance to the business sector (Milani *et al.* 2020b). More information on how to incorporate story telling can be found in the FETFX Journalist-in-the Lab Initiative deliverable.

Often, **complex information** can be efficiently reduced to something more straightforward, appealing, and accessible by using **visual communication**. For instance, **infographics** are an attractive way to present complex information (Lusuan *et al.* 2020). In many cases, imagery often provides people's first introduction to science. According to Valeria delle Cave from Istituto Italiano di Tecnologia, images can spark public imagination about science and technology and **create a sense of wonder and interest** (FETFX 2020a). In fact, because we live in a time where we are flooded by so many images, in order to show scientific advancement it is useful to use new eye-catching imagery as often as possible. In addition, using infographics, charts, photos or videos or cartoons containing demonstrations can help make explanations clear for non-expert audiences. However, one caveat stressed by Associate Professor of Data Journalism at the University of Bergen Carl Gustav Linden at the Signals from the Future workshop (FETFX 2020b) is to **avoid using futuristic robot-type imagery** for everything that can be automated as this can cause anxiety among public audiences already fearful from misleading media portrayals of, for instance, AI. Instead, showing benefits to humans diffuses negative perceptions around such technologies.

Avoid using robot-type imagery for future technologies where possible

Short, simple, **informative videos** which directly focus on key messages and include a mix of infographics, animations, real footage, researcher interviews are great tools for facilitating the transfer of more complex content to wide audiences. These can be distributed via project websites and social media, over which you could share multiple promos using different captures or make GIFs from the footage and

add subtitles (FETFX 2019). For this, and all of the above, it is helpful to **identify team members with good communication skills**. Younger researchers are often more social media savvy and have a better grasp how for to convey complicated concepts using social media.

Finally, in all communications, include a **call-to-action** to stimulate interaction. Encourage audiences to post and to participate in respectful dialogues and discussions on scientific topics and in turn… respond! Make sure they can engage with experts directly and that they receive meaningful responses to their comments (Lusuan *et al.* 2020).

Good practice #5: Take advantage of available science communication trainings

The digital realm is swamped with **fake news** and **misinformation** which no one controls; the impacts from this are understandably massive. Science communication is a crucial part of this larger, albeit convoluted, picture, which emphasizes the need for scientists to take on a more participatory role.

To make an impact and to disseminate accurate information and scientific facts as skilfully as possible, researchers must make it a priority to attend workshops, courses or programmes to acquire **science communication proficiency**. Beyond simply learning how to 'do' practical communication for sharing scientific results and findings, it is also important for researchers to develop a wider understanding about the **current mediascape** and larger **cultural context** in which we live. Scientists should learn how to engage with different audiences, to encourage participation and responsiveness, and to generate multi-directional dialogue. Establishing open communication channels and trust can work towards debunking misinformation.

Good practice #6: Use KPIs as a tool to measure communication initiatives & inform policymakers

Key Performance Indicators (KPIs) provide a numeric assessment for performance measurement. They are a series of **quantitative gauges** which enable the evaluation of communication and engagement outreach impacts on various targets by looking at audience participation and size for different messages. Explanation and guidance for the use of **KPIs for projects** is outlined in section 5.

Project KPIs are also useful tools for informing EC policymakers; they can promote research projects and topics and provide guidance for policy decision making and evaluation. Beyond simply reporting KPIs and measurements to the EC, it is also important to list the actions and activities undertaken to achieve each KPI to glean deeper insight into which of these are hitting goals and which are ineffective. Here are some of the ways that a project's KPIs can support policymakers:

- KPIs can **indicate which engagement and outreach efforts are effective** for communicating high-risk research and which are not. This information can feed into developing recommendations, requirements, guidelines, and best practices for future projects' efforts.
- By **making comparability easier**, KPIs facilitate policymakers to effectively evaluate and contrast projects and their successes. Through KPIs they receive insight into emerging topics, trends, and realities as well as outlining required actions and areas where more efforts must be applied, or new strategies determined.
- KPIs could form the basis of **EU-level science communication reward-type schemes** - official measures of success which can encourage projects and researchers to conduct frequent and effective outreach and help counter misinformation.
- Information gleaned from project KPIs can help policymakers to **identify future training areas**.
- Learning from KPIs can help EC policymakers to **design future large-scale science and research-oriented events**, **initiatives**, or **public awareness campaigns**.

Good practice #7: Use qualitative indicators to assess numerically unmeasureable activities

Scientists from high-risk research projects should also incorporate **qualitative indicators** when assessing activities not numerically measurable. These indicators can examine people's opinions or perceptions around subjects. To measure engagement and interest, **feedback** can be gathered from event participants, including those representing key stakeholder groups through direct **interviews** or **feedback forms** covering their direct engagement with the project debates and content. For example, after an event, a qualitative assessment can shed light on the **quality of the participation** and the experiences of the different stakeholders. In turn, this feedback can ensure that stakeholders have **access to the information** and the delivery of the information is shaped to the stakeholders' expectations. It can also then facilitate actions on the part of the researchers aimed at improving **sharing and collaboration**, and finetuning the project's communication tools (Schmid *et al.* 2017).

Qualitative indicators can play an important role in **promoting and understanding stakeholders' perspectives and fostering participation** in Europe's high-risk research ecosystem. Combining

KPIs - including outreach data and online engagement - with qualitative stakeholder feedback, forms the basis for an integrated analysis of the impacts generated by the project's activities (Schmid *et al.* 2017).

Good practice #8: Use personal accounts & communicate with authenticity

Scientists are perceived as being closer to civil society than institutions and can help tackle post-truth phenomena such as hoaxes and misinformation and can facilitate a more open dialogue with public audiences. In short, they can play a **mediating role** which combines the ability to be understood with an accurate understanding of scientific and technological issues (Moreno *et al.* 2020). To do so, scientists might consider maintaining a personal blog / video blog about science. **Blogs**, or **forums** such as Reddit, are two-way venues for conducting interaction - although it should be noted that participating in comment sections can be time consuming, and the presented topics **must spark public interest to** attract readers (Roedema *et al.* 2020).

Creating and maintaining a **professional image** and **network** is important for interacting with other scientists and for building public perception. Social networking sites can be a powerful tool to support visibility and networking (Roedema *et al.* 2020). Science topics are often discussed on **Twitter**, a platform where scientists and other experts are particularly active and attract **high-engagement levels**. Therefore, maintaining a personal Twitter account can also be an effective means of personal outreach (Davies *et al.* 2019). Publishing a tweet is easier than making a Facebook post or YouTube video and the platform allows members to write about a wide selection of topics over a short time span. Especially young researchers can be savvy with online media and could thus play an active role in science communication activities, bringing **scientific literacy and awareness to younger generations** and acting as role models.

At Signals from the Future, Helga Nowotny (FETFX 2020a) suggested that rather than approaching communication such as social media with a PR mentality, scientists should speak about their **authentic experiences** in their communication efforts. For instance, to add depth, do not fear to reference past failures in the same way that entrepreneurs do. This would generate a **larger impact** than strictly focusing on successes and make the communication authentic and more credible.

Good practice #9: Emphasize the unique & promote accomplishments

For more than **30 years**, the European Commission's dedicated **financial support** for emerging technologies has been essential to foster high-risk high-gain research and innovation projects with many unique features which can be translated into communication elements (FETFX 2020b). Projects should **take advantage of this uniqueness** to inform their outreach, tell stories and attract attention. Some inspiring starting points include:

- EIC high-risk research and innovation features a very strong **interdisciplinary approach** in which different teams from different countries work together and build a common identity around the project.
- EIC high-risk research and innovation features **visionary thinking** that is at least 10-20 years from the market. It is focused on often paradigm -shifting breakthroughs and can tell stories about the future.
- Many projects will deliver new technologies with **big societal impacts** - in fact, their results may well solve the biggest challenges facing society.
- Much of H2020 FET research and the resulting technologies are **inspired by nature**. This offers a good opportunity to emphasize sustainability and positive impacts for the environment.
- Be clear that science and technology can be **unpredictable** activities and because they are based on evidence and facts, they are not always able to give complete and immediate answers to problems of public interest (Moreno *et al.* 2020).
- A new generation of interdisciplinary scientists is trained through H2020 FET and Horizon Europe EIC high-risk research and innovation projects. **Young, early-stage researchers** start their careers in a very interdisciplinary way from the beginning, so are not just chemists or physicists, but acquire knowledge in several fields.
- Publicize **prizes**, **awards** and **grants** received by team members.

Good practice #10: Incorporate an interesting, unique & diverse mix of outreach & engagement

According to Schmid *et al.* (2017) **multichannel distribution of contents** is the driving factor to enhance awareness, generate impacts and foster public acceptance. Contents should not only be hosted on the project communication channels (website and social media) but should be also **widely distributed** to enable targets to access them through different sources. In addition to the already discussed channels presented in this section, there are several additional channels over which outreach can occur, including some less common:

- One interesting means through which to communicate with public, and even young audiences, is through **art**. Art installations can blur boundaries between fields in a non-academic way, maintaining the complexity of science but demonstrating it in an easy-to-understand, more fluid way (Anna Dumitriu, FETFX 2020b). Art and science can come together through, for example, Artist in Residence initiatives as part of EU projects.
- Articles written by researchers, or ideas for scientific articles could be **pitched or direct mailed** to high-tech online magazines which address the general public. Some examples include Wired, Futurism, Monocle and Futurity (FETFX 2019).
- Make use of **online multipliers** to distribute news. This can be done by sharing project press releases over services such as CORDIS Wire, EU Agenda or Alpha Galileo (Schmid *et al.* 2017).
- External channels can spread your content **beyond your community**, and having news published by other independent communication outlets will present you as a trustworthy source. For EU-funded high-risk research projects, effective channels are those offered by the European Commission, scientific magazines or news portals accessed by journalist worldwide (FETFX 2019).
- In a more traditional style, scientists can share research results in **lectures** and **conferences**, or run **science cafes** (Roedema *et al.* 2020).
- Cluster with other projects working in your topic area and make **joint communications**, or even consider hosting **joint events** to help reach wider audiences.
- To foster two-way communication in which researchers have the chance to listen and learn from participants (and vice-versa), consider hosting **participatory workshops** with policymakers, and participating in EC-supported matchmaking events to reach innovators; hosting online webinars to reach remote audiences; and joining public initiatives such as the **European Researchers' Night** which allow projects to open their lab's door to the broader public (FETFX 2019).

Good practice #11: Always be trustworthy, truthful & transparent

Always make sure that information is presented in a **truthful and objective** manner and avoid using mixed messages in communications. Provide sufficient information about the **scientific process** and describe the **research method** used and its limitations. It is also important to be open and transparent about the nature of **funding** received for the research as well as which organizations are involved both in the funding provision and the research itself (Milani *et al.* 2020b). Information about who authored studies and any sources used are also important to include. Good **ethical principles** including informed consent for participating and responsible data management and protection must be taken into account and followed. Include **links to references or sources** in the text (Moreno *et al.* 2020).

Here are some additional good practices that projects can incorporate to **maximise the effectiveness** of communication and outreach efforts:

Additional tips & good practices

- Projects should create a **monthly editorial calendar** spanning their duration into which the scheduling for all communications outreach and engagement is entered. This should cover the website, news stories, external distribution channels (ie CORDIS), videos, events and social media planning. Other relevant non-project events - for instance international dates of importance such as World Health Day or International Women's Day, or EC events such as Research & Innovation Days - should also be included and appropriate content/posts developed. Prescheduling provides an overview which facilitates an evenly distributed, steady flow of communication outputs, and allows for the coordination of communication and promotion around events and other initiatives. The calendar should be regularly updated (FETFX 2019).
- According to **PREFET** coordinator Eva García Muntión, projects should **communicate continuously** because challenges cannot be overcome by only communicating once (FETFX 2020a). Update social media regularly, publish news whenever necessary, promote events comprehensively and publish follows up news. She also notes it is vital to actively listen to feedback from your project's communities, and to respond with questions as well. Your project can then use the answers when looking at your next steps and future planning. When people feel listened to, they become more engaged.
- Build up a **database** of subscribers to distribute e-newsletters and other communications, ie event invitations to. To understand your database better, on the initial sign-up form you can include questions about their industry, organisation etc. e-Newsletters can communicate the project's most recent news to a variety of audiences and can be further

promoted over social media and on the project website. Remember to take **GDPR compliance** into account (FETFX 2019).

- Foster good relationships with EIC-funded **Coordination and Support Actions** which can help promote your research results and assist with networking and matchmaking services, and brokerage events and workshops. These enable direct engagement with stakeholders and investors and can increase capacity building in public communication.
- Participate in **workshops**, **webinars etc with other EIC-FET projects**, as well as in other high-profile events where possible, for instance **Future Tech Week** or **European Researchers' Night**, to raise your profile and receive exposure to wider audiences.
- Provide news items to **EC project officers**, who will facilitate their distribution though wider EC channels (FETFX 2019).
- Leverage your **consortium partners communications assets and communities** for all disseminations and content production (FETFX 2019).

FET Researchers: Communicating with

In general, researchers involved in H2020 FET projects acquire a certain attitude towards **broader scientific impacts** and **future economic impact**. The collaborative and interdisciplinary mode of research broadens their perspective and sharpens their focus on issues concerning future product and process innovations made possible through their research. Even projects focussing on basic research have a long-term indirect economic impact because of their specific technology orientation (Beckert *et al.* 2018). Thus, projects and researchers should be aware of different matchmaking-type events hosted within the EIC, for instance by Coordination and Support Actions. These provide an opportunity to present your consortium, your project's activities, and main research results in terms of innovation potential to the business community. Also be on the lookout for workshops and webinars about communicating with this community.

According to the FET Traces Visionary and Collaborative Research in Europe report (Beckert *et al*. 2018) to trigger an innovation ecosystem based on H2020 FET research, researchers should look beyond scientific journals for publishing their research and ideas. They should also launch communication and diffusion activities to attract attention in engineering and technology development communities and collaborate with industry R&D to further develop visionary ideas. H2020 FET and Horizon Europe EIC results could be communicated to industry by presenting projects at conferences with industry participation, or through informal channels such as emails or phone calls to contact R&D colleagues.

EIC & Policymakers

To maximise the innovation potential and future impacts of high-risk research in Europe, it is necessary to secure backing from the full range of actors and audiences – especially in light of current challenges facing science such as the spread of misinformation and the emergence of a post-truth society. For this reason, **policymakers** must also find ways to support effective and accessible science communication, so that Europe can become increasingly self-sufficient and continue to pursue solutions to society's grand challenges.


Photo: Guillaume Périgo on Unsplash

Good practice #1: Choose the right messengers—Give prominence to recognised & credible mediators

When communicating about research and results, prominence should be given to **credible mediators** who can interpret and present scientific information on different topics. Scientists and scientific institutions should, when possible, play a leading role in introducing information and disseminating scientific findings (Moreno *et al.* 2020). In fact, it has been found that when scientists have an account on a specific platform, they and other experts receive high engagement from their audiences, including a higher median engagement volume than science journalists on Twitter (Davies *et al.* 2019). This can be motivated by **supporting scientists and institutions through funding and regulation**, and by **promoting communication as part of scientists' jobs**. To overcome resistance or reluctance on the part of researchers (see the section '*Gaps, Limitations, Obstacles and Constraints in High-Risk Research*'), consider the

following options:

- Provide **funding** or **sponsor rewards** for researchers who participate in science communication activities (Moreno *et al.* 2020).
- Use participation in science communication activities as an **additional indicator of productivity and excellence** in the careers of scientists—make it a feature that can enhance their profiles during recruitment.
- Add **dissemination requirements to scientific grants** so that researchers can be rewarded for their public engagement activities and use dissemination efforts as an evaluation criterion (Llorente *et al.* 2020b).

Additionally, putting researchers such as **women scientists** on the frontlines can be inspirational and create role models for a younger generation who see that making science is a real possibility for them.

Good practice #2: Make funding available for science communication training

Science communication can **bridge the worlds of scientists and citizens**. To strengthen this bridge, and to lend credibility and authenticity to science communication, it is vital that scientists and scientific institutions take on an increasing role. But to communicate their work to non-experts, **training** is needed. For this reason, establishing communications programmes for scientists is important. These could take the form of **workshops** or **courses** for PhD students, postdocs, and senior researchers.


Photo: YRMW on Unsplash

Given the **complex nature of online media**, such programmes must go beyond teaching researchers just **practical communication skills**. They must inform about the **overall cultural context within which science communication is taking place** - including societal and media changes and their consequences for science and science communication, and the roles they might need to play - and equip them to reflect on circumstances relating to the topic they will communicate about and the technical requirements of different types of platforms (Milani et al. 2020a).

To address the complexity and dynamics of the **new science communications landscape**, scientists must also be advised on how to engage online against critics and encouraged not only to become information disseminators, but also to **interact and cocreate with the public** (Roedema *et al.* 2020). Making communication courses part of PhD curriculums can significantly improve scientists' self-confidence and communication effectiveness - transferrable skills which are always useful. In addition to scientists, it is also worthwhile to make training available for **science journalists** and **other science communicators**.

Good practice #3: Promote networking between projects

Setting up **networking opportunities** for projects gives them the opportunity to **learn from each other**, to **build upon existing know-how** and to **share best practices**. One example would be to organise thematic cluster events within which different consortia can share their communication strategies, experiences, and methodologies to find synergies and lay the groundwork for a knowledge and collaboration ecosystem (Delaney 2020). In fact, projects should be encouraged to cluster with other projects in their topic area to undertake **joint communication activities** as this could help them reach wider audiences.

Good practice #4: Public funding & support for science communication & media

There are several ways that policymakers can **support science communication and science media** across Europe. Some examples include:

- Efforts should be increased to **promote popular science media** - from publications to forums and spaces for science debate - these are information sources which have the potential to increase citizen's trust. As funding for traditional media continues to dry up, this could provide a much-needed injection of resources (Moreno *et al.* 2020).
- To attract new talent, specific resources should be dedicated towards **promoting specialisation in science communication**, for instance through scholarships at the university level. Furthermore, it could also be promoted as an alternative career path for people who have studied science (Moreno *et al*. 2020).
- Promote the creation of stable, fairly compensated **science communication positions** in public science institutions (Moreno *et al*. 2020).
- Support **scientists' communication activities** initiatives by adding dissemination requirements to grants and providing a more favourable social and professional context for

communication - for example rewarding researchers who participate in public engagement activities or using this as an evaluation criterion (Llorente *et al.* 2020b).

- Make it **easy for projects to involve professional science communicators** – as partners or through subcontracts etc.

Good practice #5: Create a source for validated & reliable information

Especially with regard to controversial science topics, it would be useful to establish a source for scientifically **validated and reliable information** gathered from across the EU research and innovation ecosystem. This could include, for example, a collective **platform** containing databases, websites and fact-checking services which act as myth-busters (Moreno *et al.* 2020). It is important that this information be **easily and broadly attainable**, well organised so that specific topics are **easy to search**, and in an **accessible language** so that it may be widely understood. For information contained therein aimed at correcting inaccurate scientific beliefs, provide factual alternatives to misinformation and explain why the misinformation was thought to be correct in the first place in a clear and understandable way.

Good practice #6: Raise awareness about misinformation & fake news

Take steps to **fight back against mis- and dis-information**: Consider launching an **awareness raising campaign** to address the issue and take steps to improve **public digital literacy**, empowering citizens to independently question and evaluate information sources (Moreno *et al.* 2020). This should be linked with Europe's research and innovation initiatives to strengthen scientists as a source of reliable information including in the public perception.

Photo: Unsplash

Good practice #7: Include science education at all education levels

To foster an appreciation for the scientific method and **enhance critical thinking skills**, more opportunities for discussing scientific issues should be included in the **curriculum at all educational levels** (Moreno *et al.* 2020). Science communication could already feature prominently at an early stage, for instance as part of undergraduate science degree programmes, and continue through master's and PhD levels so that scientists are confident and well equipped to tackle disinformation when they begin their research careers.

Good practice #8: Organize participatory initiatives which bring scientists together with target audiences to encourage two-way communication

Discussions of facts, or what is considered true, are always influenced by the **values**, **ideologies**, and **interests** of individuals. Naturally, this creates a complex environment for public discussions on science. Thus, building mutual trust between scientists and the wider public is crucial. For this reason, the scientific community increasingly embraces **public engagement as a means towards trust** (Roedema *et al.* 2020). Many current approaches educate the public about science in a one-direction, broadcast style. But bringing stakeholders together though more **interactive forms of engagement** can encourage dialogue and produce better collaboration. Venues such as science festivals or science cafes can provide an opportunity for citizens and scientists to discuss and debate research results directly. Benefits would be two-fold: On the one hand, scientists could listen to demands, concerns and other feedback about the impacts of their research from citizens, on the other, citizens would learn about science directly from credible sources and would be able to voice their concerns and ask questions. Such two-way communication could help **legitimise research activities and results** while at the same time promoting acceptance of research outcomes (Moreno *et al.* 2020). These interactions could also raise scientists' profiles and visibility.

Photo: Evangeline Shaw on Unsplash

It is also important for **science journalists and scientists to establish trusting relationships**. According to Davies *et al.* (2019) media would like

to have **improved access to scientists** rather than being hindered by layers of bureaucracy. In turn, many scientists would stand to benefit from being willing to talk about their research to the media as this could help their work to have an impact. Two-way participatory initiatives would thus go some way in **opening communication flows**.

Good practice #9: Encourage change in academic culture

Traditionally, when judging careers **academic culture** has focused on **scientific outputs** such as publications of articles in peer reviewed journals, lecturing and h-indexes. However, there is a growing disconnect between increasing expectations for scientists to take on a communication role in addition to their research and organizational priorities manifested in policies and practices of research institutions and universities (Roedema *et al.* 2020). To enhance the capability of science to produce a positive effect on society, policymakers should **find ways to encourage and support scientists to take on active communicator roles** without risking damage to their research careers.

Good practice #10: Communicate about the newly launched EIC to all audiences

As 2021 marks the launch of the full-fledged **European Innovation Council** and **Horizon Europe**, a concerted effort should be made by policymakers to ensure **clear, accessible communication around these programmes**. The preceding landscape, characterized by a wide variety of calls, some similar, from a wide variety of organisations, was confusing to navigate for researchers, industry and public alike. See the section entitled '*EIC & Policymakers'* for detailed information on this topic and a full list of suggestions for policymakers.

5. Key Performance Indicators

Although for scientists communicating about H2020 FET and Horizon Europe EIC research and innovation can be time consuming and resource intensive, it is essential to ensure support from the full spectrum of audiences within the EU - including policymakers and the taxpayers whose money funds visionary projects. By **communicating effectively, scientists can share their knowledge and promote the uptake of research results to create impacts on society**. As stated in the FETFX Communication Kit (FETFX 2019), **breakthrough scientific ideas alone are not enough** - they must by conveyed to multiple targets in order for innovation to occur. The following section will provide tips and considerations for projects incorporating a communication strategy into their overall design and looking to engage diverse audiences through a variety of methods and tools.

Key Performance Indicators

Traditionally, scientists have measured quality and relevance of research using indicators like appearances in **peer-reviewed scientific publications** and **citation rates** to examine the footprint of their H2020 FET research (Beckert *et al.* 2018). Today, as comprehensive communication strategies become a key element in project design, these indicators must expand to include a series of **quantitative barometers** to ensure widespread support among a series of target audiences. Impacts relating to understanding and awareness of H2020 FET research are generated using a variety of different communication formats and channels as part of an overall outreach programme, while acceptance and uptake are stimulated by engagement or participatory activities through organized events and online social media campaigns(Schmid *et al.* 2017).

Key Performance Indicators (KPIs) are a series of quantitative gauges which enable us to assess the impacts of communication and engagement outreach on different targets by looking at audience participation and size for different messages. This comprises both **communication products** (for example a press release or website) and **activities** (for example participation in a webinar or conference). Using KPIs, we can **measure the impact** of any communication or engagement actions (both online and offline) based on the number of people that make use of or interact with that communication; adding **engagement indicators** to the mix can further help us to measure activities associated with communication. Outreach data covering online, for instance website statistics, social media, and other channels, constitutes main instrument that can **monitor the potential impact** of a project's communication outputs on target audiences (Schmid *et al.* 2017).

The importance of measurement

At the Signals from the Future workshop (FETFX 2020b), Alexander Gerber explained that effective communication by projects can result in such positive outcomes as changes in behaviour, knowledge, skills and status among target audiences. However, to **effectively measure impacts**, we must also look at the resources devoted to creating communication products and engagement. For instance, while staff time and/or resources for events could be inputs, the resulting outputs would be the event itself or ie. a press release. The (hopeful) outcome of such efforts would be the **modification of an opinion or attitude**. But in order to know whether the inputs (resources) justify the outcome, it is important to evaluate your efforts. **Ineffective outreach is a**

waste of time and money for researchers. Thus, the design, implementation, and measurement of KPIs related to a project's communication should **span the entire project duration**. Their continuous monitoring measures the ongoing effectiveness and efficiency of the communication strategy, allowing for the **identification and introduction of corrective actions** whenever necessary (FETFX 2020b). Furthermore, by measuring and analysing the effects of your project's communication and engagement activities, you can **identify patterns**, **set targets**, **measure progress**, and **optimize your strategy**. Ultimately, a strong and effective set of indicators can constitute an integral part of their EIC project's impact assessment (FETFX 2019).

Considerations for determining your most effective KPIs

To create purposeful and targeted communication, and to avoid frustrating and ineffective activities, H2020 FET and the newly funded EIC Pathfinder and Transition projects should plan their efforts in advance by drafting a **communication and engagement plan** at the initial stage. According the FETFX Communication Kit (FETFX 2019), when drafting the plan, researchers should ask themselves which **audiences** they want to talk to; define the **key messages** they want to convey; choose the most appropriate **language and style**; and identify the best **channels and formats** for sharing their voice. Important questions to consider include:

- **Who** are your target audiences?
- Identify **What** will your key messages be and tailor them to your targets.
- **How** will you disseminate? Choose the appropriate tools and channels according to your targets. Further considerations include contents and formats, style, and tone.
- **When**? Communicate from the beginning so that you have an established audience when the projects results are ready. If newsworthy, aim to bring scientific information to audiences as soon as possible *or* when it is most relevant.
- **Where**? Work at all geographical levels - local, regional, national, European/global (keeping in mind potential language challenges).
- **With whom**? Join forces with your EIC Pathfinder and Transition consortium partners to share communication efforts and grow distribution chains, taking into consideration the EIC Project portfolio where you are engaged.

Don't forget to monitor your outreach and engagement regularly and update your strategy to increase effectiveness.

Although KPIs cannot provide a complete picture of the effectiveness of communication, they do provide a foundation upon which to **build analysis**. For EIC projects designing KPIs, the **EFFECT** project (Schmid *et al*. 2017) compiled a series of recommendations to incorporate. These include:

- The KPI must be **measurable**: It must be a measurement that can be represented numerically and something that can be analysed over time to identify trends, best practices and pitfalls or ineffective outputs.
- The KPI must be **easy to understand**: Different actors should be able to use the KPIs to ensure exploitation of the resulting analysis.
- The KPI should be **repeatable**: It can be used and collected in a consistent way every time it is needed.
- The KPI should be **available**: The sources are always available and accessible.
- The KPI should be **timely**: They are made available every time a new communication or engagement action is undertaken.
- The KPI should be **insightful**: They provide knowledge around the effectiveness of the communication and engagement effort.
- The KPI should be **reliable**: They should be drawn from trusted sources in the online analytics world.

At the Signals from the Future workshop, Alexander Gerber (FETFX 2020b) further suggested EIC projects could incorporate the **'SMART'**[1] method of evaluation to design KPIs and outreach, which implies making goals: **Specific, Measurable, Attributable/Achievable; Realistic;** and **Targeted**.

[1] *For more information on SMART Goals: https://www.mindtools.com/pages/article/smart-goals.htm*

How to measure your KPIs

According to the EFFECT project (Schmid *et al.* 2017), quantitative outreach and engagement indicators covering **online communication** draw from the monitoring of websites and social media accounts incorporate three different approaches. The first is **direct monitoring for websites**, which includes retrieving data on web traffic and views for various reports, news updates, articles and interviews (in addition to other website content). The second is **direct monitoring of the project's social media accounts** through various analytics - for instance, Twitter Analytics, Facebook Insights, or YouTube counter. The third is **indirect monitoring**, which includes identifying referrals made to a project's materials by other online and social or web resources. This provides a more sophisticated analysis of online users and requires the use of a state-of -the-art software tool such as Nuvi ®, a real time social intelligence software to determine total web and social media mentions using a set of predetermined key words. This includes blogs, forums, and more extensive appearances.

While both forms of **direct monitoring** are linked to **outreach**, **indirect monitoring** is linked to **community engagement**. These indicators help us better understand the **impacts of communication messages on target audiences** with the aim of **supporting acceptance**. Engagement metrics are a measurement of '*if*' and '*how*' stakeholders engage with the project through online interaction and can be a powerful tool for assessing the effectiveness of communication (Schmid *et al.* 2017). These are important because oftentimes, looking at website visitors and social media interaction is insufficient for assessing the evolution of acceptance towards innovation, and thus a broader context which examines the actual engagement of people into delivered content is beneficial.

Finally, don't measure the impacts of online communication products such as articles, news releases and videos immediately as the numbers for these outputs will **grow over time** as news spreads (Michi *et al.* 2017). And don't forget that **sometimes talking to a single influential person can be as effective and important as tweeting to 100**.

Table: Outreach indicators to be used in communicating EIC project results (Schmid *et al.* 2017)

Output	Measure it with...
Website (total visits, unique visitors, total page views, average time on page)	Google analytics, Sensalytics, Clicky, Heap, Open Web Analytics etc.
Editorial products on your website (news, articles, interviews)	Google analytics - views on pages containing editorial products
Twitter impressions, followers, engagement rate	Twitter analytics
Facebook viewers	Facebook insights
YouTube visualizations	YouTube counter
Impressions by external multipliers (ie Cordis, Alpha-Galileo, EU Agenda)	Outreach data provided directly by the multiplier
Project e-magazines or newsletters	Number of subscribers, open and click rates
Face to face activities, webinars	Number of participants in attendance
Distribution of flyers at events	Count total quantity

Visits, impressions, visualizations*: *Number of times a content has been seen online (note that different platforms use different terms to describe the same action).* ***Visitors, viewers: *Number of people who were in contact with the content online (Schmid et al. 2017).*

6. EIC & Policymakers

With the launch of Horizon Europe and the transition of the H2020 FET programme into the European Innovation Council (EIC), 2021 marks a significant year for the European research and innovation community. That these changes come at a time when the world continues to reel from the corona crisis has further emphasised the necessity of a robust high-risk, high-gain research programme to ensure Europe's autonomy. But to maximise the innovation potential and future impacts of high-risk research in Europe, it is necessary to gain backing from the full range of actors – especially in light of current challenges facing science. For this reason, policymakers must find ways to support effective and accessible communication, in particular around the launch of - and gaining support for - the EIC with its ambitious plans to develop and expand breakthrough innovations.

The new kid on the block: Introducing the European Innovation Council

By establishing the EIC, the EU positions itself as a **global hub for innovation and deep-tech paradigms**, enabled by a science-driven approach through EIC Pathfinder and Transition schemes. The years of planning preceding the launch have provided a useful opportunity to **take stock** of the EU's research and innovation ecosystem. According to EIC Programme Manager Iordanis Arzimanoglou (FETFX 2020a) following decades of uncoordinated actions in the realm of research and innovation across different EU organisations, the EIC now offers the opportunity become organized, establishing such details as: **who** the stakeholders are; **what** the different interests at play are; and **where** overlaps exist. By making an inventory of calls and activities, and then consolidating these under one agency, the EIC can begin to outline its strategy and develop actions.

As an entity, the **EIC** has the potential to bring together corporations and businesses, research intensive R&D and consortia - and to **find synergies** unexplored and unexploited by different stakeholders thanks to its Europe-level overview. According to Arzimanoglou (FETFX 2020a), seeing the picture in its entirety will facilitate the EIC to intervene where needed to achieve the best possible outcomes. Emphasizing this **holistic perspective** could help overcome stakeholder reservations - and doubts - that such undertakings can be done better at the EU level than in specific countries/ national research systems. One challenge surrounding the launch of the EIC, however, is how to communicate and position it as **the leading organisation of its kind** in Europe to the various stakeholders while reassuring other organisations operating in the same arena that the EIC will not take power from them.

EIC: Innovators & the SME community

In contrast to major enterprises and industries, **start-ups and SMEs** can find it difficult to extrapolate the future market potential when dealing with disruptive technology. While bigger players and industries have the chance to identify, via direct dissemination activities, the emerging technologies where further investments are needed (Michi *et al.* 2017), this is far more challenging for smaller scale businesses. For this reason, a **structured overview outlining opportunities arising from H2020 FET and EIC Pathfinder or ERC Proof of Concept results should be made available and accessible** to business interests at all levels. This should include summaries containing tangible results with clear exploitation strategies, and even information on eligible projects connected to the EIC Transition schemes. To communicate effectively with business and industry stakeholders to propel research into innovation and towards the market, policymakers should take the following suggestions into account when designing communication with this stakeholder group:

- As a first step, **identify the right people** with which to communicate within the target audience and tailor activities and messages specifically to this group. Do not focus on a broad outreach strategy targeting big numbers as this could lead to frustrations and miss your core audience.
- Design the outreach so that it is understandable to a general audience. Communicate in an **easy and approachable manner**. Avoid being too elaborate, for instance by using expert level scientific terminology.
- Avoid making false or difficult to predict promises and **be clear about the long-term timelines** associated with basic research.
- Offer **science communication training** to researchers so that they can communicate about their work across the R&I community and to non-expert, potential investors about the exciting EIC portfolio of projects within EIC Pathfinder- H2020 FET.
- Promote **match-making events** which bring investors face-to-face with researchers who have received communication training.

EIC & the research community

One obstacle faced by the EU R&I community is that the current landscape, with its wide variety of different organizations and calls, is **difficult to navigate**. Now that the EIC and its associated Pathfinder, Transition and Accelerator programmes have been launched, there could be additional confusion over how EIC Pathfinder and H2020 FET are different, and what changes this transition will bring for research and innovation communities. It will thus be helpful for the EIC to **emphasise its consolidation of different calls and activities into one location** and disseminate clearly to R&I communities how to **navigate** this new landscape.

According to Fähnrich (2020) a further challenge cited by the R&I community is the **difficulty in reaching policymakers** due to a perceived lack of interest and forums in which to meet and discuss issues. One way to counteract this is by positioning the **EIC Programme Managers** as a '**go-between**' with access to both stakeholder groups and using them as an engagement tool could facilitate a smoother flow of feedback and information between both sides.

Policymakers need to identify the links among science, innovation, and society, and how those links can influence political decisions. To do so requires clearly defined messages for evidence-based policy making – which is a challenge for high-risk basic research with its long-term outlook and complex nature. ***But by collaborating with researchers and CSAs from within the EIC Pathfinder-FET ecosystem, namely the EIC thematic and objective -driven portfolios, a series of effective messages can be identified by using science communication indicators.*** These KPIs would be applied by projects to assess individual outreach and engagement activities, and in turn could outline for policymakers which topics and methods attract particular interest among different audiences. These inputs could then inform political policies around science communication and help determine the effective communication measures.

Photo: Evangeline Shaw on Unsplash

The desire for a **European-level science communication training programme** for researchers has been widely expressed by that community (Fähnrich 2020). As audiences also perceive researchers to be more trustworthy information sources, from a policy perspective, such training would be a worthwhile investment. In addition to practical communication and media/ digital media skills, it would be useful to further include instruction on the **overall cultural context of science communication**. The complexity of the current landscape requires an understanding of societal and media changes and respective consequences for science and science communication - as well as an adequate perception by those communicating about roles within this larger context (Fähnrich 2020).

Some additional recommendations:

- Organise **thematic cluster events** to promote networking between projects and encourage sharing of best practices to build a collaborative ecosystem (Delaney 2020).
- Promote and support research centres and researchers to disseminate their results and findings by providing **funding and communication training** sponsored by the EU.
- Encourage researchers to use their **personal social media networking** accounts in service of public engagement and recognise these efforts as a legitimate means for increasing outreach.

EIC & policymakers: Communicating with the public

Given the current challenges facing science communication, there is the need to explore how **interactions between scientists and wider audiences can be intensified and undertaken in a constructive, high quality manner**. To generate public trust, one measure that the EIC can take is to put scientists and innovators on the communication frontlines, giving prominence to recognised credible mediators who are able to interpret and present scientific information on these topics (Moreno *et al.* 2020). This can be particularly helpful for controversial topics with high political relevance such as AI and climate change, where focusing on reliability and trustworthiness of knowledge - and legitimacy of expertise - in a sea of differing perspectives could positively affect public perceptions (Fähnrich 2020).

EIC gatekeepers' interdisciplinary, collaborative mode of **science-driven innovation** broadens researchers' perspective and sharpens their focus on potential future products and process innovations which might result from their research and innovation projects (Schaper-Rinkel 2017). This **big picture perspective** can make the researchers powerful public advocates for science. A further benefit of researchers taking on a more public role is that **women and scientists**

from other underrepresented demographics can be inspirational - not only as **role models** to the younger generation, potentially attracting new talent to the field, but also to show **Europe's diversity** (Valeria delle Cave, FETFX 2020b).


Photo: Evangeline Shaw on Unsplash

One challenge is finding ways to **generate a two-way conversation to engage audiences which might not take an interest in science or lack expertise**. To reach a broader group beyond those already interested in science, policymakers might consider supporting initiatives which incorporate new ways of communicating. For instance, bringing together **science and art** can maintain scientific complexity while blurring boundaries in a way that makes it easier for the public to understand the concept before them. Art can remove the academic, disciplinary boxes which surround science, allowing for a more fluid way to think (Anna Dumitriu, FETFX 2020b). This can be achieved, for instance, by **supporting Artist in Residence programmes** as part of EIC-funded projects.


Photo: Guillaume Meurixe on Pexels

Another useful consideration put forth by Carl Gustav Linden (FETFX 2020b), is the need to **highlight the human side of research and science** when communicating. For instance, in the case of AI, images of robots and other futuristic illustrations tend to accompany disseminations, social media posts and stories in the media. In reality, this practice could be damaging and should be avoided as it contributes to the **growing public fear** that robots will eliminate jobs and livelihoods. Instead, **human uses and benefits should be emphasized**. In a similar vein, Alexander Gerber (FETFX 2020b) points out that communications about EIC-type deep-tech research and innovation often **focus on economic value**; instead, it could be helpful to **emphasize more the societal value** as part of a bigger, holistic picture - in short, outlining the social aspects and benefits for public audiences.

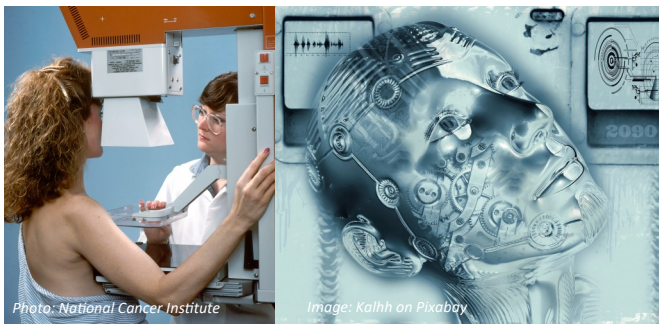
Photo: National Cancer Institute Image: Kalhh on Pixabay

Human uses and benefits of research should be emphasized in outreach

In general, it is important to determine what content appeals to different target demographics within the larger public sphere, and to recognise that the **competition for attention is very strong**, especially online. We recognise that policymakers face a plethora of competing priorities and perceive the need for public support and interest when acting. As such, establishing a robust two-way dialogue with adequate feedback is key in securing interest and funding from the policy community (Milani *et al.* 2020a).

To **generate feedback** about research and communication outreach, measures could include (Moreno *et al.* 2020):

- Create **spaces for public scientific debates** in which even controversial issues are addressed, and where scientists can discuss research results, and offer helpful advice and input in direct conversation with citizens. This will enable the science community to listen to the demands of civil society.
- Hosting a variety of **public events** in which different perspectives on research design and outputs could be gathered via networking and direct exchange.
- Because science communication is key for bridging the worlds of researchers and citizens, fund communications training for researchers. Then, use trained scientists to facilitate dialogue between science and society – give them a **mediating role** which combines their ability to be understood with an accurate understanding of scientific and technological issues.
- Give universities and public research centres a more **central role in science dissemination**

due to their perceived credibility and impartiality.

- Increase **public funding for science communication** to sidestep conflicts of interest or biased messaging that might arise from privately funded PR activities.
- Employ **professional science communicators** in government agencies and departments to ensure the effective dissemination of science-based messaging to public audiences.
- Fund science **training for science journalists** to ensure stories are portrayed accurately in media.
- Provide support and incentives for primetime science programmes on **public television**, for example documentaries, debates, interviews.
- Make a greater effort to support and promote **forums and spaces for science debate**, for instance promote popular science magazines as an information source.
- Ensure **equal accessibility** for all to relevant information by creating reference platforms that aggregate content on specific science topics in accessible language.
- Conduct **comparative analyses** between Europe and other countries/regions to assess what Europe can learn in terms of augmenting interest and trust in science and science communication.
- Include more opportunities for discussing scientific issues and enhancing critical thinking skills in the **school curriculum** at all education levels.

Expectation management

While R&I communities appreciate the freedom and possibility to try - and achieve - new and unexpected things that comes with EIC funding, it is not widely grasped by those outside the academic community, including among policymakers, that there exists a **time lag between this use-inspired frontier research and the societal and economic impacts it could produce**. While this research clearly broadens the options for future technologies, specific impacts are difficult to determine at an early phase because the stage at which application in industry or addressing social challenges directly lies at least **10-20 years** in the future (Schaper-Rinkel 2017). Policymakers and politicians want results in the shortest time possible, without taking this account. This lack of understanding renders them **reluctant to invest money into basic research**, which is what **lays the groundwork for Europe's future and emerging technologies**. Thus, there is a need to communicate about the **innovation potential of frontier research**, and the achievements of EIC Pathfinder more widely, despite the difficulty of the associated concepts to be understood and the long timeline (Martiarena 2017).

As it stands, actors such as the public and civil society may not recognize the **paradigm shifting character of frontier research**, **nor that it constitutes the foundation upon which society's emerging technologies are built.** But by communicating about these early stages, better comprehension of the efforts and time - and the science - that go into developing innovation and bringing a new technology to the market could be encouraged. Furthermore, the long-term nature of EIC Pathfinder can also be associated with a risk of overpromising these projects. **Innovation is a process which includes uncertainties and failures as well as successes**. IIT's Valeria delle Cave (FETFX 2020a) suggests that it would be useful to share with the public more messages about the **process of research and innovation** - even about the failures, to engender a certain understanding. Counterproductively, the current trend, especially among media, policymakers, and politicians, is instead to focus on late-stage research with tangible results rather than the lengthy processes behind it.

At the Signals from the Future workshop, Helga Nowotny summed up the situation:

> *"You have to solve the tension between visionary, uncertain long-term view of the future that is part of research and on the other hand, the impatience of politicians and parts of the public who want to see the impact now. Maybe they should also think about the long-term impacts."*

Thus, we recommend:

- The EIC should **address and incorporate messaging about the long timelines and high risks associated with basic use-inspired research** into its outreach strategies to the full range of audiences, including to policymakers and politicians.

Fighting disinformation: Funding for science communications

The EU's substantial funding of, and commitment to, basic research, technology, and innovation as preparation to meet **society's grand challenges** demonstrates their **cultural importance**. However, in a post-truth society, where anyone can communicate about science online, and misinformation and conspiracy theories - which often relate to key EIC Pathfinder Pilot and H2020 FET research areas such as AI or health-biotech - are rife, **obtaining public support** for such programmes may not be straightforward. The current situation, and in particular the shift to new forms of online media, necessitates **high-level support measures and funding** for science communication activities.

According to Llorente *et al.* (2020b) sometimes a **systematic approach to science communication** can be particularly important for providing the **right incentives**, in addition to giving a clear sign that it is valued. Some ways in which the EIC and policymakers can show systematic support for the fight against mis- and dis-information and **enhance legitimate science communication** in Europe include:

In general:

- Launch **dedicated calls** which provide funding for science communication activities (Moreno *et al.* 2020).
- Promote **communication as part of scientists' jobs** and **reward** or **recognise** researchers who do so. Beyond citations and journal articles, participation in science communication activities could be an additional **measure of scientific productivity and excellence** for career assessment (Moreno *et al.* 2020).
- Offer adequate **science communication training** to scientists and science students, starting already during undergraduate degree programmes and continuing at PhD level. Training **workshops or courses** should also be made available for Post Docs and senior researchers (Moreno *et al.* 2020).
- Support creation of a **network of science 'shops'** to operate as myth-busters where fake news is debunked and which combat pseudoscience, misinformation and promote scientific facts (Moreno *et al.* 2020).
- Support creation of **validated and reliable information sources** on scientific topics through databases, websites, fact-checking services etc (Moreno *et al.* 2020).
- Launch campaigns to **raise awareness about mis- and disinformation**, and promote programmes aimed at increasing public digital literacy (Moreno *et al.* 2020).
- Encourage science journalists, researchers, and industry representatives to set up **personal accounts** on social platforms, as these actors receive high engagement from their audiences (Davies *et al.* 2019).


Photo: This is engineering on Unsplash

To encourage institutions:

- Assign **value to science communication positions**. Positively assess institutions which provide communication services, potentially through stable funding, or through political support (Llorente *et al.* 2020b).

To encourage communicators:

- Earmark resources for promoting **specialisation in science** communication (Moreno *et al.* 2020). Provide stable **funding** for science communication activities (Moreno *et al.* 2020).
- **Fund and promote stability** of science communication jobs in public science institutions (Moreno *et al.* 2020).
- Provide **health professionals** with incentives and training to help them communicate science -based information on health topics (Moreno *et al.* 2020).

To help journalists & media:

- To properly assess the state of science journalism in the EU, and to get a solid understanding of where the main obstacles lie, initiate a **large-scale survey** (Istvan Palugyai, FETFX 2020a).
- Provide journalists with **specialised science training** via online courses, in-person courses, or study trips to project lab and research centres so that they can better understand complex early-stage research (Moreno *et al.* 2020).

- Give grants to small, **emerging science communication-oriented outlets,** especially online, to help grow legitimate journalistic sources of science news (Istvan Palugyai, FETFX 2020a).
- Guarantee **equal access to information under equal conditions** - remove layers of bureaucracy and **bureaucratic obstacles** that prevent journalists from being able to access researchers for statements (ie. remove the levels of permission). Perhaps establish and fund a **science media centre** which brings together researchers and journalists, allowing for direct access to sources of information (Istvan Palugyai, FETFX 2020a).
- Establish a **European award for science communication** or science journalism to attract and recognise talent in the field - also potentially for covering early stage, high risk-high gain research (Istvan Palugyai, FETFX 2020a).

For citizens:

- During education, particularly in elementary and high school, **promote the relevance of the 'scientific method'** throughout the education path to reinforce critical thinking skills.
- Ensure **access to factual information** about scientific topics and **educate the public about scientific issues**, ie. through awareness campaigns.

7. Circulation of Knowledge & Talents

In addition to bridging the gap, and thus facilitating dialogue, between the public and research community, communicating about science can also contribute towards **fostering the development and circulation of knowledge and talents** in the EU.

Conveying messages about the importance of high-risk research and its positive impacts for society can **inspire and recruit a new generation** of science students from across the region. By showcasing the attractiveness of scientific careers to young people via, for example laboratory fieldtrips and direct communication and collaborations with schoolteachers, the EU could **strengthen potential pools of future talent**. Intensifying more interactive forms of science outreach, for instance festivals or citizen science engagement projects, would enhance collaboration between scientists, citizens, and other stakeholders. In addition to generating feedback about the relevance and impact of their research, this can **raise visibility** of researchers and research careers (Moreno *et al.* 2020).

At the Signals from the Future workshop, Valeria delle Cave (FETFX 2020b) suggested that **putting researchers on the frontlines** in higher profile placements is another way to raise visibility. For instance, **women scientists can be inspirational**, and featuring them can make them **role models** to the younger generation, showing young females that a career in science is a real possibility.

At later stages of education, taking public relations and communications courses during a PhD could significantly improve researchers' self confidence, training them to become **effective communicators**. Not only does this benefit the institutions and projects with which they will be associated during their careers, but it provides scientists with a set of **useful and transferrable skills**. On the flip side, offering communicators specialised training in science, for instance as part of degree programmes, could strengthen the circulation of scientific knowledge and enhance messages about positive impacts among society at large. Including science communications in **institutional strategies**, and creating dedicated positions, can ensure more effective dissemination of information tailored to reach the full range of stakeholders (Moreno *et al.* 2020).

Photo: Gabby K. on Pexels

EIC projects offer exciting career opportunities

By participating in **EIC projects** at the **start of their careers**, a new generation of scientists receives interdisciplinary training which enables them to develop **multiple research specializations** and expand their individual strengths. This is because EIC interdisciplinary research gives PhD students the opportunity to work with, and learn from, internationally renowned scientists from a **variety of disciplines**. This **culture of collaboration** produces positive experiences which motivate young researchers to pursue their own future research in a similar international, interdisciplinary style (Schaper-Rinkel 2017).

At the **mid-career stage**, researchers with proven track records can use EIC Pathfinder-H2020 FET funding to **explore new directions** and pursue high-risk, and highly innovative, projects. The **EIC spirit**

between frontier research and engineering gives them the freedom and possibility to experiment in order to achieve unexpected things. This is in contrast to other national and European research funding programmes which are more formalized (Schaper-Rinkel 2017). According to a report by **FET Traces** (Beckert *et al.* 2018), **88%** of researchers believe that participation in H2020 FET projects had positively impacted and promoted careers, with respondents citing aspects such as **'visibility, reputation, and partnership'** and being invited to present their H2020 FET research results at prestigious institutions as positive effects.

EIC projects produce well-rounded researchers

In general, Schaper-Rinkel *et al.* (2017), found that the essential strength of the Horizon 2020 FET Open and FET Proactive programmes, which have now evolved under EIC Pathfinder, is that they enable use-inspired breakthrough research both beyond individual disciplines and beyond the horizon of individual principal investigators. One by-product of participating in successful FET projects is that researchers develop an awareness of, and certain attitude toward, broader scientific and future economic impacts. FET sharpens their focus on issues concerning future products and process innovations that become possible through their investigations - they understand that even basic research has a long-term indirect economic impact because of their specific technology orientation.

breakthrough research both **beyond individual disciplines** and **beyond the horizon of individual principal investigators**. One by-product of participating in successful FET projects is that researchers develop an awareness of, and certain attitude toward, **broader scientific and future economic impacts**. FET sharpens their focus on issues concerning future products and process innovations that become possible through their investigations - they understand that **even basic research has a long-term indirect economic impact** because of their specific technology orientation.

3. The Case of Artificial Intelligence

Society is awash with messages about Artificial Intelligence (AI); extensively covered across all media channels, and a prominent feature in long-term, strategic planning by governments around the world, it is seemingly omnipresent. This technology, which despite its ubiquity is widely misunderstood by most stakeholder groups, is an example of a EIC Pathfinder and H2020 FET research area which attracts both widespread interest and controversy - and which frequently falls prey to misrepresentation. The complexity surrounding AI made it an ideal focus for an expert panel discussion at the FETFX Signals from the Future science communication workshop hosted in collaboration with the Horizon 2020-funded QUEST project on science communication. The session produced some useful perspectives and recommendations from both researchers and media.

Misunderstanding & the media:

AI is a tricky - often fraught - topic to communicate about: non-expert audiences such as journalists, policymakers and the public have great difficulty understanding the challenges and realities associated with its development. Thus, coverage can assume disparate and even extreme tones, veering between utopian or dystopian interpretations. According to Full Professor of Computer Science at the University of Trento, Fausto Giunchiglia (FETFX 2020c), AI has outperformed world hunger and climate change to be named the biggest worry for the future: the public is scared of what AI will bring us. In the current, crowded digital space, the overselling of AI and its potential – and the focus on its perceived challenges and dangers - can also be linked to the need to attract clicks and attention.

In a survey of science journalists by QUEST (Davies *et al.* 2019) which included AI as a topic, respondents noted challenges such as its poor, or even too broad definition – which causes confusion, and general overuse as a term. Some went so far as to question whether even AI researchers among themselves can agree on what it specifically is. They further cited AI as a 'sexy' subject which is often mentioned in stories to attract views, even when the technology being described is not AI at all. Journalists can also be frustrated by having to fit layman-friendly reporting about such a complex subject into short spaces and timeframes.

AI researcher and pioneer Luc Steels (FETFX 2020c) claims a tendency by the press to treat AI as a new or future phenomenon; in reality, it dates back to the 1950s. While great advances have been made since this time, after more than 60 years, it is far from a 'new' technology. Instead of writing about its history, which as with other scientific disciplines has seen a progressive development, only new advances receive coverage. In fact, a fundamental limitation which applied to AI already in the 1980s remains in place today: as a technology, it can be

arbitrarily strong, but it can only outperform humans in a narrow domain. Outside of this domain, there is no hope that it can match humans' ability to adapt and evolve (Fausto Giunchiglia, FETFX 2020c). Still, AI is often reported on using a 'futurism frame' (Davies *et al.* 2019, 33) - reports tend to speculate on what it *might* achieve and often position this in relation to hypothetical ethical implications of its future use, for instance to robots and job loss or self-driving cars and safety. On the flip side, AI is sometimes portrayed as a general solution for many of society's grand challenges; however, such reporting regularly overlooks its capabilities and limitations (Davies *et al.* 2019).

Another concern voiced by media is that much AI research is funded and driven by private companies, including big tech like Google or Facebook, and thus information about results is not made publicly available or transparent (Davies *et al.* 2019).

The researchers' perspective:

When looking at non-expert perceptions of AI, researchers stress the importance of combatting misperceptions about the associated future possibilities. Their man concern, according to Roedema *et al.* (2020) is that both too negative and too positive characteristics are being attributed to the technology. Thus, it is important to educate and inform audiences on the true nature of AI, and to provide a realistic image of the science behind it. For instance, many people don't realize that it is already part of their daily lives.

Researchers also question the sources of stories on AI. According to Steels (FETFX 2020c), simple stories which appear in non-expert blogs - not in peer reviewed scientific journals - can become stories in newspapers about how 'AI will destroy humanity'. In the news, robots are often depicted taking over roles that should stay with humans. Public opinions around AI are arguably dominated in part by entertainment media – namely, science fiction movies that present a vision of the Terminator, which in reality has nothing to do with AI. If people were educated about the fact that AI is based on the data it is fed, and as a programme does what it is programmed to do, this could help counter the belief that it can act by itself.

Take for instance the scenario that two computers talk to each other without humans being able to understand. The reality, says Fausto Giunchiglia, Professor of Computer Science at the University of Trento (FETFX 2020c), is that AI is brittle; on its own, it has a fundamental inability to adapt to an ever-changing world in space and time, or to evolve with context. As with a car or an airplane, its algorithms need people to drive them. One was to visualize AI is to picture it as a tool, for instance a hammer, with a human standing behind it. If you hit something with the hammer, you are still behind the action (Dunja Mladenic, FETFX 2020c). Thus, there is too much hype placed on the negative possibilities and too many worries over something that is not as it is presented in mass media.

The very thin boundary that exists between what is possible and what is feasible with AI is something only experts understand. But journalists can help raise awareness that AI is not a personified 'thing' or gadget; it is a science with a long history behind it (Dunja Mladenic, FETFX 2020c). In fact, the hype, and in particular the negative slant of messaging associated with AI, the idea that it is ultimately driving towards becoming a machine with intelligence that equals or exceeds that of humans, can endanger AI because there are a lot of good things it can do. For EIC researcher and innovation communities, their work is about creating a social innovation that helps people and could be exploited by everyone, for instance by allowing access to top notch expertise. It could be a tool which could build connections, augmenting our access to the best knowledge available (Fausto Giunchiglia, FETFX 2020c).

Experts such as Steels (FETFX 2020c) also believe companies have a big responsibility in how AI is portrayed, or rather mis-portrayed, in the media, because corporate PR departments push messages about how disruptive it will be. They 'hype' their

Many AI-powered devices already provide for a human-friendly automation of processes.

technologies in service of product promotion and create a myth around an intelligent system. In reality, this is not dissimilar from PR which would be used to promote any new product - its aim is to capture attention. Through well-funded outreach campaigns, promotion makes its way into 'news' reporting. Further, big tech companies such as Google and Facebook with large internal groups doing AI present themselves as champions of the technology. Another example of corporate PR spin (Luc Steels, FETFX 2020c) is the fact that companies seeking venture capital significantly increase their chances of receiving funding by including 'AI' in their pitches.

The opportunities:

Jozef Stefan Institute AI Lab Head Dunja Mladenic (FETFX 2020c) believes AI represents a great opportunity and has the potential to become a social equalizer in the right hands and minds. The responsibility for which direction its development takes, falls on us as humans: The best results can be obtained when AI computes, but humans make conscious decisions to use it for the right purposes. Available AI networks deal with the complexity which surrounds us and can uncover existing biases, predictions, and real time analyses. The capability that we need, is to ask the right questions - if we can do this, it can lead to new ways of perceiving the world. AI could provide for a human friendly automation of processes, decision-making and analytics which combine multiple data sources.

AI should be seen as a technology and a tool: an algorithm that can calculate for us and can accomplish certain tasks more quickly, such as deep data analytics, of context, content, and dynamics of interaction; modelling of complex systems; and user-friendly communication for man-machine collaboration. The data that AI can provide us with and the insights we can gain from its analysis give more insight into the society in which we live and the processes that are there. These should be recognized as assets - it can teach us, for instance, a lot about user behaviour. Humans can develop skills to benefit from these uses of AI (Dunja Mladenic, FETFX 2020c).

Policymakers are also applying increasing pressure to use AI to regulate what is happening online. But, according to Giunchiglia (FETFX 2020c), they lack a realistic picture of what it can and cannot do. To facilitate understanding, one solution could be adding social sciences to the AI mix. Bringing disciplines together in service of a common goal (AI) can work towards solving the problem and could deliver a second generation of AI and social networks -and even potentially contribute to a new way of doing the science.

The OECD has created the expert group 'AIGO' to provide guidance in determining principles for the use of AI in society. This group is working on a framework for AI designed to inform policymakers, which can contribute towards shaping regulatory systems in the future (Dunja Mladenic, FETFX 2020c).

What can we do? Recommendations for policymakers:

- Policymakers can develop regulatory systems to ensure sustainability and that we are able to consciously orchestrate AI's use for the benefit of today and future generations. The debate around how to develop such systems can be informed by work and guidelines of the OECD 'AIGO' expert group.
- Encourage interdisciplinarity in AI research – bring social sciences into the mix to facilitate broader understanding and work towards developing the second, improved generation of social networks and AI.
- Understand that AI is a science with a 60-plus year history rather than a gadget and treat it accordingly.
- Fund training for science journalism and science communicators – or communication training for researchers, so that they know HOW to communicate about AI effectively and to all stakeholder audiences.
- Develop a better understanding of what AI is capable of, and what its limitations are, especially with regard to online content moderation.
- Find ways to hold news and media outlets accountable when their reports contain misinformation about AI and other emerging technologies.

Recommendations for researchers & communicators:

- To improve understanding and perceptions about AI among non-expert audiences, we should start talking about how AI could help people and society. Explicitly state that the goal is to build technological innovation which allows and enables better social innovation.
- Emphasise that for researchers, the progression of AI is not only about building smarter machines, but also in building machines that can contribute meaningfully to the fight against society's grand challenges.

- Scientists and researchers should themselves participate in communication outreach and engagement, presenting information in such a way that the public can understand the reality behind AI. In this way, scary media stories that are trying to provoke fear can be avoided.
- Emphasise that humans can develop skills to benefit from the use of AI -educate audiences on the strengths and limitations of AI technology.
- When communicating about AI, highlight the human angle, also with accompanying imagery. Rather than using robots or other futuristic graphics, show people using AI in their lives.
- Scientists should work together with the media to find a mutual trust in how AI is reported on and help media to tell fact-based stories understandable to general audiences, while adhering to the space and time restrictions.
- Educate the public and raise awareness that AI is based on data we feed it and it does what we programme it to do, rather than self-directed things.

Recommendations for media:

- When communicating about AI, highlight the human angle, also with accompanying imagery. Rather than using robots, or Terminator-style futuristic graphics, show people using AI in their lives.
- Recognise and report on the fact that AI is a science with a 60-plus year history behind it, rather than a new phenomenon.
- Work with scientists to find a mutual trust in how AI is reported on, in order to tell fact-based, easy to understand stories while adhering to the space and time restrictions.
- Recognise the corporate PR promotion angle when press releases and stories are being pitched by companies.
- Source stories from reliable outlets, for instance peer reviewed academic journals, rather than non-expert blogs.
- Educate the public and raise awareness that AI is based on data we feed it and it does what we programme it to do, rather than self-directed things.

9. Concluding Remarks

For more than 30 years, Europe's funding programme for emerging technologies research has been at the **forefront** in the search for solutions to society's biggest challenges. In 2021, it transitioned into the newly formed **European Innovation Council**, aimed at **identifying and supporting breakthrough technologies and game changing innovations to create new markets and scale up internationally**, as part of its 'Pathfinder' initiative. But in order for the EIC and Europe to forge ahead and maintain competitiveness, **wide-ranging support for research and innovation remains crucial**. To achieve this support, particularly in the face of the challenges facing science communication, **robust two-way communication and engagement** with all key audiences is of vital importance. This is true both for **researchers** - who will need to take a more active role in science communication, and for **policymakers** - who must determine how best to support researchers and the fact-based communication of science, while at the same time fighting the mistruths, hoaxes and conspiracies which have emerged from the new digital space. The recommendations contained in this paper should provide a **good baseline** from which to start.

10. References & Further Reading

Beckert, B. *et al.* (2018), *Visionary and Collaborative Research in Europe - Impacts of Use-Inspired Basic Research*, FET_TRACES Project, viewed 04 March 2021, <https://www.fet-traces.eu/traces-wAssets/docs/FET_Traces_final_report_2018.pdf>.

Beckert, B, Schaper-Rinkel, P. (2016), *D2 How do other FET-like funders measure impact and what can be learned?,* FET_TRACES Project, viewed 11 March 2021, <https://www.fet-traces.eu/traces-wAssets/docs/FET_TRACES_Deliverable_D2.pdf>.

Bezzi, M. (2019), *Science communication and Stakeholder engagement: towards new challenges and practices*, QUEST Project, viewed 11 March 2021, <https://questproject.eu/science-communication-and-stakeholder-engagement-towards-new-challenges-and-practices/>.

Costa, E. *et al.* (2021), *Science Communication on Social Media: Good Practices,* Project QUEST, viewed 01 March 2021, <https://questproject.eu/download/science-communication-on-social-media-good-practices/>.

Davies, S.R., *et al.* (2019), *D1.1 Summary report: European Science Communication Today*, Project QUEST, viewed 15 February 2021, <https://questproject.eu/download/deliverable-1-1-summary-report-european-science-communication-today/>.

Delaney, N. (2020), *Science Communication - Achievements in Horizon 2020 and recommendations on the way forward*, Publications Office of the European Union, viewed 10 February 2021, <https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/4b1386ba-cbc8-11ea-adf7-01aa75ed71a1>.

Fähnrich, B. (2020), *D3.1 Analysis of the status quo and demands for science communication training*, RETHINK Project, viewed 19 March 2021, <https://www.rethinkscicomm.eu/wp-content/uploads/2020/06/D3.1-Report-on-analysis-of-status-quo-and-requirements-in-focus-countries.pdf>.

FETFX (2020a). *Panel #1: High-Risk Research: Assessing FET science communication attitudes and paths to innovation*. Available at: https://www.youtube.com/watch?v=DwV48CVo6rg&list=PLFEAiVY1Lxwhq5HbmUtFX-GADngsPyDn1 (Accessed: 08 February 2021).

FETFX (2020b). *Panel #2: New approaches and mechanisms for communicating about Future and Emerging Technologies*. Available at: https://www.youtube.com/watch?v=p-j0nd6Zs7Q&list=PLFEAiVY1Lxwhq5HbmUtFX-GADngsPyDn1&index=2 (Accessed: 09 February 2021).

FETFX (2020c). Panel #3: *The Mis-portrayal of AI in the Media: What to do about it?* Available at: https://www.youtube.com/watch?v=N5RxKXg6JNk&list=PLFEAiVY1Lxwhq5HbmUtFX-GADngsPyDn1&index=3 (Accessed: 09 February 2021).

FETFX (2019), *A practical Good Practices Communication Kit for Ongoing and Future FET Projects*, FETFX Project, viewed 17 February 2021, <http://www.fetfx.eu/wp-content/uploads/2018/12/FETFX-Communication-kit.pdf>.

Henriksson, T. (2019), *10 recommendation for improving science and health journalism in the age of misinformation,* Project QUEST, viewed 10 February 2021, <https://questproject.eu/10-recommendations-for-improving-science-and-health-journalism-in-the-age-of-misinformation/>.

Llorente, C., Revuelta, G. (2020a), *Deliverable 1.5 Database of inspiring practices and recommendation on engaging scientists and communicators with science communication*, CONCISE Project, viewed 10 March 2021, <https://concise-h2020.eu/wp-content/uploads/2020/09/D1.5_Database-of-inspiring-practices-and-recommendations-on-engaging-scientists-and-communicators-with-science-communication.pdf>.

Llorente, C., Revuelta, G. (2020b), *Deliverable 1.3 Hurdles and incentives to science communication in Europe*, CONCISE Project, viewed 10 March 2021, <https://concise-h2020.eu/wp-content/uploads/2020/09/D1.3_Hurdles-and-incentives-to-science-communication-in-Europe.pdf>.

Lusuan, A., Mazzolo, G. (2020), *D4.2 Journalist-in-the-lab initiative*, FETFX Project, viewed 02 March 2021,<https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5cfcc7a28&appId=PPGMS>.

Martiarena, L. (2017), *D2.4 Report on content collection and selection*, EFFECT Project, viewed 15 February 2021, <http://www.fetfx.eu/wp-content/uploads/2019/01/Report-on-content-collection-and-selection-D2.4.pdf>.

Mazzolo, G. *et al.* (2017), *D3.1 First Report on Public Communication and Distribution*, EFFECT Project, viewed 04 March 2021, <http://www.fetfx.eu/wp-content/uploads/2019/01/First-Report-on-Public-Communication-and-Distribution-D3.1.pdf>.

Michi, C., Schmid, E. *et al.* (2017), *D5.1 Analysis of EFFECT impacts - First Release, EFFECT Project*, viewed 11 February 2021, <http://www.fetfx.eu/wp-content/uploads/2019/01/Analysis-of-EFFECT-impacts-first-release-D5.1.pdf>.

Milani, E. *et al.* (2020a), *D1.3 Investigating the links between science communication actors and between actors and their audiences*, RETHINK Project, viewed 02 March 2021, <https://www.rethinkscicomm.eu/wp-content/uploads/2020/06/RETHINK_-D1.3-Report-on-links-between-the-different-actors-engaged-in-science-communication-and-how-the-actors-foster-connections-with-their-audiences-1.pdf>.

Milani E. *et al.* (2020b), *D1.2 Report on the working practices, motivation and challenges of those engaged in science communication*, RETHINK Project, viewed 02 March 2021, <https://www.rethinkscicomm.eu/wp-content/uploads/2020/06/RETHINK_-D1.2-Report-on-the-working-practices-and-motivations-and-challenges-of-those-engaged-in-science-communication.pdf>.

Milani, E. *et al.* (2019), *D1.1 Scoping report on the science communication ecosystem,* RETHINK Project, viewed 03 March 2021, <https://www.rethinkscicomm.eu/wp-content/uploads/2020/06/D1.1-Scoping-Report-on-the-Science-Communication-Ecosystem.pdf>.

Moreno, C. *et al.* (2020), *Communication role on perception and beliefs of EU citizens about science - Policy Brief 2020*, CONCISE Project, viewed 01 March 2021, <https://concise-h2020.eu/wp-content/uploads/2020/12/CONCISE_policy_brief_EN.pdf>.

Olesk, A. *et al.* (2020), *12 Quality Indicators for Science Communication - Guide for Science Communicators*, Project QUEST, viewed 08 February 2021, <https://questproject.eu/how-to-improve-science-communication-consider-these-12-guiding-principles/>.

Roedema, T. *et al.* (2020), *Deliverable 2.1 A report on incentive and disincentive structures for research and innovation stakeholders to engage in science communication*, RETHINK Project, viewed 11 March 2021, <https://www.rethinkscicomm.eu/wp-content/uploads/2020/06/D2.1-Report-of-disincentive-structures-for-RI-stakeholders-to-engage-in-science-communication-2.pdf>.

Schaper-Rinkel, P. (2017), *Deliverable D14 Cross Cutting Analysis: Success factors derived from cases*, FET_TRACES Project, viewed 10 March 2021, <https://www.fet-traces.eu/traces-wAssets/docs/FET_TRACES_Deliverable_D14_Cross-cutting_sucess_strategies_as_submitted.pdf>.

Schaper-Rinkel, P., Beckert, B. (2016), *D3 Report: List of indicators and assignment of suitable methods*, FET_TRACES Project, viewed 04 March 2021, <https://www.fet-traces.eu/traces-wAssets/docs/FET_TRACES_Deliverable_D3.pdf>.

Schmid, E., De Ferrari, A (2017a), *D1.1 Communication and Engagement Strategy and Plan*, EFFECT Project, viewed 01 March 2021, <http://www.fetfx.eu/wp-content/uploads/2019/01/Communicaiton-and-Engament-Strategy-Plan-D1.1.pdf>.

Schmid, E. *et al.* (2017b), *D3.3 Online, social and TV media indicators used to measure outreach and impacts*, EFFECT Project, viewed 01 March 2021, <http://www.fetfx.eu/wp content/uploads/2019/01/Online-social-and-TV-media-indicators-used-to-measure-outreach-and-impacts-D3.3.pdf>.

Acknowledgements

FETFX would like to offer special thanks to the Horizon 2020-funded project QUEST for co-organizing and co-hosting the November 2020 Signals from the Future online workshop, which provided stimulating debate on the topic of science communication in Europe and planted many of the seeds which inspired this paper. In particular, FETFX would like to acknowledge the following participating speakers and moderators for their thought-provoking contributions:

Moderators: *Helga Nowotny (*Professor Emerita of Science and Technology Studies, ETH Zurich); *Alessandra Fornetti*, (QUEST Project Coordinator and Executive Director of the TEN Program on Sustainability at VIU); *Erich Prem*, (CEO eutema Gmbh and FETFX)

Speakers: *Valeria delle Cave* (Communication of Competitive Projects and Foreign Press Office, IIT); *Iordanis Arzimanoglou* (EIC Programme Manager, Biomedicine and Biotechnology); *Eva García Muntión* (PREFET Project Coordinator and Founder of RTDI); *István Paluyagi* (Science Journalist); *Alexander Gerber* (Chair of Science Communication, Rhein Waal University and Research Director, INSCICO); *Carl-Gustav Linden* (Associate Professor of Data Journalism, University of Bergen, and Docent, Media and Journalism Development, University of Helsinki); *Anna Dumitriu* (Artist); *Daniela Ovadia* (Science Journalist; Scientific Director of the Center for Ethics in Science and Journalism and Co-Director, Neuroscience and Society Lab - University of Padua); *Luc Steels* (Professor Emeritus VUB Artificial Intelligence Research Group; ICREA Research Professor, Institute of Evolutionary Biology and Scientific Coordinator H2020 MUHAI Project); *Fausto Giunchiglia* (Full Professor of Computer Science, University of Trento and Project Coordinator WeNet); *Dunja Maldenić* (Senior Researcher, Project Leader and Head of the Artificial Intelligence Laboratory, Jožef Stefan Institute); *Renate Dacinger* (Journalist, Editor and Presenter of 'Let's Bite into the Science', Slovenian Public Television); *Neil Maiden* (Professor of Digital Creativity, CASS Business School, City, University of London and QUEST Project).

About FETFX

FETFX is a developing cross-media communication platform which connects science, industry and society, in order to tell stories on Future and Emerging Technologies and engage directly with the general public across Europe and beyond.

Our key mission is to foster the public understanding of how FET research - apparently far from reality and direct applications - is actually needed to generate innovation and benefit society in the long-term.

FETFX has received funding from the European Union's Horizon 2020 FET Programme under grant agreement No. 824753.

FETFX

OUR FUTURE, TODAY

www.fetfx.eu

info@fetfx.eu

@FETFX_EU

FET FX

FETFX

Authors:
Sarah Kiehne, eutema GmbH
Marta Calderaro, APRE

This project has received funding from the European Union's Horizon 2020 FET Programme under grant agreement No. 824753.