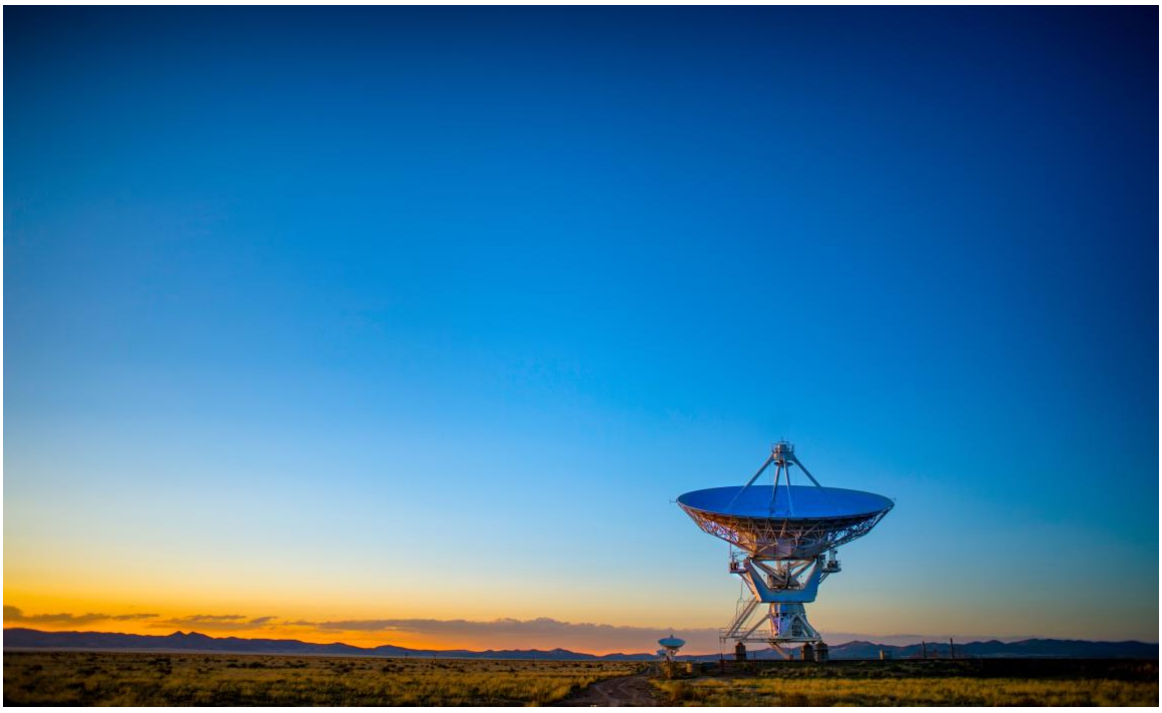
TECHETHOS

FUTURE ○ TECHNOLOGY ○ ETHICS

Societal Readiness Tool (Pre-Final Version)

D5.6



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Societal Readiness Tool (D5.6 Abridged Pre-Final Version)			
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The TechEthos Project

Short project summary

TechEthos is an EU-funded project that deals with the ethics of the new and emerging technologies anticipated to have high socio-economic impact. The project involves ten scientific partners and six science engagement organisations and runs from January 2021 to the end of 2023.

TechEthos aims to facilitate “ethics by design”, namely, to bring ethical and societal values into the design and development of new and emerging technologies from the very beginning of the process. The project will produce operational ethics guidelines for three to four technologies for users such as researchers, research ethics committees and policy makers. To reconcile the needs of research and innovation and the concerns of society, the project will explore the awareness, acceptance and aspirations of academia, industry and the general public alike and reflect them in the guidelines.

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Definitions and abbreviations

Table 1: List of Definitions

Term	Explanation
Product Societal Readiness	Product Societal Readiness is a compound concept, which comprises three elements: ethical readiness, social readiness and legal readiness (see below)

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Product Ethical Readiness	A product achieves ethical readiness when the possibility of it giving rise to ethical problems when deployed or brought to market has been adequately mitigated, including problems associated with a failure to realise benefits adequately or in the right way.
Product Social Readiness	A product achieves societal readiness when a) the possibility of its giving rise to social problems when deployed or brought to market has been adequately mitigated, b) the prospect of technology deployment has an adequate level of social acceptance, and c) the human capacity to use the technology to produce benefits is sufficiently established.
Product Legal Readiness	Legal Readiness is achieved when the product is not expected to give rise to legal issues when deployed or brought to market.

Table 2: List of Abbreviations

Term	Explanation
ATE	Anticipatory Technology Ethics
BCI	Brain-Computer Interface
CE	Climate Engineering
CEO	Chief Executive Officer
CSR	Corporate Social Responsibility
CTO	Chief Technology Officer
DoA	Description of Action
DBS	Deep Brain Stimulation
DG	Directorate-General
DIT	Defining Issue Test
EbD	Ethics by Design
ELS	Ethical, Legal and Social aspects
IEEE	Institute of Electrical and Electronics Engineers
NT	Neurotechnology
PC	Project Coordinator
REC	Research Ethics Committee
R&I	Research and Innovation

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RT	Role-Playing Tool
SRT	Societal Readiness Tool
STEEPV	Social, Technology, Economics, Ecology, Politics, Values
TRL	Technology Readiness Level
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VSD	Value-Sensitive Design
WP	Work Package
XR/ DXR	Extended Reality/ Digital Extended Reality

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Executive Summary

Abstract:

This report introduces report introduces the TechEthos Societal Readiness Tool (SRT). The TechEthos SRT is primarily intended for use by actors in product design and innovation. The tool serves two functions. First, it provides guidance for its target users, enabling them to navigate the product development process in a manner that builds in ethical and social impact considerations from the very earliest stages. The substantive methodological claim embodied by the tool is that embedding concern for ethical and social impacts in product development is a core component of societal readiness. Second, the tool enables target users to conduct qualitative self-assessment of the societal readiness level of their product. The main text of this report provides an explanation of the tool. The tool itself follows as an annex to the report.

Executive Summary:

The TechEthos Societal Readiness Tool (SRT) is a tool intended for use by developers of innovative products who wish to ensure that their products are ready for society when put on the market. It can also be used as an assessment tool by various other organizations with an interest in the societal readiness of products. The tool has a guidance function and an assessment function. The guidance function sets standards and recommends actions for developers to take in order to develop new products so as to meet standards of 'product societal readiness'. It also enables them to conduct self-assessments of the extent to which the conditions can or will be fulfilled by a product.

This report contains a number of novel proposals to extend the concept of Technology Readiness Level. Technology Readiness Level is a measure of the maturity of a technology development project towards operational deployment. It is a measure used by a range of organisations including the European Commission to make comparisons between the maturity of projects from a technical perspective. Building on the field of human-factors research, a wide range of authors in various fields have argued that TRL is too narrow a conception of readiness, because it restricts readiness assessment to assessment of successful function first in controlled conditions, then in operational conditions, without specifying what factors those conditions should simulate, the implication being that this leads to an overall successful outcome.

Societal Readiness is a supplement to the concept of technology readiness. It recognises that technological failures are not limited to failures to perform their function narrowly defined. Medium and long-term detrimental impacts upon individuals, social groups, the environment, the climate, political systems, and tension with legal regimes, can all constitute failures of a technology or technological product to perform effectively in an operational context, and therefore should all be captured in the concept of readiness.

The TechEthos SRT is aimed at actors in innovative product development. It is designed to give guidance and assessment for product societal readiness. This is a property of products-in-development, and is defined as a combination of product ethical readiness, product social readiness and product legal readiness. Product ethical, social and legal readiness are further defined as the status achieved by products-in-development expected to realise their intended benefits on operational deployment without giving rise to significantly detrimental ethical, social and legal impacts. Ethical and social impacts are partially overlapping domains of impact defined institutionally as concerns embodied in

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ethical and social impact assessment respectively. Legal impacts are defined as tensions with extant or anticipated legal regimes.

This report contains two texts on the Societal Readiness Tool. The text in the main report introduces the tool, provides a theoretical foundation for it and makes recommendations for further development of the tool. An annex provides the tool in textual form. The tool is still in prototype stage and further testing and development is recommended.

Introduction to the SRT in the main text

Section 1 of this report elaborates on the specification of key concepts deployed in the tool. It also locates the tool the context of recent and ongoing research.

Section 2 sets out the theoretical foundation that underpins the tool. The tool is based in part on an Ethics by Design approach, and in part on ethical guidance by developers for deployment and use. According to an Ethics by Design approach, fundamental values should be respected when designing technical systems from the earliest stages in the design process, and systems should be designed with fundamental values "embedded" in them. This section argues for an extended framework, building on Ethics by Design and ethical considerations regarding deployment and use, which also acknowledges the need to respect societal objectives beyond those typically grouped under the heading of 'ethics', and building concern for societal impacts into non-design interventions in the product environment (including deployment strategy, corporate structure, product-user relationships).

Section 3 gives an overview of the Societal Readiness Tool structure explains the justification for it. This structure consists of a nested hierarchy of guidance, comprised of 4 levels. The first, High-level guidance, consists of the relevant ethical values/principles and social impact criteria. The second, mid-level guidance, specifies how these values and criteria constrain features of products and their interaction with the wider environment. The third, product violations, specifies how product deployment can violate mid-level guidelines. The fourth and final level specifies what mitigations are necessary to achieve readiness in the face of these violations.

Section 4 gives an overview of the self-assessment function and explains the justification for its structure. The assessment function facilitates users in assessing the residual risk associated with the possibility of product violations after planned mitigations have been taken into account. It maps onto a "traffic light"-style system of assessment outcomes, from "Further Mitigations Required", through "Proceed with Caution", to no action required. The assessment is intended to be temporally relative, with users advised to conduct regular self-assessment by means of the tool at intervals throughout the project lifecycle, as it is anticipated users are likely to obtain different outcomes as knowledge of product-society interactions progresses or design objectives change.

Section 5 describes the prospects for future work involving the tool, in particular noting links with ongoing related research projects. It also notes the status of the tool as primarily a scholarly contribution which would require further validation through stakeholder analysis to adapt it, as envisaged, to various specific operational contexts.

Annex

The annexed tool text is divided into an Introduction, Instructions for use, and the four levels of guidance: high-level guidelines, mid-level guidelines, product violations, and mitigations. Each of the four guidance levels is followed by a "reflection stage". Reflection stages 1 and 2 support the guidance function, while reflection stages 3 and 4 support both the guidance function and the assessment function. Each level of guidance is divided into "ethical" guidance and "social" guidance. For the present prototype, legal guidance is represented where relevant within the ethical and social categories.

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Under High-Level Guidelines, the user is presented with a set of seven ethical values or principles and seven social impact categories. These are described at a high level of generality as concerns that actors should take steps to engage with from the earliest stages of the design process. They are intended to clarify the potential implications of these values across a wide variety of situations, in order to promote reflection on the part of the user as to how these values should be interpreted with respect to their specific concerns. This interpretation is facilitated for the user through a series of examples. Thus, in the following reflection stage, users are invited to carry out this interpretive work for themselves, by recording their own interpretations of the high-level guidelines with respect to the systems they are developing. There is also the opportunity to expand the tool by adding field-specific high-level guidelines.

Under Mid-level Guidelines, the high-level guidelines are applied to products specifically, through a series of subcategories, each of which reflect different aspects of the high-level guidelines as applied to the specific context of product development. The number of subcategories varies depending on the high-level guideline in question. For instance, more specific guidance is provided under many of the social impacts like harm to the environment, while fewer subcategories are included under some of the ethical guidelines, reflecting the need to capture a multiplicity of interpretations which the user can further specify. The second reflection stage prompts users to check their list of the design and technical requirements for their product development project against the ethical and social requirements embodied in the mid-level guidelines. This enables potential tensions to be identified at an early stage.

Under Product Violations and Mitigations, ways in which various categories of product violate each of the specific mid-level guidelines are listed. Strategies for mitigation are then offered for each category of violation. Violations are organised under product category, while mitigations are organised by intervention pathway: either design (the structural and functional features of the product itself), deployment (the ways in which the innovators intend to bring the product to the end user, and use (the ways in which the context in which the product will operate may have to be prepared). Finally, reflection stages 3 and 4 facilitate users in assessing the risk associated with potential violations given the application of the mitigations identified through use of the tool, in order to enable the measure of product societal readiness. The assessment function is iterative and recursive, with users encouraged to repeat the process many times over the course of the project, and to update the content of the tool on the basis of their own reflections.

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1. Societal Readiness Tool: Introduction and Summary of Aim

The TechEthos Societal Readiness Tool is a tool which enables users to receive targeted operational guidance with a view to ensuring that societal readiness is achieved prior to or coinciding with product launch. It further prompts users to reflect on the readiness status of their project, in order to conduct self-assessment of the readiness level of their projects. This section explains the intended functionality of the tool, the intended user base for the tool, and sets out key concepts as defined for the purposes of the tool. It also situates the tool within an ecosystem of past and ongoing research upon which it builds, and by which it is informed.

The Social Readiness Tool (SRT) is a tool with two functions: first, it allows relevant actors to undertake their responsibilities in relation to the ethical, legal and societal status of technological products. It achieves this through operational guidance that helps to take users beyond the high-level guidance function served by guidelines documents, towards concrete steps that can be enacted during design and deployment and use. This is the guidance function. Second, as an ethical sensitivity tool, the SRT assists users in reflecting on the social readiness level of a product. The intention is not to provide a top-down determination of a numerical social readiness level according to pre-determined criteria, but rather to serve as a tool of reflection and reflexivity, allowing users to make their own judgements about the readiness level of their projects.

The SRT can be contextualised as one of a series of proposals for extensions to the well-established TRL assessment framework. Other examples include System Readiness Level (Sauser et al. 2006), Human Readiness Level (Philips 2010), and Market Readiness Level (Hjort and Brem 2016). These are assessment frameworks which highlight oversights embedded in the TRL framework, which proponents of novel frameworks contend have given rise to technical failures in systematic ways, for instance by neglecting due consideration for human capacity to use products as intended, or an organisation's preparedness to bring the product to market. The concept of social readiness appeals to a similar contention, namely that ethical, social and compliance failings can be attributed to gaps in extant assessment frameworks, and the tool seeks to fill those gaps.

The selection of target users is informed by ecosystem mappings conducted under TechEthos Deliverable 3.1. These identify "primary actors" for each technology ecosystem (with some overlap): 'industry', 'manufacturers', 'technology providers' and 'R&I clusters'. Thus, for example, for the Climate Engineering ecosystem, the mapping identified the primary actors as follows:

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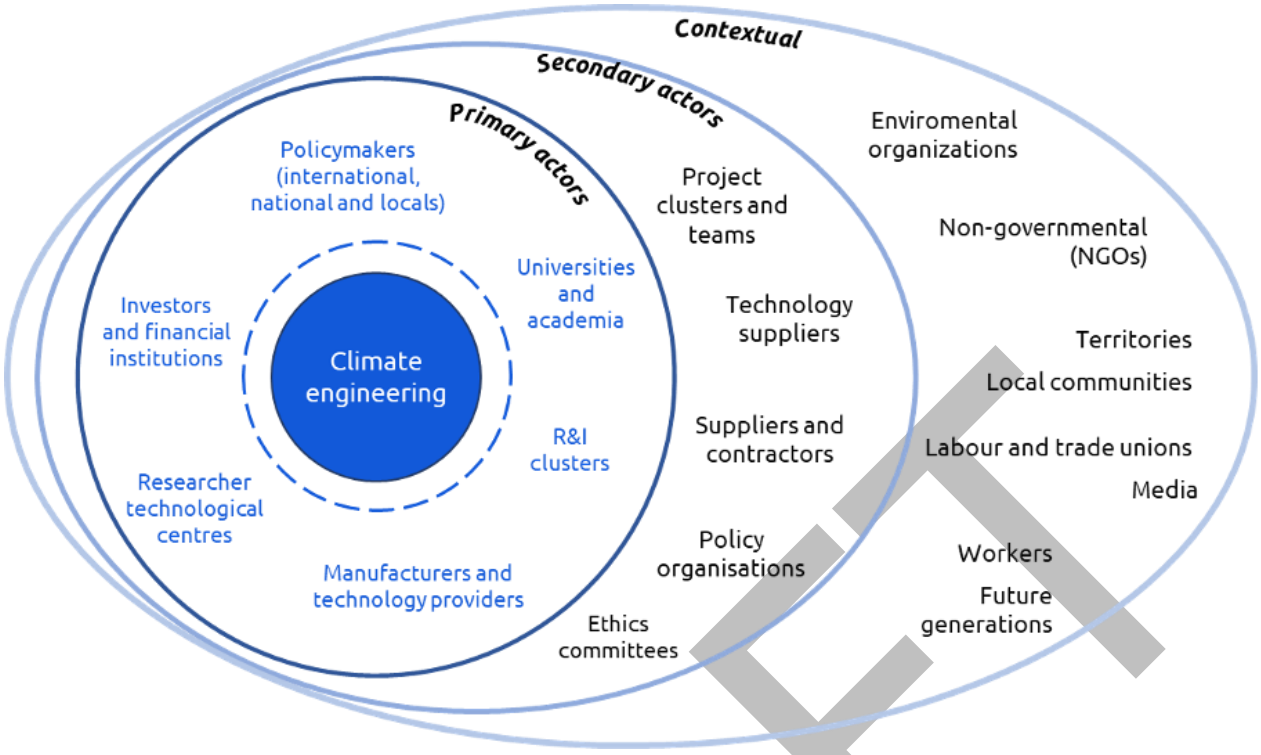

Figure 1: Innovation ecosystem of climate engineering technologies. Source: TechEthos D3.1

Responding to the need to adapt the language of the tool as closely as possible to the intended user group, the tool targets product developers as the primary user group, in particular product developers in industry. The tool still has secondary usability among indirect stakeholders, including funders and regulators, as a feature of the assessment function. An overview of key concepts will be given below. A more detailed explanation of the how the determination of aims for functionality was carried out will follow.

1.1 Specification of concepts

It was determined that the tool should focus on what we call *product societal readiness*. Product societal readiness can be defined as the extent to which a product can be relied upon to realise its intended benefits in an actual social context, in an ethical way, avoiding unacceptable societal impacts and governed, where necessary, by effective legal frameworks. In other words, product societal readiness means that there are no non-technical impediments to launching a technologically innovative new product and that it is socially and ethically responsible to do so. It is sometimes advantageous to refer to conditions of social readiness for technologies as such, rather than specific products. This level of guidance and assessment can be referred to as *technology social readiness*. Technology social readiness can be defined as the extent to which *a variety of technological products that fall under a technology* can be relied upon to achieve their intended benefits in an actual social context, in an ethical way, avoiding unacceptable societal impacts and governed, where necessary, by effective legal frameworks. Technology social readiness may be relevant, for instance, to early stages in the design process, or to certain assessment and guidance criteria, or to indirect stakeholders. While technology social readiness is an important concept, product societal readiness remains the focus of the present report.

As understood the context of the TechEthos project, Societal Readiness is a compound concept, which comprises three elements: ethical readiness, social readiness and legal readiness.

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Ethical Readiness: A product achieves ethical readiness when the possibility of it giving rise to ethical problems when deployed or brought to market has been adequately mitigated, including problems associated with a failure to realise benefits adequately or in the right way. Ethical considerations are defined over a set of values and principles, these are ideally specific to the technology family to which the product belongs. To achieve ethical readiness, ethical problems must be anticipated and mitigated at each stage of product development. For ethical problems that cannot be addressed via the design of the product itself, including problems related to the way the product will likely be received in society, adequate mitigation strategies must be in place for a product to achieve ethical readiness. These mitigations may include formal or informal governance structures.

Social Readiness: A product achieves social readiness when a) the possibility of its giving rise to social problems when deployed or brought to market has been adequately mitigated, b) the prospect of technology deployment has an adequate level of social acceptance, and c) the human capacity to use the technology to produce benefits is sufficiently established. To achieve social readiness, social problems must be anticipated and mitigated at each stage of product development, and adequate mitigation strategies must be in place for a product to achieve social readiness. This may include industrial and labour policies implemented by governments. Clearly, social problems and ethical problems are not mutually exclusive categories; issues identified as social and issues identified as ethical will form a continuum. The key distinction is that ethical problems arise in relation to ethical values and principles identified under ethical analysis methodologies, including the ATE plus methodology that was adopted during the early phase of the TechEthos project (Brey 2012; see TechEthos D2.1), and its updated variant, ATE+, developed in the course of the TechEthos project (Umbrello et al. 2023), while social problems arise in relation to social impact assessment criteria (see for e.g. Esteves, Franks & Vanclay 2012; European Commission 2009)

Legal Readiness: Legal Readiness is achieved when the product is not expected to give rise to legal issues when deployed or brought to market. It may also incorporate the requirement that existing legal frameworks are adequately adapted to mitigate any residual negative impacts not addressed by ethical design and social policy. To that extent, legal readiness may overlap in terms of its concerns, the distinction is that legal readiness is addressed through compliance with (and perhaps revisions of) existing legislation. In earlier iterations of the tool during development, legal readiness had a distinct identity within the tool structure, serving as a top-level category of guidance alongside the ethical and social components of the tool. In final version presented here, legal readiness is treated under ethical and social readiness, as legal regulation is recognised as a means of managing ethically and socially significant impacts. Legal readiness nevertheless remains a core component of the concept of Societal Readiness.

Although the Societal Readiness Tool consists of guidance, it can be distinguished from the 'ethical codes', 'ethical frameworks' and 'ethical guidelines' identified in TechEthos D2.1 and developed in TechEthos D5.3, in the following way: codes, frameworks and guidelines are resources external to the R&I process, which can be appealed to (or not) on the basis of convenience, while the SRT concept in particular is intended to tie particular responsibilities to particular stages of technological development, effectively specifying an aspect of the design process. The function of the SRT is to move beyond the checklist nature of ethical codes towards a model that provides actionable advice to developers in realising ethical principles through successive stages of development. This actionable guidance comprises not only design requirements, but also guidance which refers to the ways in which industry can influence the deployment and use of products being brought to market, or introduced in an operational context. The tool can therefore also be distinguished from Ethics by Design approaches: the SRT incorporates EbD, but is not itself an EbD approach, narrowly understood. As will be further set out below (§2.1), the SRT moves beyond EbD insofar as it incorporates an assessment function, it addresses social and legal aspects in addition to ethical aspects, and it addresses the role of corporate practices

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other than design, including marketing, post-market launch monitoring, the production of supporting materials and training, and others.

A key benefit, then, of an SRT as against codes, guidelines and principles, is that it constitutes a form of ethics intervention which resists the "ethics-washing" concerns identified in TechEthos D2.2. To summarise, these are that ethics discourse is instrumentalised in bad faith to evade the imposition of regulations that would necessitate potentially costly procedural change. Because guidance is integrated into the design process, it becomes more difficult to signal adherence to ethical principles without taking concrete steps towards genuine mitigation.

The TechEthos Societal Readiness Tool should be seen as a contribution to an ongoing discussion at the intersection of academia and industry on the extension of the readiness level concept to encompass ethical, social and legal aspects. The TechEthos tool as presented is a continuation and operationalisation of the scholarship conducted under TechEthos, and of SIENNA, NewHoRRIzon and to a lesser extent, SATORI, among previous projects. Although developed with industry in mind, in its current form it is in principle a scholarly contribution, and for that reason should be considered a prototype of a tool for deployment in specific industrial contexts. Further work would be needed to refine the tool to a variety of specific use-cases by means of stakeholder analysis, ideally developing "forks" of the tool that would adapt its structure to various fields of product development. The relationship between the TechEthos SRT and preceding work, as well as the tool's position in the wider ecosystem of ongoing projects, is further elaborated below.

1.2 Relationship with preceding and ongoing projects

The TechEthos Societal Readiness Tool builds directly on the work carried out in a number of preceding projects. The present tool can be considered a direct continuation of some key results of the SIENNA project. Although this project was focused on producing guidelines for a cluster of emerging technology fields, specifically human genomics, human enhancement, artificial intelligence and robotics, significantly, the project deliverables contained the most complete contribution to date of a fully general Ethics by Design methodology. This consists of a 5-stage model for developing an Ethics by Design approach for a specific technology field. At a basic level, this 5-stage model consists in the idea that ethical design outcomes are achieved via a reflective process which begins at a high level of abstraction, by defining a set of ethical values for the given field, then, by further reflection on the previous stage, generates increasingly specific and concrete guidance.

The 5-stage model is summarised in the below figure, as applied to Artificial Intelligence:

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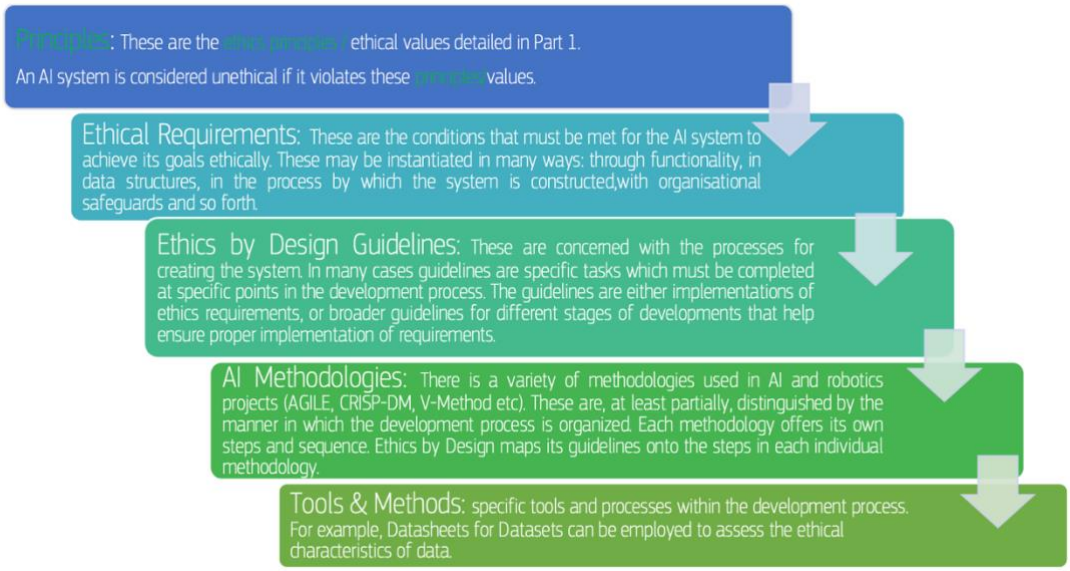

Figure 2: The 5-Layer Model of Ethics by Design, Source : European Commission (2021), "Ethics By Design and Ethics of Use Approaches for Artificial Intelligence (1.0)"

Although this figure shows the methodology as adapted for the context of AI, the idea of descending through a reiterative hierarchy from principles at the top to tools and methods at the most granular level is intended to be generic. The present tool can be read as guiding users through a simplified version of this process, raising their sensitivity to the requirements of such a process, and promoting self-assessment of the adequacy of the extent to which it has been effectively carried out.

The work of the SATORI project was built on in particular with respect to the CEN Workshop Agreement (Part 2) developed under the aegis of that project, including the guidance in relation Ethical Issues and Principles for Research on Technological Innovations (CWA 17145-2).

The task also builds on the findings of the New HoRRIzon project (2017-2021, project number 741402). This project set out to create a tool for improving responsiveness to societal values, also employing the concept of societal readiness. The primary target user group for New HoRRIzon was 'academics' involved in 'project-based research' (Bernstein et al. 2022) rather than product developers in particular fields/industries, outside academia as well as within it. For this reason, the two projects represented divergent aims and the findings of the earlier project could only indirectly inform the development of the present tool. However, the experience of project members, facilitated by overlap between the project groups, was able to inform decisions about formal structure and functionality, especially in earlier iterations of the tool. The TechEthos task team was able to draw confidence from the fact that several features of the NewHoRRIzon tool that parallel the present approach bore fruitful results.

The New HoRRIzon project used a "matrix" structure to draw out conditions for users, in the form of guiding questions. The project used the six "keys" or key ingredients for RRI that were originally included in the European Commission's Horizon 2020 programme: public engagement, open access, science education, gender, ethics and governance (EC 2012). While these remain key cross-cutting considerations, as the present project is being delivered at the end of the Horizon 2020 cycle rather than the beginning, it is important it incorporate the advancements that have been made in the intervening period. We therefore propose going beyond these "key ingredients" by using a set of principles which have been identified through work under TechEthos's "Ethics by Design" approach. These principles have a determinately ethical central thread, although they also include legal and societal concerns.

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The second axis of the matrix structure under NewHoRRIzon was the system of 4 dimensions of RRI proposed by (Stilgoe et al. 2013): anticipation, reflexivity, inclusion and responsiveness. These are extremely useful as structural categories insofar as they represent process rather than content. They therefore have a close affinity with the stage-gate structure embodied in the "readiness level" concept; they are especially well suited to drawing out a comprehensive set of considerations relative to given ethical principles and development stages. Learning from the success of the methodology applied by (Bernstein et al. 2022), the TechEthos tool implements a similar 4-part structure. As (Stilgoe et al. 2013) argue explicitly, values tend to be culture and context-sensitive, whereas a process-led approach is more likely to be adaptable to changing socio-political contexts and novel technologies. The 4 stages of the TechEthos tool - High Level Guidelines, Mid-level guidelines, Product Violations, and Mitigations – can be loosely mapped on to the Categories of Anticipation, Reflexivity, Inclusion and Responsiveness formulated by (Stilgoe et al. 2013) and operationalised by (Bernstein et al. 2022).

(Bernstein et al. 2022) determined that outputs for a tool of this kind should take the form of "guiding questions", thus creating a "thinking tool" whose purpose is to prompt users to attend to ethically relevant considerations at appropriate stages in the R&I process. This output choice has the advantage of generating a user-led experience, offering the relevant actors a way of structuring their own judgments about their project's potential ethically salient impact: a bottom-up rather than top-down approach.

A drawback of this choice of output, however, is that it less action-guiding, and has the potential to leave users with no new information should they anticipate ethical challenges. A second potential drawback is that the "guiding questions" output might be thought to dilute the "risk-gate" function that was one of the essential features of a readiness level framework structure. The authors do note that outputs should ideally function as 'conditions' to 'satisfy' through thinking and action (i.e., responses taken up in project design and implementation) rather than check-box-like 'key ingredients' to be 'considered' (Bernstein et al. 2022, p.6), but there was arguably scope to pursue the former approach more directly. The guiding questions format has the advantage of preventing users from being alienated by an excessively demanding framework, or being divorced from thinking as part of a check-box compliance mentality (Catchpole and Russ 2015; Kiran et al 2015). That said, the approach does make the tool less amenable risk-management functions (this was indeed a feature of the tool, as the intention was to move beyond a corporate-style, unreflective compliance culture). The TechEthos tool aims to incorporate the best of both approaches, with a guidance function based on a set of determinate requirements for users to satisfy, in combination with an assessment function consisting of a set of questions to promote reflection.

The TechEthos SRT informs the ongoing and future work of additional projects, notably MultiRATE. These are discussed in §4 Prospects for Future Work, below.

Most significantly, the tool should be understood as a further operationalisation and indeed a vehicle for the communication of operational guidance developed under Deliverable D5.2 and 5.3 of TechEthos. The manner in which this has been achieved is specified below under §3.3 Societal Readiness by Design

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2. Theoretical Foundation of the Societal Readiness Tool

This section explains the theory which supports the structure of the SRT. This includes the decision to begin from the kernel of the Ethics by Design (EbD) approach, building on and generalising the work of the SIENNA and SATORI projects. It further sets out the additional conceptual apparatus that was necessary to construct a bridge from the EbD approach to the concept of "product social readiness", where EbD is a factor in, but not constitutive of, the social readiness of products. It provides a theoretical justification for the deployment of the concepts defined in the previous section.

The TechEthos Societal Readiness Tool brings together three research programmes, all of which are broadly united by the aim of directing technology development in safe, reliable and socially beneficial ways. Firstly, it builds on the programme of constructing extensions to the Technological Readiness Level framework (TRL), with a view to improving product reliability and utility in an operational context. Second, it incorporates Ethics by Design, as well as the closely related research programmes Value Sensitive Design (Friedman et al. 2013; Friedman & Hendry 2019) and Design for Values (See e.g. Van den Hoven, Veermas & Van der Poel 2015). Thirdly, it builds on the ELSI/ELSA research programme and its intellectual successor, Responsible Research and Innovation.

The TRL framework, for the assessment of the progress of a technological product or component towards reliable operational deployment, was originally developed by NASA researchers, and has since been adopted by a range of organisations, including the European Commission's Horizon2020 and Horizon Europe. The framework has been invaluable as a common benchmark for intercomparison between projects and as a measure of reliability of a product or system.

The TRL framework, however, has also given rise to a critical research programme which attempts to correct the framework by providing improved analyses of factors it neglects. These added factors go together to determine a system's reliability given a proper understanding of its operational context. Other examples include System Readiness Level (Sauser et al. 2006), Human Readiness Level (Philips 2010), and Market Readiness Level (Hjorth and Brem 2016). These are assessment frameworks which highlight oversights embedded in the TRL framework, which proponents of novel frameworks contend have given rise to technical failures in systematic ways, for instance by neglecting due consideration for human capacity to use products as intended, or an organisation's preparedness to bring the product to market. The concept of societal readiness appeals to a similar contention, namely that ethical, social and compliance failings can be attributed to gaps in extant assessment frameworks, and the tool seeks to fill those gaps.

There are at least two distinct senses of societal readiness, which could be termed objective and subjective societal readiness. The subjective sense implies the extent to which society is sufficiently receptive to a given technology, the extent to which people desire it, regard it as useful, understand it, or are equipped to use it. The objective sense implies the extent to which a technology can be brought to market or deployed in a way that does not give rise to significant ethical, legal or social impacts. The two concepts may overlap but are distinct. For instance, the introduction of electricity transmission using alternating current was initially opposed because the public did not have a positive subjective attitude to it; it was viewed as dangerous. Arguably, it eventually became the standard not because of the introduction of novel engineered safety features, but because its practical advantages over direct current - long-distance transmission - won out over safety concerns. In other words, its societal readiness level in the subjective sense improved, while there was no change in its societal readiness level in the objective sense (this is of course a historical caricature, but it serves as an adequate illustration of the distinction).

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The focus of the tool will be on what was in the previous paragraph termed the objective sense of societal readiness. The tool essentially serves to promote the consideration of ELS factors and assess the extent to which those factors have been considered. It is beyond the scope of the tool to facilitate users' assessment of consumer attitudes, for example via social scientific methods. That is not to say that subjective societal readiness has no place in the analytical framework underlying the tool: public attitudes are relevant to societal readiness as understood by the tool, because the interpretation of *values* (a requirement upon users in working with the tool) inherently involves some assessment of public attitudes.

2.1 From Ethics by Design to ELS Readiness

The novel methodological proposal that underlies the TechEthos Societal Readiness Tool is that the Ethics by Design framework developed under the SIENNA project can be expanded to form one major arm of an approach to guidance and assessment across ELS dimensions.

There are a number of reasons why Ethics by Design was selected as the starting point for the project of a social readiness assessment and guidance tool. Given the target user for the tool is designers themselves, as well as the corporate responsibility of organisations in research and innovation more broadly, the proposal is to foreground aspects of readiness which are subject to the agency of the designer and the corporate agency of the wider enterprise.

Another reason for taking Ethics by Design as a starting point is a recognition of the need to account for the "temporality" of societal readiness, a consideration which emerged prominently in consultation with ADIM board members. Innovations that are initially deemed unproblematic from an ELS perspective may later reveal hitherto unanticipated ethical impacts. An example might be virtual background software used in video conferencing applications: an ethical assessor faced with this product prior to release might have been unlikely to anticipate ethically problematic impacts given the product's position in a field that is not assessed as particularly high risk, and relative similarity to extant products. When the product entered wide use, it transpired it was ineffective for people with dark skin tones, leading to negative impacts effectively targeted against particular ethnic groups – a serious ethical failure. This is precisely the kind of failure that can be mitigated through a values-first design methodology, which foregrounds, for example, the value of inclusivity as a design requisite, and the diversity of design teams as a precondition of effective design rather than an extrinsically justified regulation.

Another way of putting this point is that Ethics by Design, and Design for Values more broadly, are approaches in part conceived as responses to the Collingridge Dilemma, according to which, as innovations approach market readiness, our knowledge of them, and thus our ability to foresee their impacts, increases just as our practical ability to intervene to mitigate those impacts declines. Design for values overcomes the need to wait for improved knowledge of the precise form of future socio-technical interaction, by incorporating concern for values throughout the design process. That being said, external factors are often equally, perhaps in some cases more significant components of readiness. For this reason, it is necessary to augment the Ethics by Design approach with frameworks designed for the comprehension of environmental factors. Below, the relationship between the TechEthos SRT and Ethics by Design will be set out, followed by an exposition of the necessary complementary frameworks.

The SIENNA framework proposed a method for integrating ethical analysis into a design process, which itself builds on work in the Design for Values research programme, notably (van de Poel 2013). The SIENNA framework proposes a 5 Step generalized approach for Ethics by Design, appropriate for any technology. The 5 steps are as follows:

> *Step 1: Reach consensus on the key moral values and principles that apply to the technology field.*

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Step 2: Derive ethical requisites (or norms) from these values.
Step 3: Choose and describe an established design methodology for the development of technology in the technology field.
Step 4: Develop operational ethics guidelines that involve a translation of the ethical requisites to actionable methodological guidelines.
Step 5: Develop tools, methods and special topics.

This procedure forms the basis of the structure of guidance formulation for the tool's guidance function. The application of the SIENNA framework is directly transferable to the Ethics component of the tool. The tool's outputs are structured according to a list of values designed to have cross-cutting relevance both across the TechEthos technology families and more broadly. These are then translated into requisites/norms which form the first conditions presented to the user, as per both the SIENNA method and the Design for Values method discussed by van de Poel. The SRT refers to these as "Mid-level Guidelines", because they form an intermediate stage between the High-level Guidelines, which do not refer in general terms to ethical and social criteria to be promoted or avoided without reference to products, and the lower level at which specific operational guidance is offered.

The recommendation under the SIENNA framework for Ethics by Design was that designers should operationalise conditions to their chosen established design methodology. The SIENNA project presented in detail how this could be done for the cases of Agile, CRISP-DM and V-Method. Because the TechEthos tool is intended to have general applicability, the decision was made not to refer to a specific established design methodology in the structure of the tool itself. Instead, a generalised model of technology development was chosen, which is intended to be as widely applicable as possible, relevant to any design process.

On the basis of an analysis of such generic models in recent and relevant existing literature (Bernstein et al. 2022; Stilgoe & McNaughton 2013; Cooper 1990; Van der Poel 2015; Brey and Dainow 2021; Dainow, Brey, Jansen and Matar 2021), a 4-stage generic model was developed, summarised below:

1. Pre-design and Conceptual Design (Including specification of objectives, specification of requirements, ideation of multiple design concepts)
2. High-Level design (including simulation of design alternatives, technical and economic consideration of production processes, finalisation of layout)
3. Detailed design and development (Finalising form of components, materials, final specification of production methods)
4. Testing and evaluation (including demonstration in operational environment, advanced human factors analysis)

This model condenses the SIENNA model, by converting it to 4 rather than 6 stages. A larger number of stages in the context of the TechEthos tool would have entailed a correspondingly larger number of conditions as outputs of the tool, which was determined to be excessively complicated. A tradeoff between granularity and usability was necessary at an early stage. In order to assess this tradeoff, we drew on results from the NewHoRRIzons project in their development of an analogous tool for researchers, given shared members of the project teams. Elements of van der Poel's model, on which the SIENNA model itself drew, were reintroduced in order to add further specificity to the TechEthos model.

In earlier iterations of the tool during development, this 4-part structure of stages was given a more prominent role, with all of the guidance grouped under specific stages. This structure was not carried forward to the final product, because of the tendency of the guidance to cluster at specific stages. This meant the stages were not maximally effective in dividing up the guidance in a way that streamlined the user experience. Although in the final tool these stages are no-longer foregrounded in the architecture of the tool, they nevertheless continue to play a role in the guidance itself, as the guidance continues to refer to these stages where the relevant guidance is to be implemented at a particular stage.

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2.2 Augmenting EbD

The novel proposal implicit in the design specification of the TechEthos tool is that a SIENNA-style framework for Ethics by Design can be extended to encompass Social and Legal aspects, in addition to Ethical aspects. In essence, the proposal is that where ethical values are taken as the first stage or primary structuring inputs of the Ethics by Design framework, social and legal criteria can equally be taken as the primary structuring inputs of an extended framework. Rough analogous descriptive labels for these extended frameworks would be "social impact by design" and "Beyond Compliance by design", where "beyond compliance" indicates a policy of going beyond minimum legal requirements in order to anticipate future legal developments (Armour 2018).

From a theoretical perspective, there are clear justifications for this move in the existing literature. The extension to social aspects is most straightforward. The Design for Values/Value-Sensitive design research programme, with which Ethics by Design is closely associated, was from its inception conceived of as 'design for moral and societal values' (Van den Hoven et al. 2015 2). The distinction between moral and societal values is in any case a distinction between terms of art rather than ordinary usage: the reasons we care about societal values are ultimately ethical, in the sense that they concern whether peoples' lives go well for them. The distinction between ethical and social values is derived from the context of policymaking, where ethical values are principally associated with individual (professional) conduct (hence medical ethics, business ethics, research ethics, etc.) while social values are associated with the objects of government social policy (employment, education, health, care of the vulnerable, etc.). Thus, there is no principled reason why the project of embedding or instantiating values in the design of products and systems should not encompass both ethical and social values. In the TechEthos SRT, the focus of the social component of the tool is on minimisation of social harms, for which there are a variety of pre-existing design approaches and methodologies aimed at avoiding these harms – see for Design for Dematerialisation (Fiksel 2009), Human Capabilities in Design for Values (Oosterlaken 2015). The extension of EbD across the social dimension is premised on the incorporation of such pre-existing approaches.

The extension of the Ethics by Design methodology to legal criteria is less obvious and requires more explanatory justification. One approach to designing for legal values would be designing products and systems to be compliant with existing legislation in the jurisdictions in which it will be introduced. This is something that all designers must necessarily do in any case. In a definitional sense, then, design for legal compliance can be viewed as an aspect of design for values, given promoting conformity with the law is both a standard of behaviour to which individuals should aspire, and a proper object of social policy. On the other hand, design for compliance does not in any meaningful sense form part of a values-oriented design methodology, given it should already be captured under purely technical and commercially oriented design methodologies.

However, research conducted under the TechEthos project suggests that an Ethics by Design methodology does make important novel contributions to guidance and assessment of legal readiness, in at least two respects. Firstly, designers can be prompted to consider how systems can embed the values embodied in legal regimes that go beyond mere compliance with existing regulations. They can also be prompted to consider non-binding, aspirational and implicit legal standards and principles. These include the declarations and recommendations of international institutions and mandated professional bodies. For instance, the UNESCO Universal Declaration on the Human Genome and Human Rights does not create issues for legal compliance, given it does not create rights and duties that can be enforced by a court. However, it does create legally recognised normative standards which are highly relevant to the design of technical systems in the life sciences. In other words, design for "beyond compliance", as conceived by TechEthos, designates the practice of designing systems to embed the values embodied not only in extant law to achieve full compliance, but also looking to exceed minimum standards, aiming to actively promote the principles and values at which those standards are directed.

Secondly, the Ethics by Design methodology can be adapted to the consideration of *anticipatory* law. Part of the theorical attraction of prioritising the embedding values in designed systems was that it

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reduced the designer's dependence on anticipatory assessment practices. Rather than attempting to anticipate all the ways in which a class of systems could produce undesired or undesirable outcomes and introduce specific measures to counter them, the designer would instead prioritise building values into the system so that they would act as a kind of internal fail-safe against unanticipated negative outcomes. A similar principle can be applied to aid designers when considering how best to achieve compliance with potential future regulatory regimes in the context of legal uncertainty. Instead of attempting to predict these changes, Beyond Compliance by Design promotes design practices designed to circumvent the need for such predictions, for example by adapting designs to conform to a range of regulatory eventualities, or temporarily pausing development when crucial regulatory issues look set to be clarified in the near-term.

2.3 Divergence from Ethics by Design

Use-Context Interventions

Product societal readiness cannot solely be established via designing for ethical, social and legal values, however successful. Some factors determining whether a product can be said to have achieved societal readiness are external to the design itself and are beyond the direct control of the designer. For this reason, product social readiness goes beyond Ethics by Design and the broader literature on Design for Values in its underlying theoretical framework.

The concept of use context conditions as it appears in the tool can be traced in part to the practice of Context of Use analysis, as it developed as a feature of Usability Studies (Alonso-Rios et al 2010). ISO Standard 9241-11 defines Context of Use in terms of users, tasks, equipment and environment (ISO 9241-11: 1998(E) p.4), and this understanding of the term, with some variation, has formed the basis of how the term is used in subsequent analyses (Kirakowski and Cierlick 1999; Maguire 2001). This conception of Context of Use, however, refers to the context that must be taken into account in useability assessments; it is thus narrower than the conception of use context invoked for the purpose of ELS readiness assessment. Although the aforementioned standard, for instance, acknowledges the role of the 'social and cultural environment' in assessment, consideration is limited to conditions which condition product ergonomics and efficiency, meaning the understanding of these terms is limited to proximate factors like office culture and the organisational structure of companies. ELS readiness assessment, meanwhile, must take account of the conditions present in society at large, as well as larger institutional structures. Thus, the term "use context interventions" for the purposes of the tool does not merely imply a description of the use cases in which the system can be effectively deployed, but rather, a description of the contextual conditions that have to be in place to enable reliable deployment. These can be interventions that are within the control of the designer or manufacturer, or interventions which are not within the direct control of the designer or manufacturer, but through which they may be able to have some influence.

Thus, the concept of Use Context Conditions employed by the tool is modified and augmented by research in the Responsible Innovation literature, drawing in part from the lessons of partially analogous tools that have already been developed through the Horizon2020 programme, including RRI Tools, MoRRI, COMPASS, FIT4RRI, ORBIT, PRISMA and NewHoRRIzon.

Deployment Interventions

The concept of product societal readiness is also partly constituted by a number of organizational factors which delineate the relationship between the innovation organisation and the wider social environment. Again, these must be seen as going beyond the scope of Ethics by Design and Value Sensitive Design, as they are not focused on the product itself, but on the procedures and practices in place in the innovation organisation. They must also be distinguished from Use-Context Conditions, as they refer to procedures to be carried out by innovation organisations, rather than general societal conditions over which innovators have no direct control. Design Conditions and Deployment Conditions are obviously closely interrelated, especially given that we can expand the scope of the design conditions concept to encompass organisational design and system design.

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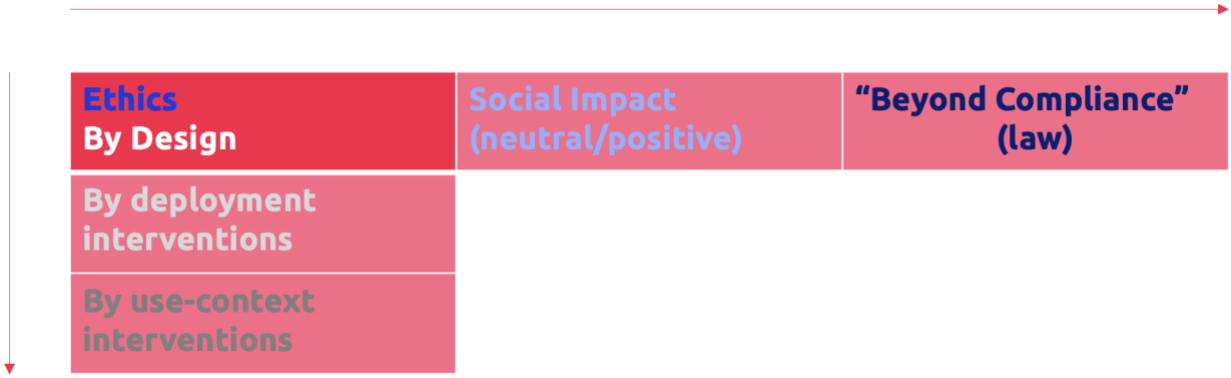

Figure 3: Extending EbD across two dimensions

Assessment

It has been argued that there exists no general method for verification or validation of having successfully instantiated values in an engineered product (Van de Poel 2013 685). While it is possible to carry out checks to establish whether certain specific values, like safety, have been met, there is currently no standardisable way of determining success with respect to all values, or a given value. Judgement on the part of the designer and the assessor (who might be the same person) must come into play, given the current state of the field, and arguably by necessity. In the absence of such a method, assessment must focus mainly on procedural criteria, i.e. an assessment of whether steps to promote the instantiation of the required values have been taken, rather than an assessment of whether the values are in fact instantiated in the product under assessment.

Thus, in one sense, any attempt to develop a tool for readiness assessment must necessarily diverge from the practice of Ethics by Design and/or Design for Values, as assessment of procedural criteria ultimately implies the need for a checklist at some level of analysis. The innovation of the TechEthos SRT is to incorporate a greater role for reflectiveness in the processes of assessment, so that the assessment itself has the function of raising users' ethical sensitivity. This is achieved through users being prompted to explain, in their own words, how they have attempted to fulfil the conditions set out by the tool and then to assess the extent to which their explanation succeeds in satisfying the condition. In other words, the assessment function allows users to attain a greater understanding not only of the objective measures on which their project may fall short from an ELS perspective, but also a greater subjective understanding of ways in which their proposed responses to ELS concerns could be improved.

The limitation of this approach is that given assessment has a major subjective component, meaning users may be inclined to overestimate their own success. This drawback is mitigated when one bears in mind that this is not intended as a certification tool, but a tool of reflection and qualitative self-assessment. The decision not to develop a tool that played a certification function was motivated by the core concern, arising from the Ethical Analysis conducted under D2.2, that a certification function would facilitate 'ethics washing'. It also builds on advice from the TechEthos ADIM board (via a workshop conducted April 25 2023), which strongly surfaced the concern that a linear modal of progress towards readiness would neglect temporal aspects of readiness, whereby assessments of readiness can radically shift in light of new information or attitudinal changes precipitated by events. There are also practical advantages to avoiding a certification model of assessment. Certification would require tests administered by independent assessors, necessitating significant costly institutional structures to which organisations may have insufficient incentive to voluntarily submit, whereas a self-administered

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voluntary tool has fewer barriers to access. Any voluntary self-assessment tool takes a measure of integrity on the part of its users as a starting assumption, and thus it is appropriate that the TechEthos tool effectively makes use of that integrity, in an instructive role.

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3. Societal Readiness Tool Framework

This section sets out the framework of the Societal Readiness Tool, explaining its intended context of use, its structure, its method of use, and the relationship between the tool text and the scholarship on which it draws. The structure of the tool is explained with excerpts from the tool text. The tool text is annexed to this report (Annex 1).

The TechEthos Societal Readiness Tool framework was developed from March to December 2023. Development began with a series of scoping questions. The first was to determine the primary target user group for the tool: while the conceptual foundations of a tool of this kind can in part be located within the RRI tradition, there has been a proliferation of tools for researchers, in a university context and the context of public research organisations, under the aegis of RRI. Tools aimed at product developers, for instance in private industry settings, meanwhile, were expected to constitute a greater need given the state of the field. There was also a recognition of the desirability of serving a separate user base from the NewHoRRIzon tool in order to maximise the extent to which the various potential users were served by appropriate ethical sensitivity tools.

The second question was to determine a level of analysis for the tool. In particular, it was important to establish whether the tool would limit its conception of societal readiness to a product level, or whether it would also apply the concept of readiness to the technology level (see Umbrello et al 2023; Brey 2012). A more precisely specified systematisation of levels and objects of ethical analysis in anticipatory technology ethics was one of the central contributions to the ATE+ framework developed under the aegis of the TechEthos project (Umbrello et al 2022), which was an updating of the ATE framework (Brey 2012). ATE's 3 level taxonomy of objects of analysis, 'technology level', 'artifact level', 'application level' (Brey 2012, 2), was transformed under ATE+ into a 5 level taxonomy: 'technology family level, 'technology level', 'technique level', 'application level', and finally 'use case level' (Umbrello et al. 2023, 6). This updated taxonomy thus gives rise to the question of whether to provide guidance specific to *techniques* and *applications,* in addition to (or perhaps instead of) products and technologies.

In order to determine a response to these initial scoping questions, an expert workshop was carried out. The expertise and backgrounds represented in the workshop group comprised figures who work both in academia and in industry, industry figures, academics, science communication specialists, regulation policy experts and risk management experts. A number of important considerations were surfaced in the course of this workshop which fed directly into the development of the tool.

While a range of potential target audiences for the tool were discussed no overriding view on target emerged. However, the principle that the content should be as precisely targeted towards its intended audience as possible was strongly represented. This was judged to militate in favour of depth rather than reach in terms of user targets, and given the factors favouring a product developer focus already adduced in terms of overcoming potential lacunae in existing research, it was determined that product developers should be the focus of precise targeting.

This determination had downstream effects on the question of scoping in terms of level analysis. (Umbrello et al. 2023) effectively disaggregates the product/artefact level by introducing the category of 'device' which is 'comprised of one or several techniques and procedures'. While this is useful in a scholarly context insofar as it is intended to establish more formal consistency between levels of analysis, with each level being defined recursively, these categories arguably have less utility in an applied context. This is because the concepts 'device', 'technique' and 'application' become to some extent terms of art with stipulated definitions. The term 'product' meanwhile obviously comes directly

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from the industrial context. Although vague as an ontological category, as (Umbrello et al. 2023) effectively point out, 'product' was determined to be the most suitable target for an operational tool given the utility of using conceptual categories in established use in existing institutional and organisational contexts.

The TechEthos SRT has a 4-part hierarchical structure which mirrors the structure of the EbD methodology. This structure is set out in the below figure, and further explicated in the following sections.

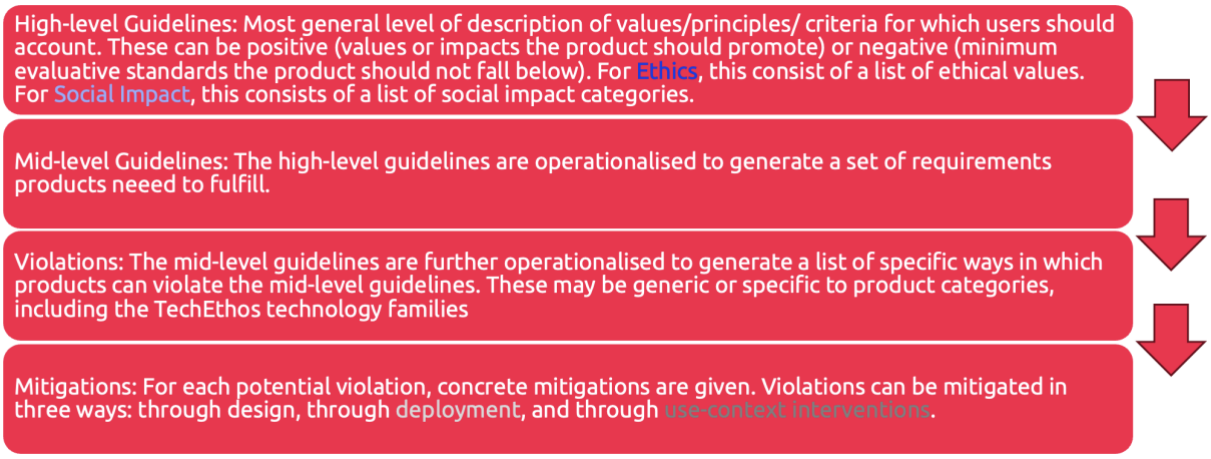

Figure 4: Hierarchical structure of SRT mirroring structure of EbD process

3.1 Procedure

It is envisaged and recommended that use of this tool will take place in the context of a Societal Readiness Management strategy adopted by innovation organisations. This involves making societal readiness management part of the organisation's CSR strategy and mission, appointing officers and creating teams to support Societal Readiness Management, doing Societal Readiness Management training, assigning budget for Societal Readiness Management, and incorporating Societal Readiness Management into the management structure of the organization.

It is proposed that this strategy should follow an 8-step procedure, as follows:

Step 1 - Product categorisation

It is recommended that Societal Readiness Management is initiated right at the beginning of product development, at the initial stage of design in which objectives are established for the product, before the stage at which requirements are specified. Societal Readiness Management can also be started later in the development process, but this risks extra cost and effort that may be involved for redesign. As a first step, we recommend that it is established, for the purposes of SRM, what type of product is being developed. Societal Readiness Management employs a number of product categories that imply somewhat different Societal Readiness Management trajectories.

Step 2 – Assessment of objectives

During this step, it is assessed whether the objectives of the product (the function that it is used for and the benefits that it is thought to provide) are compatible with standards of ethics, law, and avoidance of harm. Some objectives may be inherently unethical or illegal or be associated with unavoidable harms. The assessment should be based on the ELS standards formulated for the product category plus any other

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principles that seem to apply. Objectives should be modified in order to meet ELS standards. If this is not possible, the project should be abandoned.

Step 3 – Complete Initial ELS assessment

During the design stage at which product requirements are formulated, initial product requirements are formulated, after which an initial ethical risk assessment, social impact assessment, and legal assessment is done. These assessments are intended to establish significant ethical, social and legal issues that need to be accounted for in working towards societal readiness, and to assess risks of noncompliance. The assessments should include all the ELS requirements for the product requirement, but also be sensitive to other issues that may not be covered by the requirements.

The assessment should include an assessment of potential misuse of the product and ways in which misuse could introduce ELS issues, and an assessment of potential uses, user groups and use contexts of the product, and ELS issues that could result.

It is recommended that the assessment is updated several times during product development, to account for new information about the product, the context of use, and potential issues and impacts.

Step 4 - Establishment of requirements

During this step, the initial design requirements are tested against the ELS requirements (including new requirements resulting from the assessments) and they are modified to ensure compliance. The ELS requirements are used to formulate additional design requirements, to the extent possible.

Step 5 – Societal Readiness Management detailed planning

A detailed plan is made for further SRM, both in the design process, and in product guidance for deployment and use.

Step 6 – ELS implementation in further design, development and testing

Further Ethics by Design actions in product design, as well as similar actions for social impacts and legal compliance.

Step 7 – ELS implementation for further product guidance for deployment and use

These are efforts to steer the deployment and use of the product, so that it is used in the intended manner, by intended categories of users, in intended use contexts, and so that mitigating actions are made by third parties to mitigate negative ELS effects. This includes efforts in marketing and promotion, guidance and training (of deployers and users), sales and distribution, and customer support and service.

Step 8 - Pre-market societal readiness assessment

Societal readiness assessments can be made at any point in time, but the most determining assessment should take place after completion of the design process and before product release. If this assessment leads to an overall verdict of societal readiness, then the product can be launched. If not, then further mitigating actions are needed, either in design or product guidance, or by inducing other actors to create needed changes in regulation or the product environment.

The TechEthos SRT is a device for guiding users through a simplified version of this process. It does so by presenting a generic set of requirements that should be fulfilled by a broad spectrum of product categories, allowing users to begin reflection on ELS aspects and to conduct societal readiness self-assessment. As the process is repeated during the product development cycle, users should ideally begin to treat the tool as an exemplar, which they should adapt to the concerns specific to their product

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category. The SRT is a device to facilitate and inform a fully adequate Societal Readiness Management strategy, it should not be treated as constitutive of such a strategy.

3.2 High-level Guidance

The SRT is fundamentally structured according to a set of high-level requirements which consist of a set of ethical values or principles and a set of social impact criteria with general applicability across technology families. These are intended to provide a generic model according to which product developers across a variety of industries can structure their own reflection on how to build ethical principles and practices into their design processes. These requirements as stated can only be a first step, however, as ethical values and social impact criteria should be adapted for individual technology fields. The tool is intended to facilitate this process.

The term "high-level guidance" corresponds to the concept of Ethics by Design Values within the generalised framework for an Ethics by Design proposed under SIENNA (SIENNA D6.3 Brey et al 2021). The term "high-level guidance" was selected as an effective generalisation of "Ethics by Design Values" in the context of the present tool's theoretical development of the EbD approach to comprise an analysis of the entire product environment and to broaden the analysis to social and legal aspects.

This section proposes a set of generic high-level ethical and social requirements and explains how these can be applied, both as self-standing criteria for promoting ethical sensitivity, and in the context of the kind of Social Readiness Management process just set out, by serving as exemplars to be tailored for a specific type of product.

3.2.1 Ethical Criteria

The high-level guidance function of the ethical component of the tool consists of a set of ethical criteria as follows:

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Ethical Criteria
Diversity, Equity and Inclusion
Safety and Security
Fairness and Distributive Justice
Freedom and Autonomy
Privacy
Responsibility and Accountability
Individual Wellbeing

Table 3: Ethical Criteria

Note that the order in which the criteria are listed is of no significance, this also goes for the social and legal criteria, below.

These criteria were identified via the following method. Firstly, ATE (Brey 2012) was identified as a core ethical assessment approach within TechEthos from the initial stages, and the framework was updated via TechEthos results throughout the course of the project, culminating in the ATE+ framework (Umbrello et al. 2023). These frameworks identify a list of key values of primary importance in ethical technology assessment, which were arrived at via a detailed expert survey of the theoretical literature as well as some technical literature. In the context of the present project, therefore, these frameworks were identified as the primary starting point for candidates for generic high-level ethical guidance.

This initial ATE-derived set of high-level ethical guidance criteria was then augmented with reference to key TechEthos results. In particular, research conducted under the TechEthos project identified a number of 'cross-cutting' ethical issues in technology ethics. These arose from analysis of the three TechEthos technologies, but were identified as being of general importance with respect to both emerging and innovative technology development and their corresponding policy contexts.

One set of cross-cutting concerns which augmented the foundation laid by ATE/ATE+ arose from ethical analysis conducted under TechEthos D2.2 (Adomaitis, Grinbaum, Lenzi 2022), an analysis based largely in philosophical and theoretical literature.

These were the following:

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D2.2 Cross-Cutting Concern	Gloss
Irreversibility	Relates to ethical concerns of 'hubris', 'unreflect[ive]' ' haste', and the principle that an action may be judged not just for its consequences but for their 'irreparable character' (Adomaitis, Grinbaum, Lenzi 2022, 16-17)
Novelty and speed of change	'[E]thics of technology essentially amounts to questioning the speed at which technology brings novelty into the world' (Adomaitis, Grinbaum, Lenzi 2022, 18)
Vulnerability and structures of power	'[A]n ethical analysis should look at the way risks and benefits are distributed across several dimensions, including gender, race, sexuality, social class, age, ability, origin and North/South relations' (21)
Governance of uncertainty	'TechEthos aims at facilitating [governance of uncertainty] on the level of personal systems (individuals) such as researchers, on the level of organizational systems such as research organizations (universities, enterprises), research ethics bodies, research funding bodies, and policy bodies; and eventually on the level of function systems (science, economy, law, politics)' (23)
Perception of uncertainty	'the description of the future yielded by those who create the technologies which can potentially shape it, is expected to "cause" change much like a teleological force' (24)
Security	'Security situations are best analysed as conflict situations', 'Being negligent with regard to security can negate all ethical design by enabling damaging consequences' (26)
Ethics washing	'pushing for an ethical governance of [e.g., AI] in order to avoid hard laws that could limit technological innovations' (27)

Table 4: D2.2 Cross-Cutting Concerns

A second set of cross-cutting considerations was derived from qualitative empirical research via the citizen awareness and attitude events conducted under TechEthos WP3. These events surfaced a number of value-centred considerations which citizen participants raised as relevant concerns with respect to all technology families addressed by TechEthos.

These were the following:

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D3.2 Cross-Cutting Concerns	Gloss
Safety and reliability	'In CE…unknown effects and potential dangers…to…physical safety…and the ecosystem'; 'in XR…safer life…in context of dangerous jobs', 'addictiveness'; 'In NT....health impacts, [more concern regarding] invasive applications' (Buchinger et al. 2023, 109)
Equity, Diversity and inclusion	'In CE…major concern is global distributive justice…making sure all can benefit…regardless of socioeconomic status or location'; 'In XR…insuring equal access to the technology for all social groups…potential for exacerbating existing inequalities between social classes'; 'In NT…'neurodiversity and respecting the uniqueness of humans' (110)
Responsible use and accountability	'In CE…having an accountable party for potential disasters', 'In XR…who is responsible [given that] there are many different actors involved from the creation of the technology until its utilization'; 'In NT…well planned use of the technology…prioritiz[ing] applications in more important areas like healthcare' (110)

Table 5: D3.2 Cross-Cutting Concerns

Some of these cross cutting-concerns directly influenced the selection and interpretation of the high-level guidance categories, while others influenced the structure of the tool more indirectly, but no less profoundly. As already intimated, the concern for ethics washing, for instance, was addressed as a structural design feature of the tool, by developing a procedure intended to circumvent what (Bernstein et al 2022) called 'the drumbeat of technological development', i.e. the assumption that progress from concept to deployment is linear and inevitable and that ethics is just a hurdle to jump along the way.

As is no doubt evident, of the other cross-cutting considerations, several were adopted directly for the purposes of the high-level guidance categories, in particular, "Equity, Diversity and Inclusion". This was a convenient and instructive umbrella concept which brings together a number of concerns identified under ATE but treated separately, including non-discrimination and equal treatment relative to age, gender, sexual orientation, social class, race, ethnicity, religion, disability, etc., north–south justice and intergenerational justice (Brey 2012, 12).

The remaining cross-cutting concerns were brought under other categories, thereby adding multiple layers to their possible interpretations across projects and a variety of potential use-contexts. For instance, the D2.2 key concerns with the governance of uncertainty and irreversibility were primarily captured under the concept of responsibility and accountability, with this category including the recognition of the appropriateness of a precautionary stance in certain cases. The security concerns identified under D2.2, with their primary focus on the security of information systems, networks and programmes, was generalised to include within its scope the safety and reliability concerns identified as being of central significance during citizen workshops.

The list of high-level values selected therefore reflects recognition of the idea that ethical value categories are liable to receive radically different interpretations when applied to different fields. The decision was effectively to make a virtue of this multiplicity, by encouraging the user to begin by reflecting on the potential of their system to implicate ethical values in the broadest terms, thereby anticipating as great a range of parameters of analysis as possible.

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Examples of how these value categories should be interpreted for specific fields are given with reference to the TechEthos technology families. For instance, the high-level guidance for the value of Freedom and Autonomy, the guidance text reads:

> ***Freedom and Autonomy***
>
> *Freedom refers to the protection of personal freedoms of the kind typically safeguarded by liberal constitutions, including freedom of expression, freedom of assembly and freedom of association. It is the value of non-interference by external actors, including (but not limited to) states, in the sphere of legitimate behaviour. Freedom in this sense is sometimes referred to as negative freedom, or "freedom from...".*
>
> *Autonomy refers to the value of people being able to act according to their own values and to direct their lives as they see fit. Autonomy is sometimes referred to as positive freedom or "freedom to...". Autonomy comprises the value of non-manipulation and of informed consent.*
>
> *Freedom and autonomy are interrelated. Freedom of thought and expression, for instance, can be achieved by protections against interference, either by the state or by other systems of power, including technological systems. Expression and free thought, are, however, important instances of the exercise of autonomy. Freedom and autonomy are therefore mutually supportive. Loss of autonomy can be more insidious than loss of freedom. We lose autonomy when other entities make decisions on our behalf, or influence our decisions in a way that prevents us from full rational consideration of them.*

This would have a range of different specific interpretations depending on the product design project in question. In AI applications for instance, the value of autonomy, with its concomitant value of non-manipulation, is cashed out primarily as recognition of the dangers of 'over-reliance' on AI applications on the one hand, and 'interfering with end user's decision-making processes in an unintended or undesirable way' on the other (see ALTAI EC DG Communications Networks and Technology 2020).

In medical technologies, including clinical neurological implants, reflection on of the value of autonomy can raise the radically different concerns. For instance, the importance of balancing the need to conduct experiments using human subjects with diminished decision-making capacities, including children and people with neurological impairments (in order to develop interventions for the benefit of these categories of subject), against the difficulty of obtaining prior informed consent from these subjects as a result of precisely those diminished capacities. (Greely et al. 2018).

The tool elicits reflection on how to draw out these multiplicities of interpretation by means of examples. For instance, one example it offers for the value of Freedom and Autonomy draws on specific concerns in relation to Solar Radiation Modification:

> *SRM: Reflection on autonomy is important in relation to SRM because open-air experimentation in the development of such technologies has the potential to materially affect human subjects, giving rise to considerations of prior informed consent.*

3.2.2 Social Impact Criteria

The high-level guidance function of the social component of the tool consists of a set of social impact criteria as follows:

Social Impact Criteria

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Environmental Impact
Property
Social Institutions
Basic Needs and Socio-Economic Security
Social Cohesion
Social Relations
Human and Civic Capabilities

Table 6: Social Impact Criteria

There is scope for a multiplicity of interpretations at a conceptual level for social impact criteria as there are for ethical values. However, it remains the case that different projects are certain to have radically different primary concerns with respect to the possibility of impacts falling under these categories.

Under the criterion of Social Cohesion, for instance, for AI applications, the importance of mitigating the potential for AI systems to impact on a society's political culture has been prioritised, notably 'when AI systems amplify fake news, segregate the electorate, facilitate totalitarian behaviour' (see ALTAI EC DG Communications Networks and Technology 2020). In genomics meanwhile, a key concern is that new technologies will contribute to a 'genomic divide' (Singer and Daar 2001) between regions that have access to the most advanced techniques and those that do not.

The tool enables users to navigate these differences in primary concern foregrounded for the purposes of different use-cases by means of examples. For instance, for social cohesion the guidance text draws on the potential for novel forms of online platform to facilitate socially disintegrating forms of speech:

> *Certain online platforms and products provide a space for the dissemination of hate speech, discriminatory content, and extremist ideologies. Products designed without effective content moderation or safeguards against abuse may inadvertently contribute to the amplification of divisive narratives.*

3.2.3 Note on Legal Aspects

The prospect of following a similar procedure for legal aspects was trialled during the tool development process. Two possible courses of action were pursued as potentially viable. One was to develop a set of legal impact criteria that could fulfil a role analogous to that of ethical values and principles in the EbD generalised framework, the other was to cover aspects of legal impact under the aegis of ethical and

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social impact criteria. A draft framework of criteria for readiness analysis of legal aspects was proposed, as follows:

Legal Criteria
Compliance Risk
Soft Law/Governance Frameworks
Legislation in progress
Proposed law/ regulatory risk
Fundamental Rights

Table 7: Legal Criteria

In principle, these criteria would structure guidance in the same way as the ethical and social criteria, as dimensions for analysis that assist the user in checking the consistency of their design objectives against legal norms, anticipating potential product violations of legal norms, and identify mitigating actions via design, deployment conditions and use-context interventions.

In the context of the present tool, it was determined that there was limited utility in treating legal criteria separately. There were two main factors which influenced this determination. First, such an analysis is necessarily so specific not only to the innovation field, but also to the particular project under consideration, that the degree to which a generic tool of the kind presented here could supply meaningful guidance is limited. Second, product compliance is a highly developed specialised field which is operationally separate from design ethics, with significant organisational resources typically already devoted to it. The institutional and organisational barriers to uptake of a tool that proposed to bring compliance under the larger umbrella of ELS readiness, rather than continuing to treat it as a self-standing concern, are therefore greater than they would be for a tool positioned in the design ethics space. For these reasons, it was determined that it was preferable to consider legal aspects within the social and legal criteria in the context of the present tool. For instance, fundamental rights are principally captured under "Freedom and Autonomy" of the ethical criteria.

These legal criteria are, however, set out in this report as they could serve as a basis for future applications of the tool, in particular, if adapting the tool to one or more specific innovation fields. The proposed legal criteria could be used to structure reflection about design specifications, the management of design processes, and preparing the product environment to achieve societal readiness.

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Ethical Criteria	Social Impact Criteria	Legal Criteria
Diversity, Equity and Inclusion	Environmental Impact	Compliance Risk
Safety and Security	Property	Soft Law/Governance Frameworks
Fairness and Distributive Justice	Social Institutions	Legislation in progress
Freedom and Autonomy	Basic Needs and Socio-Economic Security	Proposed law/ regulatory risk
Privacy	Social Cohesion	Fundamental Rights
Responsibility and Accountability	Social Relations	
Individual Wellbeing	Human and Civic Capabilities	

Table 8: The High-Level Societal Readiness Criteria

3.3 Societal Readiness by Design

This section explains how ethical and social requirements can be accounted for in design in the context of the TechEthos SRT. Ethics by Design (EbD) is 'an approach for systematically and comprehensively including ethical considerations in the design and development process of new technological systems and devices' (Brey and Dainow 2023). It can be viewed as a generalisation of approaches in computer science including 'privacy by design' (Cavoukian 2009) and 'secure by design' (e.g. UK Department for Culture, Media and Sport 2018), which are premised on the claim that designers of programmes and information systems should build privacy and security features into the architecture of those systems, so that (ideally) it is in principle impossible for many standard privacy and security breaches to occur. These approaches in turn arguably related to back to the still earlier concept of 'quality by design' in management theory (Juran 1992).

Ethics by Design methodologies are methods for incorporating ethical guidelines, recommendations and considerations into design and development processes (SIENNA D6.2, Brey et al. 2021, 26). A key contribution of these methodologies is that they are intended to provide a means of bridging the gap between abstract guidelines and operational decision-making in the day-to-day activities of innovation organisations. Ethics by design methodologies ideally aim to locate ethical considerations to different stages the development process. They do this by finding ways to translate and operationalise ethical guidelines into concrete design practices. Ethics by design approaches evolved from and are a continuation of approaches in computer science and engineering that begin in the early 1990s, initially under the name 'Value-sensitive Design' (Friedman, Kahn, Borning & Zhang 2006) and later also under the label of 'Design for Values' (van den Hoeven, Vermaas and van der Poel 2015). The SIENNA project

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and the related publication (Brey and Dainow 2023) are the most complete EbD approaches developed hitherto, although the IEEE's whitepaper *Ethically Aligned Design – Version II i*s another significant contribution (The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems 2017).

Beginning from the foundational premise that embedding ethical values and standards in designed artifacts is a central component of achieving product social readiness, the guidance function of the TechEthos SRT enacts and guides users through an EbD-centred approach in particular by showing by example how high-level guidance can be progressively translated first into design requirements, then into concrete procedural actions in the design process.

First, the high-level guidance described in the previous section is translated into "mid-level guidelines". The term "mid-level guidelines" in the context of the TechEthos SRT corresponds to the term "Design Requirements" in the EbD framework ((SIENNA D6.3 Brey et al 2021; Brey and Dainow 2023). As with the term "high-level guidelines" the term represents a generalisation of the EbD concept to encompass non-design interventions (see 3.4 Shaping Deployment and Use, below). Mid-level guidelines are an application of the High-level guidelines to the *product level,* they specify in generic terms the ways in which products need to conform to the ethical and social standards embodied in the high-level guidelines for ELS readiness.

Thus, for instance the high-level guideline:

Safety and Security

Is translated into the mid-level guidelines:

- *Safety: Products should be safe to use, without significant risk of physical harm or harms to mental health and well-being. This applies to all users and third parties, with special consideration for children and members of vulnerable groups.*
- *Security of the person: Products should not undermine security of person, including protections from arbitrary arrest, violence, physical harm, threats to well-being, freedom from torture, and access to justice. This applies to all users and third parties, with special consideration for children and members of vulnerable groups. In particular, products should be developed in a way that anticipates the potential for dual use and minimises malicious uses while maintaining beneficial applications.*
- *Security of the system: Products should be free of vulnerabilities which would allow third parties to create threats.*

Again, in the context of an EbD methodology, mid-level guidelines are field-specific. Thus, mid-level guidance under the TechEthos SRT serves two interrelated functions. First, it provides generic guidance to which a wide range of product categories need to conform to achieve societal readiness. Second, it serves as an example of how high-level guidance can be translated into product requirements, enabling users to add to the mid-level guidance as appropriate, recursively updating the tool, especially as their knowledge of product-society interactions increases over the course of the development cycle.

The development of field-specific guidelines is an aspect of the broader Social Readiness Management process specified above. However, it is beyond the scope of the tool itself to provide an algorithm for how this should be done. The tool provides a set of scaffolding to both prompt reflection on field-specific ethical requirements, and provide a procedure for applying those requirements once established. If field-specific guidelines for the domain already exist, it is recommended that they be included in the guidance at this stage. TechEthos has developed field-specific guidelines for projects working in the fields of solar radiation management, carbon dioxide removal, digital extended reality, and neurotechnology by refining existing guidelines on the basis of TechEthos's expert and citizen engagement (Cannizzaro, Bhalla, Brooks, Richardson, Francis & Lenzi 2023). Innovation organisations working in these fields are invited to apply these guidelines at this stage. The TechEthos Guidelines developed under D5.3 also provide a model for the development of guidance which can be generalised

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to other fields. This model builds on and complements the generic model for the development of ethics guidelines for a given field produced under SIENNA (SIENNA D6.3 Brey et al 2021, 50).

Societal Readiness Management requires innovation organisations to set down a list of technical requirements, the design features the product is intended to have, and to test those requirements for consistency with the mid-level guidelines. Effectively, mid-level guidelines are added to the product specification, and then the full list of technical, ethical, social and legal requirements is assessed to determine whether all requirements can be achieved simultaneously. This EbD-derived procedure is represented in the tool through 'Reflection Stage 2', which guides the user through the procedure as described, recursively updating the tool accordingly.

The final steps under the guidance function of the SRT is to assist the user in anticipating ways in which a product in development could violate mid-level guidelines, and to prompt reflection about appropriate mitigations. These correspond roughly to "Tools and Methods" under the methological hierarchy of EbD (see figure 2, above), and suggest specific operational design interventions according to which ethical values and social impact goals can be embedded in product design.

Thus, for instance, the example given for mitigating action in response to violations of security of the system is as follows:

- *(Design) Products should be designed according to Secure by Design Principles, whereby threats of malicious interference are assessed from the Conceptual Design phase onward, and mitigations are as far as possible embedded into the structure of the product and its environment. Reference should be made to field-specific standards on cyber security including the following IEEE standards, ISO 27001-2, the SHERPA guidelines*

The mitigation thus locates mitigating actions to specific phases in the design process, and points the user towards independently validated standards, conformity to which represents the most appropriate response to potential violations. As with the other levels of analysis, the violations and mitigations are intended not only to provide concrete guidance but also to serve as examples, as the tool anticipates that the list of potential violations and corresponding mitigating actions will continue to be updated as the user reiteratively continues to use the tool.

3.4 Shaping deployment and Use

In addition to design-based interventions, Social Readiness Management requires innovation organisations to reflect on organisational conditions of product social readiness, embodied in the organisational structures of innovation organisations themselves, their strategies for product deployment, and the ways in which they can act to shape the context in which the product is used. Reflection on ethical analysis in industrial design should therefore look at technologies from the perspective of the organisations, context and sectors in which innovation takes place.

The design, development, commercialisation, and use of a new and innovative solution is a complex process, engaging one or more individual organisations, working in an innovation ecosystem made of several different actors (R&I partners, suppliers, distributors, sellers, up to end-users).

Key stakeholders identified in TechEthos with respect to the innovation ecosystem of new and emerging technologies include: researchers, technological, economic, legal, and ethics experts, science engagement professionals and civil society actors; scientific/technological communities, ethics committees, regulatory structures, economic and cultural practices, technology owners, developers and producers as well as actors having a decision-making role in the organization or institution (e.g., CEO, CTO, R&D Manager, senior researchers, etc.).

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TechEthos has mapped stakeholders according to the level of influence and interest in a technology family, as primary, secondary and contextual stakeholders. An example of the innovation eco-systems of TechEthos technology families, the one on extended digital reality, is provided in figure 5 (see deliverable 3.1, see also Figure 1, above).

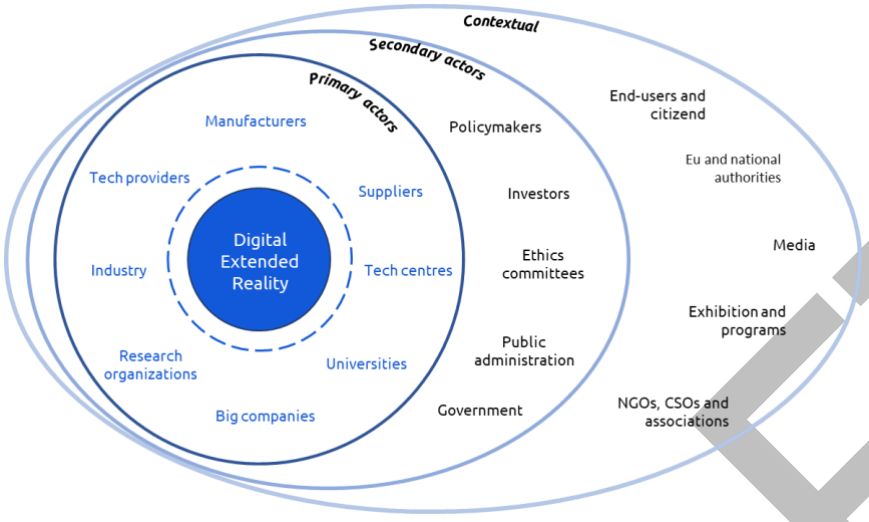

Figure 5: Innovation eco-system of Digital Extended Reality

These are the actors to whom companies should target any action aimed to develop and promote the innovative solutions (e.g. guidance and training, production, sales, monitoring of customer requests and feedback), including any aspect concerning ethics analysis and ethical implications on humans and the environment.

Promoting ethical use and mitigating unethical use and negative social impacts in the deployment and use of innovative products should consider conditions and behaviours of both the individual organisation developing the innovation, and all other actors concerned (the so-called context analysis, see below).

Managing quality, risks, impacts of products is a usual need for any company, above all once we are dealing with new and innovative products. The innovation process itself is characterised by uncertainties and risks. Companies have developed ways to identify, bring and oversee specific requirements into their processes and operations, and share these aspects with innovation ecosystem actors. Besides requirements and constrains (e.g. due to risks), there is an increasing emphasis on reflecting also on values and principles by which companies operate and their corporate culture, and use this knowledge to exploit the business potential.

Nowadays, these concepts have been widely integrated into so called **management systems**[1], guidelines that provide requirements (for products, processes, services, professions), but also convey principles values and methods, and are strategic for positioning, access, and market penetration.

[1] A management system is the way in which an organization manages the interrelated parts of its business to achieve its objectives. These objectives can relate to a number of different topics, including product or

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We refer in this section to the knowledge developed in "management systems" standards. Examples are the ones developed concerning process and product quality (UNI EN ISO 9001), risk management (UNI ISO 31000), social responsibility (UNI EN ISO 26000), value management (UNI EN 12973). There also management systems concerning more in detail the process of innovation (ISO 56000 innovation management) and responsible innovation (CEN CWA 17796).

These norms focus on aspects such as process approach and leadership, realisation of value for stakeholders, management of complexities, uncertainties and risks, which also fully characterise the research and innovation process (and its ethical analysis). More generally, the set of these technical standards provides useful tools to steer the innovation process towards a socially responsible approach, so that research and development intervention is aimed at progress and improvement of the quality of life, in accordance with the expectations of the various stakeholders, and that it is environmentally, socially and economically sustainable overall.

Table 1 provides an overview of the objectives and principles proposed by some of these norms. Most if not all of them are aligned with the adoption of ethics by design approaches, as proposed by TechEthos. They provide valuable insights on how to integrate ethical analysis in the deployment and use of new and emerging technologies. In particular, ISO 56002 provides a set of innovation principles and an innovation framework (figure 2) that characterise and describes the overall innovation process, from the identification of initial opportunities and the creation of innovation concepts to the realization of the innovation value by deployment and use of the final solutions developed.

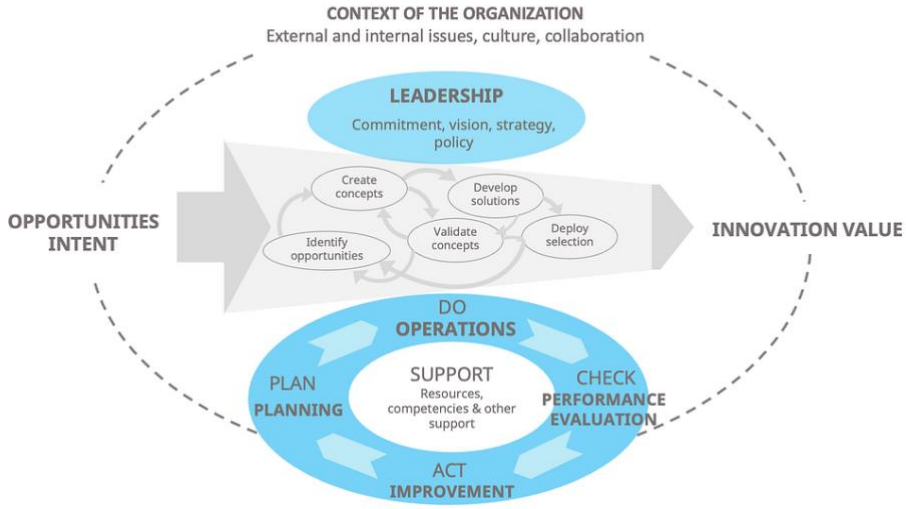

Figure 6: ISO 56002 innovation management framework, guiding the adoption of an ethics by design approach throughout any type of innovation process related to new and emerging technologies

service quality, operational efficiency, environmental performance, health and safety in the workplace and many more.

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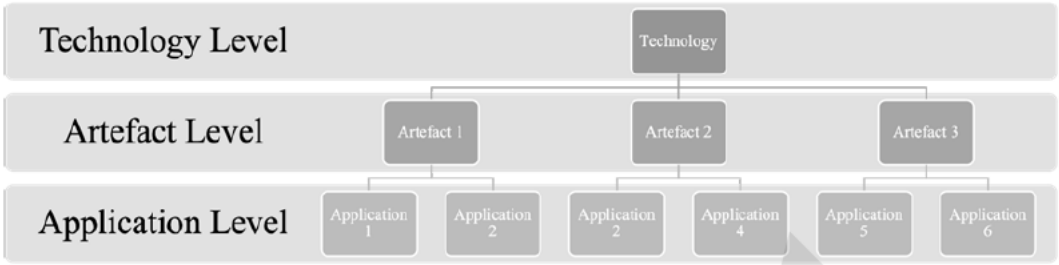
The framework is based on seven key elements, in common with any type of "management system" standard: context, leadership, planning, support, operations, evaluation, and improvement.[2] The framework provides a systematic approach to promote and facilitate and manage innovation capabilities of the organization (including understanding and support of ethics).

Ethics by design is at the core of the TechEthos approach to the ethics of new and emerging technologies. This approach involves the inclusion of a broad array of human and environmental values since the early stages and throughout the innovation process. It requires accompanying the organisation all along the product development cycle, starting from the analysis of the context of the organisation, and the identification of opportunities for innovation (left side of the figure 1 framework), toward the creation of concepts, and development and deployment of solutions (centre part of the framework), until the realization of value during the use and the overall life cycle of the product (right part of the framework). A set of support actions should be put in place to support the process, including planning, implementation, performance evaluation and continuous improvement (bottom part of the figure).

The framework proposed by ISO 56002 is applicable to any type of organisation, and all types of innovations, such as product, service, process, model, and method, and as well to innovation ranging from incremental to radical (technology families discussed in TechEthos include few incremental innovation, such as some included in the digital extended reality family, and radical as most of the other in this and the other two tech families).

This is relevant and aligned with the Anticipatory Technology Ethics approach proposed by TechEthos (figure and deliverable 5.1), that underlines the importance of ethical analysis at different levels of technology and product development: technology level (e.g., climate engineering, digital extend reality, neurotechnologies as well as extended reality and natural language processes and other more specific technologies); the artefact and techniques level (e.g., chatbots for XDR, or Deep Brain Stimulation and Brain Computer Interfaces for Neurotechnologies), the application level (avatars, or therapeutic support of people).



[2] The elements outlined are part of the so called Harmonized Structure (HS), or High Level Structure (HLS), (see ISO/TMB/JTCG N 361, Terminology Guidance) a guideline for the development of ISO management system standards. Harmonized structure and requirements are based on the following elements: Context of the organization: understanding of internal and external matters, the needs and expectations of relevant interested parties; Leadership: top management responsibility and commitment, policies, organizational functions, roles, responsibilities, and authorities; Planning: measures to manage risks and opportunities, quality objectives, and plans to achieve them; Support: necessary resources, competence, awareness, communication, and documented information; Operations: operational planning and governance; Performance evaluation: monitoring, measurement, analysis and evaluation, internal audit, management review, Improvement: nonconformity, corrective action, and continuous improvement.

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Figure 7: The Anticipatory Technology Ethics framework (Source Umbrello et al. 2023, after Brey 2012)

The type of actions that should be put in place by the organisation, and the stakeholder of the innovation ecosystem to interact with, in order to promote ethical use, and mitigating unethical use and negative social impacts can vary depends on the type of technologies and innovative solutions developed by the organisation (first level), the specific techniques (second level) and the intended uses (third level).

Given the overall context of ISO56002 and the links between this and the TechEthos work described above, we focus here on two aspects underlined by the norm: leadership and management, and support (in terms of competences, and planning, operations, performance evaluation and improvement)

Leadership of the organisation is related to the commitment, vision, strategy and policies oriented toward human and environmental values, and is essential to secure adoption of an ethics by design approach in all steps of the innovation process. The top management of the organization is called upon to define, first of all, the vision for innovation that will then guide the definition of policies, objectives and strategies.

In this context**, horizontal competences and soft skills** of executives and managers dealing with innovation play a key role to deal with increasingly complex and interconnected systems (and related ethical implications). These include, among others knowledge of enabling technologies and their trends and understanding and analysis of ethical, legal, social, environmental and economical impacts. These aspects enable the manager to promote awareness of the enabling technologies within the organisation and the stakeholder network, fostering the creation of innovative collaboration models taking into account relevant ethical values.

Within this framework we identified examples of actions that companies can take to guide the deployment and use of their products, with the aim of promoting ethical use, and mitigating unethical use and negative social impacts.

Pre-Design: promote actions to understand and anticipate ethical implications. Examples include (adapted from TechEthos work and CEN *CWA 17796):*

- Include ethical principles in company's mission and vision, include reflection on creating shared value
- Conduct ethical analysis and ethics impact assessment through foresight, scenario analysis, social phenomena, trends evaluation, etc.
- Design for values; stakeholder and value inventories/scenarios
- Hold internal meetings with R&D personnel to reflect on ethical issues and promote internal knowledge transfer
- training and internal knowledge exchange mechanisms for R&D personnel
- Solicit advice from (independent and external) ethics experts as needed
- Develop and introduce ethical frameworks, codes of conduct
- Implement social life cycle assessment
- Achieve a common internal understanding of stakeholder engagement and define a strategy to its approach

High-Level Design, Detailed Design and Development: include and engage with stakeholders to discuss ethical implications. Examples include:

- Set and implement a communication and dialogue strategy on ethical issues

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- Set and implement an internal platform that promotes a culture of internal knowledge exchange (including reflection on company values)
- Work with business and social actors sharing values and creating positive ethical networks
- Co-design product through dialogue with policy actors, authorities, and normative bodies (EU, regional, and local)
- Organise public dialogues, build/use public platforms for expressing needs and concerns
- Connect to or organize living labs and social experimentation using participatory methods
- Build user-based communities of practice
- Promote initiatives for social inclusion, provide consumers an official role in the innovation process
- Promote capacity building with vulnerable actors in the value chain

Testing and Evaluation, Post-launch monitoring and improvement: improve and adapt your actions considering ethical impact**.** Examples include:

- Integrate user-centred design, user innovation, flexible and adaptive design, co-creation approaches
- Screen suppliers for positive (ethics) practices
- Set up procedures for investigating reports of concerns or misconduct
- Ensure non-discriminatory recruitment processes in all company activities (e.g., hiring committees, engagement activities), support a culture of knowledge exchange
- Employ adaptive risk management, including aspects concerned with ethics
- Embed ethicists in the R&I process
- Establish an ethical, social, and legal monitoring board
- Include ethical, legal and social criteria in internal procedures for R&D project quality monitoring
- Ensure ethical management of research data
- Ensure transparency in the handling (collection, analysis, interpretation) of research data
- Promote a culture of transparency by making research open access whenever possible
- Perform regular ethical reviews and get ethical certification (by independent bodies)
- Obtain social accountability and quality certification at company and supply chain levels
- Monitor post-marketing ethical and social impacts
- Include ethical implications of R&D and Innovation products in the CSR/sustainability reporting
- Support and invest in ethical supply chains
- Select funding mechanisms based on ethics/responsibility requirements

Table 9: Objectives and principles of some of the most relevant ISO and CEN "management standards" with respect to approaches for consideration and support of ethics and ethics by design by companies dealing with new and emerging technologies

EN ISO 26000 (Social Responsibility)	**ISO 31000 (Risk Management)**	**ISO 9001 (Quality Management)**	**ISO 56000 (Innovation Management)**	**CEN CWA 17796 (responsibility-by-design)**
Guidance to integrate, implement, and promote socially responsible behaviour	Guidance on a common approach to managing any type of risk throughout the	Requirements to demonstrate organization's ability to consistently provide products	Describes the fundamental concepts, principles, and vocabulary of	guidelines to develop long-term strategies (roadmaps) for innovating responsibly,

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throughout the organization and, through its policies and practices, within its sphere of influence	life of the organization	and services that meet customer needs (conformity) and applicable statutory and regulatory requirements	innovation management	thereby helping organizations to achieve socially desirable outcomes from their innovation processes
➢ Accountability ➢ Transparency ➢ Ethical behaviour ➢ Respect for stakeholder interests ➢ Respect of the rule of law ➢ Respect for international norms of behaviour ➢ Respect for human rights	A risk management framework: ➢ Integrated in all organizational activities ➢ Structured and comprehensive ➢ Customized to the organization's external and internal context ➢ Inclusive, considering knowledge, views, and perceptions of stakeholders ➢ Dynamic and adaptable ➢ Based on best available information ➢ Considering human and cultural factors ➢ Based on continual improvement through learning and experience	➢ Customer focus ➢ Ensure leadership in the management system ➢ Engagement of people ➢ Process approach, to operate as an integrated and complete system ➢ Continuous improvement to meet customer requirements and enhance customer satisfaction ➢ Evidence-based decision-making ➢ Relationship management	➢ Realization of value as the ultimate objective for organizations engaging in innovation activities ➢ Future-focused leader, driven by curiosity and courage, challenges the status quo ➢ Strategic direction for innovation ➢ Culture of creativity, quality, and innovation ➢ Exploiting insights: using a diverse range of internal and external sources ➢ Managing uncertainty ➢ Adaptability ➢ System approach	➢ Reflection & Anticipation on ethical, legal and social impacts since the early stages ➢ Inclusion, engagement of quadruple helix stakeholder ➢ Responsiveness, Integrating monitoring, learning, and adaptive mechanisms

These pre-existing management standards have informed the content of the tool in a number of different areas, well as informing the development of the specific condition of the tool, in particular the mitigations identified as use context and deployment mitigations. These mitigations within the tool text also reflect the product lifecycle-specific recommendations listed above.

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The conditions for the planning phase, ISO 26000 informed the choice of High-Level guidelines, especially under the social subsection of the tool. Moreover, within the tool text, a number of requirements are identified as features of CSR policy – these draw on the seven core subjects of corporate responsibility defined by ISO 26000. ISO 31000 on risk management and ISO 56000 on innovation management inform the development of the concept of Societal Readiness Management and key features of a Societal Readiness Management Strategy defined in the 'How to use' guidance, below, including the initial screening to determine whether a project constitutes innovative design. ISO 9001 on quality management is embodied in the 8-step general procedure for Societal Readiness Management set out under §3.1 Procedure, above.

3.5 Assessing Societal Readiness

Where sections 3.4 and 3.5 set out the *guidance* for societal readiness and explain its foundations, this section describes the *assessment* of societal readiness: how is it determined whether and to what extent requirements have been satisfied, and what follow-up actions are recommended.

The assessment of societal readiness is a potentially problematic process. On the one hand, it would in principle be very advantageous to introduce an assessment procedure which allowed assignment of a societal readiness level score, which enabled the intercomparison of projects in the same manner as the Technological Readiness Level (TRL) Framework. Such a framework would facilitate the prioritisation of resources and more effective management of the so-called 'pacing problem' whereby the pace of technological change has a structural tendency to move faster than the changes in legal and social systems necessary to regulate that technological change (Downes 2009; Marchant, Allenby and Herkert 2011).

On the other hand, TRL is a linear framework which establishes a set of stage gates to be passed on the way to full scale deployment in an operational context. As such, it is inherently ill-suited to what participants in expert consultation referred to as the 'temporality' of societal readiness – the observation that, unlike technological readiness, societal readiness is a moving target, which may seem to move in step with technological readiness for a certain period, then reverse course and decline even as technological readiness increases. Assessment of societal readiness can shift as we gain greater knowledge of product capabilities, greater understanding of product-society interactions, and as we update our understanding of ethical values themselves. These considerations militate in favour of societal readiness assessment being both an iterative and recursive process, with repeated assessments being necessary given the expectation of different results, and with previous results being fed back into the process, updating procedures themselves on the basis of new information or novel reflective insight.

These considerations have led to two courses of action in the existing literature on the concept of societal readiness, which suggested two potential pathways for the development of the TechEthos SRT: one was to pursue a framework on the lines of (Innovation Fund Denmark 2018) which attempts to directly adapt the TRL scale to "societal" rather than purely technical considerations. It does this, for instance, via the theoretical device that stakeholder analysis can fulfil the same role with respect to societal readiness that laboratory testing plays with respect to technological readiness (see also Bruno et al. 2020). The other was to build on the insights of the NewHoRRIzon Societal Readiness Thinking Tool, which aims to provide 'generic reflective questions intended to aid identification and accounting for key societal dimensions of innovation at different stages of a project' (Bernstein et. al 2022, 6). It emphasises the reiterative conception of societal readiness analysis, but in so doing eschews an assessment function.

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The proposal represented by the TechEthos SRT is that it is possible to take a middle way between these two approaches. This is through the idea of a structured self-assessment, which enables users to conduct a temporally relative, qualitative, self-directed appraisal of societal readiness with respect to their given product innovation project. It does this by requiring users to qualitatively assess the severity of violations of ethical and social requirements, termed "mid-level guidelines", while placing some hard constraints on that self-assessment via a risk analysis procedure. This retains some of the advantages of the "risk-gate" function embodied in the TRL framework that are lost in a pure guidance tool, while also avoiding the direct equation of "pure" technical problems and socio-technical problems, as bugs to be systematically screened out, rather than tensions that are potentially inherent to the design objectives of certain projects, requiring reiterative and recursive reflection to acknowledge and overcome.

The TechEthos SRT implements an assessment function via the final two of four 'reflection stages'. The first of these requires users to carry out an assessment of the *magnitude* of any potential violations of ethical and social requirements identified in the preceding steps. The second of requires users to carry out an assessment of the *likelihood* of those violations occurring, given the mitigations already planned, and thus to assess the residual *risk* associated with continued development towards deployment. Three magnitude categories and two probability categories are mapped on to three potential results:

- Further mitigation required
- Proceed with caution

And the implied outcome, when no action is required:

- Currently assessed as safe to proceed towards launch

Crudely speaking, these outcomes can be understood traffic light-style system of "pause", "take special care", "go", but these outcomes are expressed as calls to action rather than a static level score, emphasising the need for continued reflection.

The impact magnitude categories are as follows:

> *An impact is **unacceptable** if any of the below conditions hold:*
>
> *The impact is both significant and has transboundary (international) scope, the impact would constitute a violation of human rights, the impact would violate statutes, the impact involves significant novel dual use risk, the impact would be irreversible, the impact involves the cognitive behavioural manipulation of people or specific vulnerable groups including children, the impact involves 'social scoring', the impact involves real-time and remote biometric identification systems.*
>
> *An impact is **significantly detrimental** if any of the below conditions hold, but none of the conditions for unacceptable impacts holds:*
>
> *The impact would represent a significant cost in terms of individual wellbeing, the impact does not itself constitute a rights violation but makes it more difficult for such violations to be identified, the impact would represent a serious threat to social cohesion, or the impact relates to any of the following - biometric identification and classification of natural persons, management and operation of critical infrastructure, access to essential services and benefits including healthcare, migration, or the application of the law.*
>
> *An impact is **mildly detrimental** if none of the conditions for seriously detrimental impacts or moderately detrimental impacts hold, and the impact is intuitively mild, comparable to commonplace acceptable risks associated with extant systems. If there is any doubt about the severity of possible impacts, the user should err on the side of caution and classify the violation as moderately or seriously detrimental.*

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The impact likelihood categories are as follows:

> *A violation is **likely** if: the user makes an intuitive assessment that the chance of the violation occurring on upon the full operational deployment of the product in its final state is high, for instance because there is a clear causal connection between the product's design, deployment strategy or anticipated product environment, and the violation in question.*
>
> *A violation is **plausibly foreseeable** if: there is a known mechanism in the technical literature according to which deployment of the product could trigger the impact in question, and that mechanism has not been positively determined to have been ruled out, via technical testing and evaluation.*

These magnitude categories are based on the recognition of the need to allow for some risk in order to avoid potentially damaging barriers to innovation, combined with the recognition that there are ethical impacts with respect to which a precautionary attitude is appropriate. The view that a key contribution of the tool would be its ability to represent 'absolute ethical boundaries', including regulation of dual-use risk, was strongly brought out in expert consultation. At the same time, experts also noted that a readiness assessment that triggered moratoria on development would be unlikely to receive uptake given the voluntary nature of the tool, meaning recommendations for concrete steps that could be taken to approach readiness would be more practical.

This simple self-assessment protocol is strongly influenced by the risk management protocol developed for the EU's draft (at time of writing) proposal for the AI Act (EU COM/2021/206 final). The concept of 'unacceptable' impact is adapted from this draft regulation, and the set of application cases which trigger attributions of unacceptable risk incorporates the set of cases categorised as presenting an unacceptable risk under the draft AI Act. Similarly, the category of "significantly detrimental impact' draws on the category of 'high risk' adopted under the act, and again refers to some of the application cases identified under it.

Where the draft AI Act distinguishes unacceptable and high-risk applications on the basis of application type, the present tool disaggregates the concept of risk into impact magnitude and likelihood. This is because it is not feasible to identify high-risk application areas in the context of a generic tool, because many applications areas would be innocuous with respect to many technology types, even if they are high-risk with respect to certain specific technology fields (e.g. AI). Thus, a tool that identifies high-risk application areas would be too restrictive in the case of some projects and technology fields. Instead, the combination of 3 impact magnitudes and two likelihood categories yields 6 potential risk categories (these categories are then linked to 3 action recommendations, meaning in practice they overlap). This enables the tool to represent a precautionary attitude, by assessing unacceptable impacts that are plausibly foreseeable as "Further Mitigations Required". It also avoids stifling innovation, by allowing merely significant impacts that are "plausibly foreseeable" but not "likely" to progress, as long as measures to ensure monitoring and reversibility are in place.

In addition, the self-assessment protocol incorporates principles established and validated through the practice of Environmental Impact Assessment. In particular, EIA applies the screening principle that projects 'likely' to have 'significant environmental effects' should be subject to full EIA prior to Development Consent being given (EC DG Environment, COWI, Milieu 2017). The Directive on Environmental Impact Assessment determines that projects that are neither on the inclusive list of projects automatically required to submit to EIA, nor the exclusive list of project categories exempt from EIA, must undergo "case-by-case" screening to determine whether the project is likely to have significant environmental impacts. At the "case-by-case" screening phase, the DG Environment has developed a set of screening tools which provide a set of parameters for analysis, eg. 'will the project

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result in environmentally related social changes?'. In response to these, the user is required to answer whether they believe impacts under these parameters 'are likely to result in a significant impact' ((EC DG Environment, COWI, Milieu 2017, 54)). To that extent, the concept 'likely…significant impact' is left unanalysed and is left to the judgment of the responsible officer.

Mirroring this approach, the TechEthos Tool also offers an intuitive operationalisation of 'likely…significant impact'. The approach adopted operates on the premise that the officer carrying out the assessment on behalf of the innovation organisation is likely to have the most knowledge about the potential impacts of the project and is best placed to make an informed assessment of the extent to which potential violations of mid-level guidelines are significant.

3.6 Using the SRT

It is recommended that the tool be used in the context of a societal readiness management strategy. A Societal Readiness Management strategy has the following features:

- Societal Readiness Management should begin as early as possible in the product development lifecycle
- The organisation should assess whether industry-specific ethics codes or ethics guidelines have been developed, and if so, ensure these standards are communicated to all relevant audiences throughout the organisation, from senior managers to technicians.
- The organisation should responsibilities for societal readiness guidance and assessment within role descriptions for relevant staff. For large organisations, this could involve appointing a societal readiness officer, creating an ethics officer with responsibility for societal readiness, or assigning the role to a different officer with obligations related to ethical, social and legal impacts, such as a compliance officer. In small organisations where officers must carry out multiple roles, it is important all staff are aware who has responsibility for societal readiness management.
- The organisation should ensure that officers with responsibility for societal readiness guidance and assessment are trained in awareness of ethically salient impacts and the execution of ethical and social impact policies and procedures.[3]

It is in the context of this strategy that the tool should be deployed. First, the officer with responsibility for Societal Readiness Management should determine whether use of the tool is appropriate for the product under development. It is recommended that the tool be used in the context of projects in innovative design, rather than routine design. To determine whether use of the tool is appropriate for the project under consideration, it is recommended the prospective user apply the following simple test:

I. Does the planned product employ new solution principles, based on the latest scientific knowledge and insights? (Inventive Design)
II. Does the planned product realise new functions or properties? (Innovative Design)
III. Does the planned product use an existing solution to a problem, with only the embodiment being novel, adapted to new requirements and constraints? (Adaptive Design)

[3] This high-level description of a Social Readiness Management strategy draws on (Brey, Lundgren, Macnish and Ryan 2019, as well as ISO 56000)

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IV. Does the planned product vary the size or arrangements of parts or assemblies within limits set by previous product structures? (Variant Design)[4]

If the user answers yes to either I or II, use of the TechEthos SRT is recommended for the project.

If the user answer no to both I and II, but yes to either III or IV, the TechEthos SRT is not recommended for the projected.

Projects at the concept formulation and validation phase, (TRL 2-3, "Product Planning", "Specification of Requirements", or "Conceptual Design" in the SIENNA Generic Engineering Design Model), are encouraged to use the tool. That said, users need to navigate the tool with a particular conceptual design in mind (however rough), even if this design will continue to evolve in product development. The tool can be used freely by projects at TRL levels 4-8.

If it is determined that use of the tool is appropriate for the project, the responsible officer should develop a protocol to ensure the tool is used at regular intervals throughout the product development lifecycle. It is expected that responses will change as knowledge of the product improves with continued development. The responsible officer should be the primary user of the tool, and should determine which other relevant staff should use the tool – for example, key design staff. This can either function as Societal Readiness training, or as part of the Social Readiness assessment process.

As discussed above, the tool consists of 4 levels of guidance, each level increasing in its degree of operational specificity. After reading through the guidance at each level, users are invited to respond to a set of questions to promote reflection.

- After the first level, High Level Guidelines, users are invited to reflect on the relationship between their project and a list of ethical values and social impact criteria that are of cross-cutting relevance to projects of all kinds (Reflection Stage 1)
- After the second level, Mid-level Guidelines, users are invited to reflect on a set of requirements that *products* need to fulfil. (Reflection Stage 2)
- At the third level, Product Violations, users are invited to reflect on specific ways in which products can violate the Mid-Level Guidelines, and to assess the severity of those violations (Reflection Stage 3)
- Finally, users must reflect on how those violations can be mitigated, and to assess the adequacy of those mitigations (Reflection Stage 4).

Reflection Stage 3 and Stage 4 constitute the assessment function described in the previous section. They require users to make a self-assessment of the extent to which the potential for product violations has been, or will be, adequately addressed.

In the supporting materials for the tool, users are reminded that the tool is not intended to fulfil a final certification function. The SRT is primarily a tool of reflection and should not be treated as the only means of verifying social readiness. Rather, the tool facilitates a level of readiness self-assessment, especially by identifying dimensions of analysis to pursue improvements.

[4] This taxonomy of designed products according to degree of novelty is adapted from (Pahl, Beitz, Feldhusen & Grote 2007 p.64)

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4. Prospects for Future Work

This section sets out areas in which the TechEthos SRT and the supporting theoretical work presented in the present report represent potentially fruitful avenues for future research. It also describes some valuable connections that have already been made with going and future projects. These projects will be able to built on the results not only of this deliverable, but of many of TechEthos's research outputs, providing a strong case for an optimistic outlook for the integration of Societal Readiness within the existing ecosystem of readiness assessment frameworks in technology R&I.

As already stated, the TechEthos SRT is a prototype tool that is primarily a scholarly contribution to the field of Societal Readiness level analysis. It is intended to serve as an test case, demonstrating how an EbD-based methodology can be applied in an operational content to produce product social readiness guidance and assessment, as well as serving as a dissemination vehicle for TechEthos's ethical analysis, legal analysis and operational guidance developed under Deliverables 2.2, 4.1, 4.2 and 5.3, in addition to guidance delivered through the project's policy briefs, all of which have directly fed into the guidance function of the tool. There are excellent prospects for the SRT be taken forward, as TechEthos has already established links with ongoing and soon-to-begin projects which make reference to TechEthos and look set to bring forward approaches developed in the tool.

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5. Conclusion

Part 1 of this report has offered an overview of the aims of the TechEthos SRT, the theoretical foundation which underlies those aims, and has gone on to explain how the aims have been achieved through the tool's structural framework. The tool itself is a significant body of work which it has only been possible to summarise here by means of excerpts. The tool is designed to be inherently adaptable and will continue to evolve beyond the end of project.

The TechEthos SRT is a prototype tool which enables its target users - actors in product design innovation - to receive guidance regarding the necessary actions required to achieve 'product social readiness', defined as the capacity for a product to be operationally deployed in a way that realises its intended benefits without giving rise to negative ethical, social or legal impacts. This guidance consists of a nested hierarchy of increasing levels of operational specificity, moving from high-level guidelines at the most general level, to specific mitigating actions at the most concrete. The tool further enables self-assessment of the readiness level the product design project under consideration, stressing that this assessment remains temporally relative and should be subject to regular reiterative reflection.

While the tool specifically avoids mapping assessment onto a quantitative readiness level scale which parallels TRL, the self-assessment function does map to one of three outcomes, effectively producing a "traffic light" style system of societal readiness assessment which to some extent parallels EIA. As the tool is a scholarly contribution in its current form, there remains potential for future work to validate the tool for operational use via stakeholder analysis, and there are promising prospects that ongoing and future projects will be able to pursue this potential.

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Annex: Societal Readiness Tool Text

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TECHETHOS

FUTURE ○ TECHNOLOGY ○ ETHICS

Societal Readiness Tool

December 2023

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Introduction to the Tool

This prototype tool is intended for use by designers of innovative products across a range of industries. It is designed to promote reflection on how to align design objectives with ethical and social impact criteria in order to promote Societal Readiness. It is also intended to prompt self-directed assessment of the qualitative Societal Readiness of the product in development.

The tool can be used many times throughout the course of a project, it is intended that developers return to it often, as results may differ as the user's knowledge of the product in development grows more concrete as the project progresses. The tool is designed to promote reflection on the Societal Readiness of *products*. For this reason, it is not intended for use by projects that are still at the stage of basic scientific research (TRL 1).

The tool is based on an Ethics by Design approach. According to this approach, an ethical design process should begin by identifying a set of values and principles that are specific to the technology field under consideration.

However, because this tool is intended for use in a broad range of industries, it begins with a set of values that are generic to any technology field. Ideally, when using the tool, users should reflect on how to interpret the values described in the way most appropriate to their particular field. In this sense, the tool should be reflexive – use of the tool should prompt users to update the tool itself.

The tool also goes beyond an Ethics by Design approach by recommending a broad range of mitigation strategies for managing ethical and social impacts, beyond design alone. There are many elements of the product lifecycle that can lead to violations of ethical and social mid-level guidelines which are within the sphere of action of the innovation organisation, but go beyond design itself. There are correspondingly a range of mitigating actions innovation organisations may be required to take to respond to these violations, which go beyond design-based interventions.

These include the procedures adopted prior to and during the design process within the innovation organisation, for example, the adoption of industry standards. They also include consideration of the impact of material selection and sourcing, both during design itself and in the formulation of the business development strategy. Notably, innovators should attend to the impact of supply chains especially with respect to sustainability, including impact on fundamental rights as well as ecosystems, but also the economic impacts of shifting patterns of demand locally and globally.

They also include deployment strategy, in particular consideration of which markets are targeted and in what order, the agreement and adoption of voluntary standards, for example via professional associations, and independent engagement with regulators at a state and European level, as well as independent standardisation organisations. Deployment strategy also comprises protocols for beta testing, post-market launch monitoring, end-user feedback, updates, recalls and improvements.

Violations of guidelines can also arise from use-context conditions, some of which are only partially under the influence of the innovation organisation. This includes new infrastructure (e.g. charging points, improved network connectivity), and human factors such as level of social acceptance, end-user awareness, ability and desire to use the product, in particular a sufficient level of knowledge and understanding to use it safely. Use context conditions also comprise any requirements for institutional change in the organisational structures in which the product will operate.

The guidance set out in the tool should be read as promoting reflection on the potential for products to be used in beneficial or harmful ways, with the aim of fostering development that promotes benefits,

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while anticipating and mitigating potential harms. As just stated, product violations arise from a combination of design conditions, deployment conditions and use-context conditions. The guidance should not be read as implying the mere existence of products, and their formal features, wholly determines ethical and societal impacts. This assumption - technological determinism – can undermine the responsibility of innovators, by making it seem as if benefits are guaranteed or harms are unavoidable.

Where the guidance does in certain cases talk in terms of products "supporting/promoting" certain values, this should be read as empowering designers and innovation organisations, while also emphasizing their responsibility, by reflecting on the potential for their decisions to have large-scale, long-term societal impacts. It does not imply that technological products inherently determine societal transformations, independently of how we choose to deploy and use them.

Although the guidance is designed to be generic, applicable to a wide range of projects, it is illustrated by reference to the three technology families that were the particular focus of the TechEthos Project. These are Climate Engineering , Digital Extended Reality, and Neurotechnology. More information on the ethical, legal and social aspects of these technologies can be found at www.TechEthos.eu.

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The TechEthos Societal Readiness Tool is influenced by work conducted by the NewHoRRIzon project (EU H2020 Grant No 741402) and the authors are grateful for discussions with former members of the NewHoRRIzon project (now finished) during development of the tool.

Instructions for Use

It is recommended that the tool be used in the context of a societal readiness management strategy. A societal readiness management strategy has the following features.

- The organisation should assess whether industry-specific ethics codes or ethics guidelines have been developed, and if so, ensure these standards are communicated to all relevant audiences throughout the organisation, from senior managers to technicians.
- The organisation should responsibilities for societal readiness guidance and assessment within role descriptions for relevant staff. For large organisations, this could involve appointing a societal readiness officer, creating an ethics officer with responsibility for societal readiness, or assigning the role to a different officer with obligations related to ethical, social and legal impacts, such as a compliance officer. In small organisations where officers must carry out multiple roles, it is important all staff are aware who has responsibility for societal readiness management.
- The organisation should ensure that officers with responsibility for societal readiness guidance and assessment are trained in awareness of ethically salient impacts and the execution of ethical and social impact policies and procedures.

It is recommended that the tool be used in the context of projects in innovative design, rather than routine design. To determine whether use of the tool is appropriate for the project under consideration, it is recommended the prospective user apply the following simple test.

V. Does the planned product employ new solution principles, based on the latest scientific knowledge and insights? (Inventive Design)
VI. Does the planned product realise new functions or properties? (Innovative Design)
VII. Does the planned product use an existing solution to a problem, with only the embodiment being novel, adapted to new requirements and constraints? (Adaptive Design)
VIII. Does the planned product vary the size or arrangements of parts or assemblies within limits set by previous product structures? (Variant Design)

If **yes** to **either I or II**, use of the TechEthos SRT **is** recommended for your project.

If **no** to **both I and II**, but **yes** to **either III or IV**, the TechEthos SRT **is not** recommended for your project.

Projects at the concept formulation and validation phase, (TRL 2-3, "Product Planning", "Specification of Requirements", or "Conceptual Design" in the SIENNA Generic Engineering Design Model), are encouraged to use the tool. That said, users need to navigate the tool with a particular conceptual design in mind (however rough), even if this design will continue to evolve in product development. The tool can be used freely by projects at TRL levels 4-8.

The tool consists of 4 levels of guidance, each level increasing in its degree of operational specificity. After reading through the guidance at each level, users are invited to respond to a set of questions to promote reflection.

- After the first level, High Level Guidelines, users are invited to reflect on the relationship between their project and a list of ethical values and social impact criteria that are of cross-cutting relevance to projects of all kinds (Reflection Stage 1)
- After the second level, Mid-level Guidelines, users are invited to reflect on a set of requirements that *products* need to fulfil. (Reflection Stage 2)
- At the third level, Product Violations, users are invited to reflect on specific ways in which products can violate the Mid-Level Guidelines, and to assess the severity of those violations (Reflection Stage 3)
- Finally, users must reflect on how those violations can be mitigated, and to assess the adequacy of those mitigations (Reflection Stage 4).

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Reflection Stage 3 and Stage 4 play the role of social readiness *assessment*. They require users to make a self-assessment of the extent to which the potential for product violations has been, or will be, adequately addressed.

The tool is not intended to fulfil a final certification function. The tool is primarily a tool of reflection and should not be treated as the only means of verifying social readiness. Rather, the tool facilitates a level of readiness self-assessment, especially by identifying dimensions of analysis to pursue improvements.

The tool should be used regularly throughout the product development lifecycle, as it is expected that knowledge will improve as development continues.

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High Level Guidelines

Ethical Criteria

Diversity Equity and Inclusion

Diversity includes the value of diversity of background, and of thought, within organisations and across societies. It is a value that builds on the value of fairness and equality, by implying that societies, organisations and other groups should ideally be composed of people with a broad range of social identities. Diversity is valuable for its own sake, because it is inherently linked to the value of relational equality and equality of opportunity. It is also instrumentally valuable, because it promotes creativity and innovation, by providing access to knowledge and experience from a variety of perspectives.

Equity includes equal treatment of morally equal cases in the face of systems of formal or informal rules, including those embodied in technical systems. The value of equity underlies legal systems, both Common Law and Civil Law systems, where it represents the principle that rules should take account of individual circumstances. Equity is about ensuring that the application of rules does not offend against our natural sense of fairness, for instance by producing undeserved benefits or imposing unbearable penalties.

Inclusion signifies the value of ensuring people of all abilities are empowered to participate in organisations and institutions, and access important goods and services, on equal terms. On the one hand, this is about ensuring the structure of those organisations, institutions, goods and services accounts for the specific needs of those people who need to use them. Inclusion in this sense involves the value of accessibility. On the other hand, inclusion is about establishing an ethos whereby the potential for diverse, differently able people to contribute to organisations, institutions and communities is acknowledged and appreciated.

Examples:

- Solar Radiation Modification: it would be important to reflect on equity when developing solar radiation modification systems because these systems have the potential to effectively allocate costs and benefits across different populations with different levels of comparative advantage.
- Digital Extended Reality: It would be important to reflect on inclusivity when developing a DXR system involving digital avatars, for example, because it would be important to ensure the available range of avatars represented the diversity of all potential users. In this case, inclusivity reflects the importance of ensuring an equally engaging user experience for all categories of user, so that no category of user feels alienated by the product.
- Neurotechnologies: It would be important to reflect on the value of diversity when developing devices intended to treat certain neurological conditions, as it would be important to recognise the unique contributions neurodivergent communities make to organisations and wider society. Developers would have to consider ways to ensure innovations preserved and validated neurodiversity.

Safety and Security

The value of security connotes security of the person, meaning the value of protection from physical or mental harm. The value of security is expressed through several fundamental rights as recognised

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by the Human Rights tradition, including the prohibition of torture, inhuman or degrading treatment, and protection against arbitrary detention.

In relation to digital technologies, security is mostly understood as information security, which comprises different fields, like access control, cyber security, cryptography, anonymization. Security in this context is the value of protecting networks, data and devices from unauthorised use, most importantly for criminal purposes. The interpretation of the value of security in relation to digital technologies can be generalised to apply to the appraisal of systems of all kinds, as the value of ensuring the system does not provide new means for adversarial actors to cause harm, or exacerbate existing means of causing harm.

Examples:

- Solar Radiation Modification: Reflection on safety and security would be important during development of these technologies, for instance because of their potential implications for international security. Deployment of these technologies has the potential to create transboundary harms. As well as having implications for individual safety, these could potentially lead to inter-state conflict, requiring careful consideration of how to manage these risks.
- Neurotechnologies: Brain-Computer interfaces may create novel forms of person data which may be uniquely useful to adversarial actors if disclosed.
- Digital Extended Reality Technologies might also create such novel data sets.

Fairness and Distributive Justice

Impacts related to justice and fairness affect the distribution of goods, opportunities and power. In widely accepted liberal conceptions of justice, equality of opportunity is a core principle. This means that if any social position, office or job has the potential to create a material inequality between people, then that position must be equally accessible to all. Fairness requires treating every human being, independently of attributes such as gender, race, or sexual orientation, with equal respect.

Many people believe distributive justice requires a baseline absolute standard of the kinds of goods that make people's lives go well, or that priority must be given to the least advantaged when making decisions that have distributive effects. This understanding of the value is widely thought to be grounded in the value of respect for human dignity, the idea that people have inherent worth in virtue of their humanity and therefore are worthy of equal concern when contemplating actions that have the effect of distributing burdens and benefits in society. Social policies have this effect; the development of new technologies may in certain cases also have this effect and may therefore involve considerations of distributive justice.

- Carbon Dioxide Removal: Reflection on distributive justice would be important for developers of these technologies because access to carbon removal is an aspect of climate burden sharing more generally, meaning justice might demand technology transfers between countries, for example. This may have important design implications.
- Digital Extended Reality: These technologies have the potential to produce large-scale economic transformations which could upset distributions on all kinds of metrics, for example by disrupting the market for accommodation in cities. It is important to acknowledge distributive justice when making decisions that will affect these disruptive impacts.
- Neurotechnologies: distributive justice is an important consideration in relation to these technologies as their potential to augment individual capacities creates a novel form of comparative advantage, and so needs to be managed fairly.

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Freedom and Autonomy

Freedom refers to the protection of personal freedoms of the kind typically safeguarded by liberal constitutions, including freedom of expression, freedom of assembly and freedom of association. It is the value of non-interference by external actors, including (but not limited to) states, in the sphere of legitimate behaviour. Freedom in this sense is sometimes referred to as negative freedom, or "freedom from...".

Autonomy refers to the value of people being able to act according to their own values and to direct their lives as they see fit. Autonomy is sometimes referred to as positive freedom or "freedom to...". Autonomy comprises the value of non-manipulation and of informed consent.

Freedom and autonomy are interrelated. Freedom of thought and expression, for instance, can be achieved by protections against interference, either by the state or by other systems of power, including technological systems. Expression and free thought, are, however, important instances of the exercise of autonomy. Freedom and autonomy are therefore mutually supportive. Loss of autonomy can be more insidious than loss of freedom. We lose autonomy when other entities make decisions on our behalf, or influence our decisions in a way that prevents us from full rational consideration of them.

Examples:

- SRM: Reflection on autonomy is important in relation to SRM because open-air experimentation in the development of such technologies has the potential to materially affect human subjects, giving rise to considerations of prior informed consent.
- DXR: Autonomy is important in relation to these technologies as they might provide the opportunity for forms of nudge-based advertising which affect individual agency in novel ways.
- Neurotechnologies: autonomy is important in relation to these technologies because of their potential to alter mental states. Depending on the nature of these interventions, they have the potential to both promote and undermine autonomy.

Privacy

The value of privacy is the value of respect for one's private and family life as well as one's correspondence and the home. The value of protection against attacks on one's honour and reputation is also considered to be an aspect of privacy (for instance under the UN Universal Declaration of Human Rights). The value of privacy is grounded in a range of moral considerations. One is the principle of the presumption of innocence before the law. Another is the value of protecting a "private sphere", in which behaviour which may violate custom, but does not harm others, should be allowed to continue in case it proves to benefit either the individual or wider society.

An important domain of privacy is data privacy. This is the form of privacy which is upheld by, for instance, the EU General Data Protection Regulation. Data privacy in this sense involves strict rules on the collection, storage and use of personal data, notably, informed consent before personal data is stored and processed. It also involves requirements to allow people to access, correct or delete their personal data, and a requirement to store personal data securely. Furthermore, special protections are required for "sensitive" personal data, including data pertaining to sexual orientation, health, political affiliation and criminal record. Special protections are also required for data pertaining to certain categories of person, including children, people with disabilities, and vulnerable groups. In addition to the traditional explanations for the value of privacy, data privacy is also grounded in the importance preventing exploitation. Technological developments are a key source of impacts on data privacy, such as new techniques for data collection and data analysis.

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- DXR systems and Neurotechnology might both have impacts on privacy by creating novel forms of personal data requiring novel systems of protection.

Responsibility and Accountability

Responsibility is the value of recognising the duty to act in accordance with moral standards, and of recognising that accepting liability for the negative consequences of one's actions intrinsically connected to any claims to benefit or reward for the positive consequences of one's actions. In one important sense, responsibility can be understood as stewardship, meaning the importance of continued concern for the ongoing consequences of projects one is involved with or continues to benefit from.

Accountability is the value of ensuring responsibility is promoted in institutional contexts. For example, legal accountability ensures that laws properly apportion sanctions and rewards, avoiding perverse incentives and ensuring negative consequences are borne by perpetrators rather than innocent victims. Financial accountability involves requirements for proper financial reporting and auditing. Stakeholder accountability involves the duty of organisations to engage with external parties who may be affected by their activities.

Responsibility and accountability therefore include the value of transparency. They also include the value of a precautious attitude, especially in the context of uncertainty and the potential for irreversible impacts. They include considerations of integrity in the consistent and good-faith application of ethical standards, rather than treating ethics as a public relations device. Finally, the value of responsibility and accountability may also involve consideration of whether some novel the system or policy might impact stakeholders' overall ability to feel a sense of personal responsibility for their actions throughout their lives, for instance by undermining their sense of self.

Examples:

- CDR: Responsibility is important in relation to these systems because of their potential to have far-reaching and long-lasting effects, meaning those deploying them will have special duties of care and stewardship.
- DXR: Responsibility is important in relation to these systems because of their potential to blur the boundary between virtual and actual reality. This feature could promote responsible behaviour by effectively training users for the real world, or undermine responsibility with dissociative states of mind.
- Neurotechnologies: Consideration of responsibility is important in relation to these technologies because neurological interventions have the potential to disrupt the way we think about civil and criminal liability.

Individual Wellbeing

Impacts on individual wellbeing concern how individuals fare in a society. These are impacts on how well people function in daily life and how content they are with their life, whether their basic needs are fulfilled, and whether they regard their life as meaningful. Wellbeing or welfare is a scalar measure of value. As such, it is sometimes contrasted against economic measures of value such as profitability or contribution to gross domestic product. When evaluating projects, it is not necessarily the case that there should be an absolute requirement to promote wellbeing, as in certain cases there may be acceptable economic justification for the pursuit of projects that are not activity aimed at the promotion of wellbeing. Negative impacts on human wellbeing, however, are always to be avoided.

- Digital Extended Reality: Wellbeing is an important consideration in relation to DXR because of these novel ways these systems are likely to affect the human mind, as well, potentially, as the body.

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- Carbon Dioxide Removal: Wellbeing is important in relation to these techniques as many are recommended because of their wellbeing co-benefits, for instance they can improve people's opportunities to interact with the natural environment.
- Neurotechnologies: Consideration of wellbeing is important in the context of these technologies as they have the potential to intervene in the domain of mental health, for instance treating the symptoms of conditions like Generalised Anxiety Disorder, creating novel ways of promoting or undermining wellbeing that require special attention.

Social Criteria

Harmful environmental impact

Environmental impact resulting from the deployment and use of technological products and structures has emerged as a growing concern in contemporary society. With our increasing reliance on technology, it is imperative to acknowledge the potential adverse effects of these innovations on our environment. Environmental harm encompasses any detrimental impacts on the natural world and the planet as a whole, stemming from a variety of activities such as industrial processes, energy production, deforestation, and pollution. The potential for technological products and structures to significantly contribute to environmental harm lies primarily in factors such as energy consumption, resource extraction, and waste production.

Moreover, the life cycle of technological products, from manufacturing to disposal, plays a critical role in environmental impact. The extraction of raw materials, manufacturing processes, and transportation contribute to the carbon footprint of these products. Additionally, the rapid pace of technological advancement leads to shorter product lifespans and increased electronic waste. The improper disposal of electronic devices further exacerbates environmental concerns, as toxic components can leach into soil and water, contaminating ecosystems. Efforts to address these issues involve promoting sustainable practices throughout the product life cycle, from designing eco-friendly products to implementing responsible recycling and waste management strategies. As consumers, businesses, and policymakers navigate the complex landscape of technology use, a comprehensive approach is necessary to mitigate and counteract the environmental consequences associated with our reliance on technological innovation.

Examples:

- E-Waste pollution: the rapid advancement of technology leads to a substantial increase in electronic waste (e-waste) generated by obsolete devices. Improper disposal of electronic devices, containing hazardous materials such as lead, mercury, and cadmium, contributes to soil and water pollution, posing serious threats to ecosystems and human health.
- Deforestation for product components: the demand for certain materials essential in manufacturing technological products, such as rare earth metals and minerals, can drive deforestation. Extracting these resources often involves clearing large areas of forests, disrupting biodiversity, and releasing carbon into the atmosphere, thereby contributing to climate change and environmental degradation.
- Energy consumption in data centers: the operation of data centers, crucial for hosting digital services and storing vast amounts of data, requires significant energy consumption. The environmental impact arises from the reliance on fossil fuels to power these centers, contributing to greenhouse gas emissions and climate change. Implementing sustainable energy solutions and improving energy efficiency in data centers is crucial to mitigate this environmental harm.

Harm to property

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The concern over harm to property has become increasingly prominent as societies grapple with diverse forms of assets and possessions owned by individuals and organizations. Property, encompassing a wide range of assets, is a fundamental aspect of our socio-economic fabric. Various categories, such as personal property, public property, real property, intellectual property, and digital property, represent the diverse nature of ownership. Harm to property can manifest in multiple ways, including physical damage, theft, vandalism, or infringement on intellectual and digital assets. Safeguarding these diverse forms of property requires a nuanced understanding of the potential risks and challenges associated with each category.

Each type of property faces unique threats and vulnerabilities. Physical property, such as homes or businesses, may be susceptible to natural disasters, accidents, or criminal activities. Intellectual property, comprising creations of the mind like inventions or artistic works, faces challenges like unauthorized use, plagiarism, and piracy. Digital property, in the form of data and online assets, is vulnerable to cyber threats, hacking, and data breaches.

Examples:

- Urbanization and infrastructure development: Rapid urbanization and infrastructure development can lead to the encroachment on private properties, causing erosion of property values. Increased demand for space may result in the forced acquisition of land, affecting homeowners and businesses. This can lead to disputes, economic losses, and changes in the social fabric of affected communities.
- Intellectual property infringement in creative industries: In the realm of creative industries, such as music, film, and literature, intellectual property infringement poses a significant threat. Unauthorized reproduction, distribution, or use of copyrighted materials not only undermines the economic value of creative works but also hampers the incentive for further innovation.
- Cyber-attacks on digital property: As digitalization continues to play a crucial role in business operations, cyber-attacks pose a serious threat to digital property. Unauthorized access, data breaches, and ransomware attacks can lead to the loss or compromise of sensitive information, financial data, and digital assets.

Harm to social institutions

Products can also have adverse consequences for fundamental institutional structures, including the economy, politics, education, healthcare, media, and cultural spheres. In the economic realm, products with flawed designs or harmful components can lead to financial crises, market disruptions, and inequalities, adversely affecting the stability and prosperity of nations. Political institutions are vulnerable to the influence of products associated with corruption, misinformation campaigns, and political instability, eroding trust in governance and undermining the democratic processes that form the backbone of societal order.

Furthermore, products in the educational, healthcare, media, and cultural sectors can pose specific risks. In education, the introduction of substandard educational tools or technologies may perpetuate unequal access to learning resources and biased educational content, hindering the development of an informed and equitable society. In healthcare, products with safety issues or inadequate access can jeopardize public health and well-being, exacerbating disparities in healthcare delivery. Media products, if manipulated or disseminating misinformation, can distort public understanding, influencing political narratives and eroding trust. Additionally, cultural products, whether through cultural appropriation or the degradation of artistic expression, may contribute to the erosion of cultural heritage and diversity within society. Mitigating harm caused by products demands a comprehensive approach, including rigorous quality control, ethical product design, and vigilant regulatory measures across various sectors.

Examples:

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- Economic disruption: the introduction of flawed financial products, such as high-risk investment instruments or predatory lending practices, can contribute to economic crises and market volatility.
- Political instability from misinformation: products designed to spread misinformation, including fake news platforms and deceptive social media tools, can contribute to political instability. Manipulative products may influence public opinion, sow discord, and undermine democratic processes, eroding trust in political institutions and diminishing the integrity of electoral systems.
- Educational inequities from biased EdTech products: the deployment of educational technologies with biased content or unequal access features can perpetuate educational inequities. Substandard edtech products may limit educational opportunities for certain demographics, exacerbating disparities in learning outcomes and hindering the goal of providing an inclusive and accessible education for all.

Harm to the provision of basic needs and socio-economic security

The impact of products on the provision of basic needs and socio-economic security has become a pressing concern as societies grapple with various challenges. The production and deployment of certain products, such as environmentally unsustainable agricultural practices, can contribute to disruptions in the supply chain of essential goods. For example, the use of harmful pesticides and intensive farming techniques can degrade soil quality, reducing agricultural productivity and compromising food security. Additionally, products associated with unequal resource distribution, such as water-intensive industries or wasteful consumption patterns, can exacerbate water scarcity issues, hindering access to clean water and impacting public health.

Furthermore, socio-economic security is at risk due to products that contribute to economic disparities and unemployment. Products manufactured without adherence to fair labor practices or those associated with discriminatory hiring policies can perpetuate socio-economic inequality. Additionally, the introduction of technologies that automate jobs without providing adequate replacement opportunities can lead to unemployment and financial instability. Mitigating harm caused by products to the provision of basic needs requires a critical examination of production processes, sustainable resource management, and the equitable distribution of products to ensure that they contribute positively to societal well-being and security.

Examples:

- Food insecurity due to agricultural disruptions: the use of certain agricultural products, such as environmentally harmful pesticides and intensive farming methods, can contribute to disruptions in food production. These practices degrade soil quality, reduce agricultural productivity, and compromise food security.
- Water scarcity linked to water-intensive products: the production of water-intensive products, including certain industrial goods and crops with high water requirements, can contribute to water scarcity issues. The overuse and mismanagement of water resources in the production process hinder access to clean water for drinking, sanitation, and agriculture.
- Socio-economic inequality from unethical labour practices: certain products, especially those associated with industries employing unethical labour practices, can contribute to socio-economic inequality. Products manufactured under exploitative conditions or with insufficient consideration for fair wages and workers' rights perpetuate disparities. Additionally, the introduction of automated products without adequate retraining opportunities can lead to unemployment, exacerbating financial instability and social inequality within communities.

Harm to social cohesion and social stability

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Social cohesion is the degree of unity, cooperation, and mutual trust among individuals and groups within a society. It represents the harmonious coexistence of diverse individuals, regardless of their backgrounds, and is characterized by a shared sense of belonging and a commitment to the common good. A society with high social cohesion typically sees individuals and groups collaborating, supporting one another, and working together to address collective challenges. This cohesion is nurtured by healthy social relations, a sense of attachment to a larger community, and an orientation toward the well-being of all its members.

Social stability, on the other hand, is a state of order, equilibrium, and peaceful cohabitation within a society. It reflects the absence of widespread conflict, violence, or upheaval and is marked by the functioning of social institutions as expected. In a socially stable society, individuals can live their lives with a reasonable expectation of safety and continuity, and social institutions are capable of delivering essential services and upholding the rule of law.

These two concepts are interconnected: social cohesion contributes to social stability by fostering an environment where individuals and groups can interact and cooperate without friction, while social stability, in turn, creates the conditions for social cohesion to thrive. However, both can be influenced by a range of factors, including economic disparities, cultural diversity, access to education and healthcare, the quality of governance, and the impact of technology and products on social interactions. Balancing these factors is a central challenge in maintaining a society that is both harmonious and stable.

Examples:

- The spread of misinformation via social media platforms: Certain social media platforms, designed to maximize user engagement and advertising revenue, can inadvertently contribute to the spread of misinformation and divisive content. Products designed with algorithms that prioritize sensational or polarizing information may create echo chambers, reinforcing existing beliefs and contributing to social fragmentation.
- Online platforms facilitating hate speech: Certain online platforms and products provide a space for the dissemination of hate speech, discriminatory content, and extremist ideologies. Products designed without effective content moderation or safeguards against abuse may inadvertently contribute to the amplification of divisive narratives.

Harm to social relations

Harm to social relations can encompass a wide range of adverse consequences that affect the quality, depth, and overall well-being of human connections. This harm may manifest as increased isolation and loneliness due to excessive digital interactions, disrupted communication patterns that hinder understanding and empathy, or a diminishment of shared experiences and emotional closeness. It can also involve the negative impact of cyberbullying and online harassment, which inflicts emotional distress and strains relationships. Furthermore, harm to social relations can include the replacement of meaningful human connections with less fulfilling human-machine interactions, leading to a sense of emptiness and disconnection. Depersonalization and dehumanization in virtual spaces can diminish empathy and respect, impairing the fundamental elements that foster meaningful social relations. Recognizing these challenges and taking steps to mitigate them is crucial for maintaining healthy and fulfilling connections in the digital age.

Examples:

- Social networking applications fostering social isolation: while social networking apps are designed to connect people, excessive use and reliance on these platforms can lead to social

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isolation. Products that encourage constant virtual interactions may inadvertently contribute to a decline in face-to-face communication and meaningful relationships.

- Digital communication tools and miscommunication: products such as instant messaging and social media platforms can lead to miscommunication and misunderstandings. The absence of non-verbal cues in digital communication may result in misinterpretation of tone or intent, leading to conflicts and strained relationships.
- Addictive video games impacting interpersonal connections: certain video games, especially those designed with addictive features, can strain social relations by consuming excessive amounts of individuals' time and attention. Products that promote prolonged solitary gaming experiences may lead to withdrawal from social activities, impacting friendships, family relationships, and romantic partnerships.

Harm to human and civic capabilities

Harm to human and civic capabilities can encompass a range of negative consequences that hinder individuals' ability to lead fulfilling lives and actively engage in the betterment of society. It can involve a decline in critical thinking and problem-solving skills, leaving individuals ill-equipped to navigate complex challenges. Emotional intelligence may suffer, leading to difficulties in understanding and managing one's emotions, which can strain personal relationships and hinder effective communication. Diminished civic knowledge and media literacy can result in a lack of awareness about societal issues and an inability to engage in informed decision-making, potentially undermining the democratic process. Ethical decision-making skills may erode, leading to unethical behavior and a breakdown of trust within the community. Reduced learning skills and weakened social networking abilities can limit adaptability and connections with others. Cultural misunderstandings may arise, causing division and exclusion. Furthermore, virtues like honesty, integrity, empathy, and courage may deteriorate, fostering a climate of dishonesty, insincerity, and apathy. In sum, harm to these capabilities can result in a society where individuals struggle to lead meaningful lives and actively contribute to the common good.

Examples:

- Manipulative social media algorithms: some social media platforms utilize algorithms that prioritize sensational or polarizing content to maximize user engagement. This can create filter bubbles, limiting users' exposure to diverse perspectives and contributing to echo chambers.
- Educational technology with inequitable access: certain educational technology products, such as online learning platforms or digital resources, may contribute to disparities in educational access. Students without reliable internet access or necessary devices may face limitations in their learning capabilities, exacerbating existing inequalities in education. Inequitable access to educational products can hinder civic capabilities by impeding equal participation in the knowledge economy and limiting opportunities for civic engagement.
- Deepfake technologies: the rise of deepfake technologies, capable of generating hyper-realistic fake videos or audio recordings, poses a significant threat to human and civic capabilities. Products developed for creating deepfakes can be misused to spread false information, manipulate public perception, and undermine trust in media and institutions.

Reflection Stage 1

For each ethical value or social impact criterion listed, reflect on the following questions:

How that value might be implicated by the system under consideration?

What is the most important interpretation of the value in relation to the system under consideration?

In addition, reflect on:

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Are there important values that might be implicated by the system under consideration that are not listed? Can you explain why they are important?

Mid-level Guidelines

Ethical Criteria

Diversity, Equity and Inclusion

- Equity: Products must be developed, deployed and used in with equity in mind. Within reasonable limits, (prospective) users who are disadvantaged or have special needs (members of vulnerable groups, including but not restricted to the elderly, people with disabilities, minorities and indigenous peoples, refugees and asylum seekers, first-generation immigrants, the LGBTQ+ community, economically disadvantaged and homeless people, people with mental health conditions, people with chronic diseases, low-education individuals, and single parents) should be provided with added resources and opportunities.
- Diversity: Products should be developed, deployed and used in a way that recognises and embraces diversity. This means including a diverse community of users with diverse abilities, interests and needs, as well as diversity of product stakeholders in general.
- Inclusion: Products should be developed, deployed and used in an inclusive manner by promoting full participation by diverse people with different identities and by promoting the positive valuation of differences.

Safety and Security

- Safety: Products should be safe to use, without significant risk of physical harm or harms to mental health and well-being. This applies to all users and third parties, with special consideration for children and members of vulnerable groups.
- Security of the person: Products should not undermine security of person, including protections from arbitrary arrest, violence, physical harm, threats to well-being, freedom from torture, and access to justice. This applies to all users and third parties, with special consideration for children and members of vulnerable groups. In particular, products should be developed in a way that anticipates the potential for dual use and minimises malicious uses while maintaining beneficial applications.
- Security of the system: Products should be free of vulnerabilities which would allow third parties to create threats.

Fairness and distributive justice

- Accessibility: Products should be accessible to and usable by all users, to the extent possible. Access barriers should be removed, including barriers resulting from lack of physical access, lack of skills and lack of usage opportunities. Products that provide or affect access to important social goods, including rights, liberties, powers, opportunities, income, wealth, and social recognition, should provide such access fairly, taking into account the equality of all human beings.
- Avoiding Bias: Products should not contain social biases by which some users and user communities are treated unequally, including physical access biases, skills biases, functional biases, algorithmic biases, and representational biases in design.
- Non-Discrimination: Products should not facilitate, or contain material that endorses or constitutes, discriminatory practices, including communication of hateful and discriminatory content, discriminatory harassment, hate crimes involving assault, abuse and damage to property, and discriminatory policies or practices by companies, associations, and clubs.

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- Human Equality: Products should support the equality of all human beings, guaranteeing equality of rights and of opportunity, and supporting equal protection against discrimination, equal access to public services, and equal pay for equal work.

Freedom and autonomy

- Freedom of Expression: Products should be developed, deployed and used in a manner consistent with the right to freedom of expression, including expression through written and oral speech, nonverbal speech, and art. Restrictions on freedom of expression should only be supported for speech that poses risk to imminent harm or violates other rights and speech that causes offense while having no redeeming value.
- Bodily Integrity: Products should be developed, deployed and used in a manner which respects the right to bodily integrity, which involves the right to control over one's own body and freedom from unwanted intrusion or physical contact.
- Freedom of Movement and Residence: Products should be developed, deployed and used in a manner which respects the right to freedom of movement and residence.
- Freedom of Assembly and Association: Products should be developed, deployed and used in a manner which respects the right to freedom of peaceful assembly and association
- Individual Autonomy and Self-Determination: Products should be developed, deployed and used in a manner which respects individual autonomy and self-determination, including access to information and counsel for everyday decision-making, support of freedom of thought, and support for freedom from manipulation, deception and disinformation, and coercion.

Privacy

- Right to Privacy: Products should be developed, deployed and used in a manner which respects privacy, including the privacy of users, bystanders and data subjects whose personal data are recorded, stored and processed with or by a product. Privacy protections in the metaverse should extend not only to information privacy, but also to bodily, spatial, proprietary, intellectual, decisional, associational and behavioural privacy, and should include protections against acts of (virtual) physical interference, intrusive observation, and intrusive information collection and use. This means that actions and processes that intrude on these forms of privacy should not occur, unless there is meaningful informed consent, implying that the user, data subject or third party is given accessible information that sufficiently explains the consequences of consent in relation to his or her interests before consent is given.
- Processing of personal data: Products should subject the processing of personal information to common principles of privacy protection, including notice, informed consent, purpose limitation, data minimization, security, accuracy, time-limited retention, and accountability.
- Processing of sensitive data: Sensitive data, such as biometric data, health data, and data about personality traits, emotional states, and political or ideological beliefs should only be collected or created with consent and for prespecified, restricted uses that serve a compelling user interest or public interest.
- Entities with a private character: Data about entities that have a private character, such as privately owned or used buildings, spaces, and containers, private conversations and associations, should only be collected or created with consent and for prespecified, restricted uses that serve a compelling user interest or public interest.
- Purpose-specific consent: Data must not be used for purposes that were not consented to.

Responsibility and Accountability

- Definite responsibilities: The responsibilities of producers, as well as those of users and other stakeholders, should be clearly and transparently defined before a product is marketed.
- Transparency: In the interest of accountability, products and product policies should be transparent, meaning that there should be disclosure of detailed information about them in a

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way that should be accessible and understandable to users and stakeholders. The purpose, capabilities, limitations, benefits and risks of the system must be openly communicated to all stakeholders.
- Precaution: Products should be developed, deployed and used according to a precautionary attitude. This means the identification of a potential risk of harm to public health or ecosystem health should provide a reason to pause development, deployment or use, until that risk can be properly assessed and either ruled out or mitigated.

Individual Wellbeing

- Physical Health: Products should not involve risk of loss of physical health. This includes risks of physical injury, infectious diseases, chronic and degenerative conditions, and death.
- Mental Health: Products should not involve risk of loss of mental health, including anxiety disorders, mood disorders, obsessive-compulsive disorders, Attention-Deficit/Hyperactivity Disorder (ADHD), sleep disorders, low self-esteem, body image and eating disorders, loneliness, social isolation, and problematic use and addiction, with particular attention to their occurrence in adolescents and young adults and in vulnerable groups.
- Other Categories of Wellbeing: Products should not involve risk of harm to other aspects of well-being, including loss of pleasure, social well-being, achievement, experiences of meaningfulness, or personal growth and self-actualization.

Social Criteria

Harmful environmental impact

- Disposal and End-of-Life: Products should be properly disposed of or recycled, especially electronics, as not doing so can lead to hazardous substances seeping into the soil and water, endangering ecosystems, animal welfare, and human welfare. The rapid pace of technological advancement leads to frequent upgrades and replacements of electronic devices, resulting in a massive amount of e-waste.
- Energy efficiency in product manufacturing and use): When manufacturing products, the power requirements of technological devices and the data centers should be taken into account with the aim to be more energy efficient, in order to reduce energy consumption (especially from non-renewable sources).
- Resource depletion: Products should be designed and manufactured in such a way that resource depletion is actively mitigated by adopting sustainable sourcing practices.
- Air and water pollution: Products should be designed and manufactured to prevent air and water pollution, including deployment and use, and recycling.
- Eutrophication: Manufacturers must incorporate measures to prevent eutrophication caused by their products, by minimizing the release of nutrients, such as nitrogen and phosphorus, into ecosystems, particularly water bodies, to preserve water quality and ecological balance.
- Plastic waste: Manufacturers must integrate measures across the entire product life cycle to minimize plastic waste generation, including reduced plastic packaging, increased product durability, and the promotion of recycling and sustainable disposal practices, to mitigate the environmental impact of plastic waste.
- Noise and light pollution: Manufacturers are required to implement strategies and design considerations that prevent noise and light pollution attributable to their products.
- Habitat fragmentation: Manufacturers must prioritize measures to prevent habitat fragmentation arising from their products, such as considering the spatial and ecological

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impacts of infrastructure development and land use changes, to maintain the connectivity and integrity of natural habitats.
- Deforestation: Manufacturers must undertake practices that prevent deforestation resulting from (the manufacturing process of) their products, emphasizing sustainable sourcing and responsible land use.

Harm to property

- Product malfunctions: (Technological) products, including electronic devices and vehicles, should be designed and built with safeguards to prevent malfunctions, financial loss, or physical harm caused by design flaws or software glitches, particularly when the product is considered to be personal property.
- Theft and cybercrime: Manufacturers should establish and maintain stringent security protocols to prevent the invasion of personal property facilitated by technology, including surveillance cameras and data breaches. Unauthorized access to personal devices or hacking should be actively thwarted to preserve the security and confidentiality of personal property.
- Vandalism and damage: Manufacturers should develop and implement measures to prevent the facilitation of vandalism and damage to public property through technological tools. This includes considering the potential for graffiti and destruction of public infrastructure when designing and distributing modern equipment and tools.
- Cyberattacks on (digital) infrastructure: Products should encompass stringent security measures to protect public infrastructure, including transportation systems and utilities, from cyberattacks that may disrupt services and compromise public safety.
- Unauthorized use and access: Manufacturers should implement measures to prevent unauthorized use of public property, including parks or government buildings, through technology-related activities.
- Environmental damage: Manufacturers should implement measures to mitigate the environmental harm that may result from the development and deployment of technological infrastructure and industrial facilities.
- Structural damage: Products should be designed in such a way as to prevent damage to nearby real property during the construction and maintenance of technology-related structures, such as cell towers or power lines.
- Land use conflicts: Manufacturers should proactively address and mitigate potential land use conflicts that may arise from the deployment of technological structures, such as wind turbines or solar farms.
- Copyright infringement and counterfeiting: Manufacturers should take steps to prevent and address copyright infringement and counterfeiting resulting from the widespread availability of digital content and its ease of online copying and distribution.
- Data theft: Manufacturers should establish robust security measures to safeguard against intellectual property theft, including trade secrets and proprietary information.
- Data breaches: Manufacturers should prioritize cybersecurity and implement robust measures to protect digital property stored on online platforms, including personal data, financial records, and confidential information.
- Loss of digital assets: Products should include safeguards and recovery mechanisms to prevent the loss of digital property, including domain names and online accounts, due to hacking, identity theft, or technical issues.
- Data corruption and loss: Products should include preventative measures and security protocols to mitigate the risk of data corruption or loss resulting from technological failures or malware attacks.

Harm to social institutions

Economy

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- Job displacement: Manufacturers should actively address the potential for job displacement in various industries resulting from the automation of tasks through technological products, including robotics and artificial intelligence.
- Income inequality: Manufacturers should take measures to prevent the concentration of wealth in the hands of a few individuals as a result of technological advancements. Addressing income inequality is essential to maintain economic stability and promote social cohesion.
- Market disruption: Manufacturers should make efforts to anticipate and address the potential disruption of traditional markets by emerging technology-driven business models.

Political institutions

- Cyberattacks: Products should come with robust security features to prevent their misuse for cyberattacks on political institutions.
- Misinformation and disinformation campaigns: Manufacturers should take measures to combat the spread of misinformation and disinformation through technology, including through and on social media platforms.
- Social fragmentation and political polarization: Products must be designed and developed in such a way that the formation of echo chambers and filter bubbles when using these products is minimized.
- Shift in political power and influence: Products should be designed and marketed in such a way that they do not unduly concentrate political power and influence in large (technology) companies and digital platforms.

Educational institutions

- Digital divide: (digital) Products should be available to all students, in order to bridge the digital divide.
- Altered learning environments: Manufacturers should promote responsible and balanced use of technology in education to prevent an overreliance that may negatively alter traditional teaching methods and the student-teacher relationship.
- Standardized teaching methods: Products used in education should be designed in such a way that they complement rather than replace traditional teaching methods, and can give aid to individual students' needs.

The healthcare system

- Overreliance on automation: Products focusing on automation in healthcare need to be designed in such a way that overuse is prevented, as this may lead to a lack of human oversight.
- Overreliance on remote health products and services: Digital health products and telemedicine services need to complement in-person healthcare, instead of being an alternative to in-person healthcare.
- Medical device vulnerabilities: Medical products need to be protected against cyberattacks, ensuring patient safety.

Media

- Misinformation and 'fake news': (digital) products should address the issue of misinformation and 'fake news', particularly on social media platforms, to prevent the rapid spread of such content.
- Disinformation campaigns: (digital) products should address the issue of disinformation campaigns, particularly on social media platforms, to prevent the rapid spread of such content.
- Online harassment: Products should include features and mechanisms to prevent online harassment and cyberbullying.

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Cultural institutions

- Cultural appropriation and misrepresentation: Manufacturers should establish guidelines and best practices for the creation of digital content and exhibits using technological products, such as digital media and virtual reality, to prevent cultural appropriation and misrepresentation.
- Digital divide and access to cultural institutions: Digital content and online platforms (especially those provided by cultural institutions) need to be designed with accessibility in mind, addressing the potential digital divide that could exclude marginalized communities.
- Preservation challenges: Manufacturers should develop and support digital preservation standards and methods to address the challenges related to the preservation of digital content, particularly cultural artifacts and heritage.
- Commercialization of cultural products: Cultural products should be commercialized in a responsible way, prioritizing conserving cultural authenticity and significance, and ensuring that the pressure for commercial success does not lead to the loss of traditional or indigenous cultural elements.
- Cultural imperialism: Manufacturers should work to prevent cultural imperialism resulting from the dominant presence of specific digital products or platforms, particularly those originating from powerful cultural centers.
- Cultural censorship: Products should be developed in such a way that they respect and promote the authentic representation and free expression of cultural heritage and values, preventing instances of cultural censorship.
- Exploitation and misappropriation of indigenous knowledge: Products should not exploit or misappropriate indigenous knowledge, especially through digital products.

Harm to the provision of basic needs and socio-economic security

- Food: Manufacturers should recognize and respect the right to an adequate and nutritious food supply as a fundamental human right, ensuring that individuals and families do not go hungry and can maintain good health.
- Water and sanitation: Manufacturers should recognize and prioritize that people need to have access to clean, safe drinking water and adequate sanitation facilities, and should prevent the pollution of drinking water.
- Housing and shelter: Manufacturers should prioritize providing secure and adequate housing as a fundamental human need. This not only offers a sense of security but also establishes a stable environment for individuals and families.
- Work: Manufacturers should acknowledge their responsibility, to a certain extent, in ensuring the provision of meaningful and gainful employment, including job security.
- Social services: Manufacturers should recognize the importance of providing access to a comprehensive range of social services, vital for fostering the well-being and inclusion of individuals and communities. These services should encompass support systems such as welfare, counselling, pension, unemployment, and childcare.
- Utilities and infrastructure: Manufacturers should prioritize acknowledging the crucial role of reliable access to essential utilities and well-developed infrastructure in sustaining modern life. This encompasses electricity, transportation, and other basic amenities, all of which underpin economic development and enhance the overall quality of life for individuals and communities.
- Information and communication: Manufacturers should recognize the fundamental importance of providing access to effective information and communication networks in the contemporary world. This involves ensuring reliable internet connectivity, telecommunications, and media outlets to promote the exchange of knowledge and ideas, fostering societal connectivity, and supporting informed decision-making.

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Harm to social cohesion and social stability

- Fragmentation and isolation: Products should be designed and developed in such a way as to mitigate the risk of social fragmentation and isolation, particularly in the digital realm.
- Disinformation and polarization: Products should encompass measures to mitigate the spread of disinformation and polarizing information through digital products, especially via social media and content platforms.
- Disconnect from real-life communities: Products should promote a healthy balance between digital and physical interactions.
- Loss of shared values: Manufacturers should prioritize the development of products and platforms that encourage respectful dialogue and understanding among diverse viewpoints while respecting established social norms and values.

Harm to social relations

- Isolation and disconnection: Products should promote a healthy balance between digital engagement and real-life social interactions.
- Distraction: Products should include features that minimize distractions and support focused interactions.
- Loss of shared experiences: Products and product features should help individuals engage in and cherish shared experiences, even in the presence of digital devices.
- Cyberbullying and online harassment: Products should include features and mechanisms to prevent online harassment and cyberbullying.
- Impoverished communication and miscommunication: Products and communication tools should enhance the quality of (digital) interactions, particularly by addressing the limitations of text-based communication.
- Increasing number of human-machine interactions: Manufacturers should prioritize the design and promotion of products that enhance human-machine interactions without replacing the depth and empathy found in human interactions.
- Harm to the development of communication skills: Manufacturers should prioritize the development of products that support the healthy development of communication skills. This requirement includes creating educational and interactive features that encourage active listening, empathy, and the ability to engage in meaningful face-to-face conversations.
- Depersonalization and dehumanization: (Digital) products should promote personalized and empathetic online interactions, discouraging depersonalization and dehumanization.

Harm to human and civic capabilities

- Decline in critical thinking and problem-solving skills: Manufacturers should avoid creating products that might contribute to the decline in critical thinking and problem-solving skills through exposure to sensationalized or biased media content.
- Decline in emotional intelligence: Products should not facilitate an increase in the decline in emotional intelligence through the incorporation of addictive design features, such as constant notifications.
- Diminished civic knowledge and media literacy: Products should avoid contributing to diminished civic knowledge and media literacy, for example through the dissemination of misinformation and social media algorithms that create echo chambers.
- Erosion of ethical decision-making skills: Manufacturers should avoid creating products that might contribute to the erosion of ethical decision-making skills. This involves steering clear of design features, such as persuasive technologies aimed at maximizing user engagement, that may inadvertently prioritize profit over ethical considerations.
- Reduced learning skills: Products should encourage active engagement and participation to foster the development of effective learning skills, rather than relying on passive consumption of content.

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- Weakened social networking abilities: Products should avoid over-emphasizing online interactions at the expense of face-to-face communication.
- Lack of cultural understanding: Products should refrain from promoting exclusivity or creating digital divides, in order to prevent a lack of cultural understanding, to avoid perpetuating stereotypes, and to prevent inadequately representing diverse cultures.

Reflection Stage 2

Create a list of the design objectives and requirements for your system, the features and functions you intend the system to have when finally deployed in its operational environment.

Now, treat each item of mid-level guidance as a design requirement.

For each item of mid-level guidance, reflect on:

Is this requirement consistent with your design requirements, or is there any potential tension? If so, explain the tension in your own words.

For any potential tensions identified, can you reformulate your design requirement to overcome the tension? State the reformulated requirement here.

If it is not possible to reformulate the requirement to be consistent with the mid-level guidance, it should be abandoned.

Violations and Mitigations

Ethical Criteria

Note that:

- Violations are listed with dash bullet points
    - Mitigations are listed with circular bullet points

Diversity, Equity and Inclusion

Equity:

- (Digital Product) A product might fail to screen out inadvertent historic biases leading to unintended discrimination against protected categories of user or indirect stakeholder.
- A product might fail to accommodate users who are experiencing poverty or homelessness, for example by requiring a fixed address to create an account, requiring a personal rather than a shared device, or simply being unaffordable for core demographics that would stand to benefit from the product, due to commercial decisions.

Diversity:

- (Digital Product) A product that uses video capture might fail to function effectively for all skin tones.
- A product might stigmatise or alienate users of different abilities by unnecessarily highlighting the accommodations that have been made for them.
- A product might that is not consciously designed for gendered use may implicitly assume a male “default user”, meaning the product is less appealing or less effective for users who do not identify as male.

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- A product might fail to represent the diversity of its prospective stakeholder community, for instance by characterising the user as a particular category of person in instructional material or marketing.

Inclusion:

- A product might fail to provide an identical or equivalent user experience for people of all abilities. For instance, accommodations for users of different abilities might make the system less aesthetically or ergonomically appealing.
- A product might fail to make ethically necessary functions (like privacy, security and safety) equally available to all users.
- A product might be fail to include certain users by being unnecessarily complex or counter-intuitive.
- A product might fail to offer multiple sensory modes for the delivery of essential information or user experiences in case modes are unavailable to certain users (verbal, pictorial, tactile).
- A product might fail to provide integrated functionality with devices to support people with sensory or physical limitations, or be poorly adapted for use supported by a personal assistant.
- A product might fail to allow for tolerance for error, through fail-safe features.
- A product might fail to minimize strenuous or potentially physically uncomfortable user interactions.
- A product might fail to include older users by due to small text size which is illegible to users with presbyopia.
    - (Design) At the conceptual design stage, assess potential designs against the Principles for Universal Design. Designers may also wish to refer to the Inclusive Design Toolkit, the Stanford Gendered Innovations page, and the British Standard on Managing Inclusive Design.
    - (Design) At the specification of requirements stage, use participatory design practices to involve stakeholders in the development of the technical specification.
    - (Design; Use) To eliminate bias, ensure data used by the system does not contain any personal information about protected characteristics that is not strictly necessary for the effective operation of the product.
    - (Design) To eliminate bias, during the High-Level Design stage develop a bias Impact Statement
    - (Design) To eliminate bias, in the Detailed Design and Development stage, simulate use by protected groups to test for biases. In the Testing and Evaluation stage, subject the product to rigorous final screening for biases including red teaming.

Safety and Security

Safety:

- (Physical Product) A product might violate safety by contributing to a hazardous situation for its user for instance by obstructing their vision or distracting them during other potentially hazardous tasks.
    - (Use) If using the product could obscure vision or distract the user during other potentially hazardous tasks, ensure that the contexts in which the product is safe to use are clearly described in the supporting literature with which the product is shipped. User research and testing should determine whether it is likely the product will be used outside the primary intended context of use. If the risk of hazardous use is determined to be great, the product should not be launched unless it is possible to build in safeguards.

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- (Physical Product) A product might violate safety by being directly hazardous to the user, either through faults, or through being safe to use in an overly narrow set of use context conditions that are unlikely to be respected by ordinary users.
    - (Design, Use) Product safety must be assessed in all plausible contexts of use, not just those primarily envisaged by the manufacturer. These contexts should be established during the conceptual design phase, and used as a guide when assessing safety during prototyping and pre-market launch.

Security of the person:

- A product might violate security by being capable of being used for military or offensive purposes, or being capable of being used as a component in a military or offensive system, where these uses are not the primary or intended use of the product (dual use).
    - (Design, Deployment) Products and the strategies for distributing them must be compliant with any existing licencing regimes.
    - (Design, Distribution) At the Conceptual Design phase, consideration should be given to whether there is a significant risk of offensive use that would create novel threats. If there is any plausible possibility of offensive use, after a High-Level Design has been developed, that design and plan for distribution should undergo independent assessment for whether the dual-use risk will be adequately mitigated. If it is determined the risk cannot be mitigated, development should not proceed.
- A product might violate security if there is a significant unmitigated risk that it might be misused by malicious actors, for example criminals or authoritarian governments, to cause physical, mental or economic harm, or to violate rights.
    - (Use) In addition to respecting existing regulations export licencing for specified categories of product, for example under the EU Dual Use Regulation, companies should engage with state agencies to ensure the regulatory environment is adequate to prevent the product from being used for criminal purposes or to violate civil and political rights. For instance, dialogue with regulators and professional associations may determine that it is necessary to add new categories of product to existing lists of categories to which export restrictions apply.
- A product might violate safety if there is significant unmitigated risk of it being accessed by children or vulnerable adults who are not competent to use it without significant danger to themselves or others.
    - (Design) If there is significant risk that access to the product by children or vulnerable adults would present a danger to themselves or others, as far as possible, fail-safe mechanisms should be built into the product to prevent access by persons not competent to use it, such as virtual or physical locking mechanisms.
    - (Use) If there is significant risk that access to the product by children or vulnerable adults would present a danger to themselves or others, training materials should be provided with the product to instruct users on best practice for preventing unauthorised access.
    - (Use) If there is significant risk that access to the product by children or vulnerable adults would present a danger to themselves or others, and this risk cannot be adequately mitigated by design interventions and instructional materials, innovation organisations should engage with regulators to ensure regulations are in place to limit access. In this circumstance, the product should not be launched until such regulations are in place.
- A product might violate security by having unintended secondary effects on deployment that cause harm; where these effects have impacts that transcend international borders, this could in extreme case serve as a motive for international conflict.
    - (Design, Deployment) During the High-Level Design phase, an ethics assessment should be carried out by a qualified ethics expert. This assessment should determine whether

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there are plausible scenarios raised either in the expert community or civil society according to which products in this category are at risk of causing significant transboundary impacts. If such scenarios do exist, then the company should cooperate with state agencies, trade bodies, and civil society organisations, to develop a legally binding governance regime to regulate transboundary impacts prior to market launch.

Security of the system:

- (Digital Product) A product might violate security by containing vulnerabilities that enable malicious actors to steal valuable information from the system on which the product is running.
- (Digital Product) A product might violate security by containing vulnerabilities that enable malicious actors to block user access to the system on which the product is running, for example in order to extort a ransom.
- (Digital Product) A product might violate security by containing vulnerabilities that enable malicious actors to cause damage to the system on which the product is running.
- A product might violate security by containing vulnerabilities that enable malicious actors to co-opt the system for illegal or harmful ends.
- A product might violate security by revealing a user's physical location to actors who wish to harm them.
    - (Design) Products should be designed according to Secure by Design Principles, whereby threats of malicious interference are assessed from the Conceptual Design phase onward, and mitigations are as far as possible embedded into the structure of the product and its environment. Reference should be made to field-specific standards on cyber security including the following IEEE standards, ISO 27001-2, the SHERPA guidelines

Fairness and Distributive Justice

Accessibility

- A product that provides an important social good might fail by limiting access to that good on equitable terms, for example by only being marketed in certain regions (urban vs rural, global north vs global south, etc.).
- A product that provides an important social good might fail by rolling out distribution of the good to different regions on drastically different timeframes, meaning that populations that are already comparatively advantaged (urban vs rural, global north vs global south, etc.) are allowed to increase their comparative advantage in the intervening time.
- A product might fail by placing a burden on indirect stakeholders, for example by competing for resources in a way that advantages users at the expense of non-users.
- A product which enables novel forms of access to power or advantage might violate distributive justice by facilitating the rapid exacerbation of existing inequalities in power or advantage, or facilitating the creation inequalities across different dimensions.

    - (Deployment) When developing the business case for the product, assess where the product is most needed, not only where it is can be marketed most profitably. Ensure that the product is deployed accordingly, consistent with commercial necessity.
    - (Deployment) At the Conceptual Design stage, assess whether the product is likely to create inequalities of power between users and non-users. If this threat is assessed as serious, when building a marketing strategy for the product, ensure the product is accessible for consumers in relatively disadvantaged regions at the same time as consumers in relatively advantaged regions. If a just marketing strategy is found to be incompatible with the business case for the product, consider implementing alternative

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models of business organisation, for example by partnering with governments, charities or developing a not-for-profit arm.
    - (Design) During the Detailed Design and Development phase, a Life Cycle Impact Assessment should be completed to assess the impact of the materiality of the product. If supply chains are expected to plan a burden on non-users, first line mitigation should focus redesign of materials.

Avoiding Bias

- A product might fail by relying on existing infrastructure that is itself unfairly distributed, for example by being unavailable in rural areas due to poor internet access. This is especially salient where the product provides a fundamental good like access to medical care.
    - (Deployment) If product provides a fundamental good, but is likely to be unfairly distributed because of existing inequalities with respect to necessary infrastructure, companies should engage with relevant state agencies to promote capacity-building.

Non-discrimination

- (Digital Product) A violation occurs when a product systematically promotes discriminatory user-generated content, for example, a software application that contains an algorithm that tends to increase the visibility of discriminatory content to other users.
- A violation occurs when a product contains features that facilitate discriminatory harassment. For example, a metaverse product might contain standard or custom avatars that reproduce racial stereotypes.

    - (Deployment) If a product contains significant user generated content and therefore has a high risk of discriminatory content, ongoing monitoring is necessary and testing is necessary to ensure such content is not being systematically promoted, either deliberately or in unforeseen ways.
    - (Design) At the Detailed Design and Development and Testing and Evaluation phase, participatory design practices should be used to ensure the product design is guided and tested by representatives of diverse communities.

Human Equality

- (Physical Product) A product might fail by using unfair trade practices in its supply chain.
    - (Design) Assessment of the fairness implications of product materials should be conducted as early as possible in the design process and fair trade practices built into the design of the product.
    - (Deployment) Ensure systems are implemented to prioritise traceability of supply chains on an ongoing basis both pre and post market launch, with the flexibility to modify supply chains if exploitative trade practices are uncovered at any point in the product lifecycle.
- (All categories EXCEPT consumer product) A product might fail by profiting from the exploitation of politically marginalized populations, for example by relying on contracts from state entities that benefit elites at the expense of taxpayers.
    - (Deployment) For infrastructure, healthcare and other products marketed at state agencies, companies should adopt a policy of refraining from sales to nondemocratic states (as measured for instance, by the EIU democracy index) unless there is credible evidence the product will be used for the public good.
- A product which creates access to power or advantage in novel ways might violate distributive justice by rapidly exacerbating existing inequalities in power or advantage or creating inequalities across different dimensions.

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- (Design) (Deployment) During the high-level design phase, an ethical impact assessment should be carried out by an independent ethics expert. This should assess whether the product is likely to rapidly exacerbate existing inequalities in power or advantage across different dimensions. If a product is assessed to be high risk in this respect, companies should engage with industry bodies and state agencies to ensure the regulatory environment is adequate to manage the risk of social upheaval.

Freedom and Autonomy

Freedom of expression

- *A product might violate freedom by providing novel means for governments or other authorities, such as employers, to monitor and control legitimate expression.*
  - (Deployment) In addition to respecting existing regulations on surveillance technologies, for example under the EU Dual Use Regulation, companies should engage with state agencies to ensure the regulatory environment is adequate to prevent the product from being used to violate civil and political rights.

Bodily integrity

- *A product might violate freedom by facilitating torture, cruel or unusual punishment, or execution.*
  - (Design, Deployment) Products which intentionally violate freedom should not be developed.

Freedom of movement and residence

- *A product might violate freedom by facilitating a state or other authority from preventing people from exiting their country of residence or re-entering it having exited.*
  - (Deployment) In addition to respecting existing regulations on surveillance technologies, for example under the EU Dual Use Regulation, companies should engage with state agencies to ensure the regulatory environment is adequate to prevent the product from being used to violate civil and political rights.

Freedom of assembly and association

- *A product might violate freedom by providing novel means for governments or authorities, such as employers, to limit legitimate assembly, for example by surveilling formal or informal civil society groups.*
  - (Deployment) In addition to respecting existing regulations on surveillance technologies, for example under the EU Dual Use Regulation, companies should engage with state agencies to ensure the regulatory environment is adequate to prevent the product from being used to violate civil and political rights.

Individual autonomy and self-determination

- *A product might violate freedom and autonomy by being intentionally designed to intervene in peoples' freedom or self-determination.*
  - (Design, Deployment) Products which intentionally violate freedom should not be developed.
- *A product might violate freedom by containing components that are produced by child labour or forced labour such as debt bondage.*
  - (Design) At the Detailed Design and Development phase, refer to the Design For Freedom toolkit to incorporate safeguards against child labour and forced labour in either the realisation of the product or the manufacture process

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- *A product might violate freedom by being developed from research derived from human trials conducted without prior informed consent.*
    - (Design) Ensure any primary research using human subjects is conducted only with the prior informed consent of those subjects.
    - (Design) Ensure any human subject research data used in product development was obtained only by means of trials conducted with prior informed consent.
- *A product might violate freedom by facilitating infringements of freedom of thought, conscience or religion by governments or authorities, for example by facilitating threats on religious grounds.*
    - (Design) Ensure products do not collect or display data on the political, conscientious, or religious affiliations of users, even with their express consent, unless that data is expressly necessary for the legitimate functioning of the product.
    - (Design) In the Testing and Evaluation phase, ensure that the political, conscientious, or religious affiliations of users cannot be inferred from other public data unless such identification is expressly necessary for the functioning of the product and has user consent.
- *A product might violate freedom by facilitating violations of the right to marry a person of one's choosing, for example by facilitating so-called "honour crimes".*
    - (Design) In the Testing and Evaluation phase, ensure that the political, conscientious, or religious affiliations of users, as well as attributions including caste cannot be inferred from other public data by means of the product, unless such identification is expressly necessary for the functioning of the product and has user content.
- *A product might violate autonomy by facilitating the propagation of false or misleading claims or media representations intended to manipulate behaviour, especially by inciting discrimination, hostility or violence against nations, religious groups or minorities.*
    - (Design) If a product will either be marketed as a trusted information source, will plausibly be used as a trusted information source, or the business case for the product contains the expectation that users will treat it as such, the developer has a responsibility to monitor the extend of dangerous misinformation reproduced via the product and to control its spread. This means features to enable this must be built into the product at the detailed design and development stage.
- *A product might violate autonomy by restricting or heavily influencing a person's access to accurate or balanced information, effectively manipulating them into adopting certain viewpoints, or by restricting their access to accurate counsel and advice services.*
    - (Design, Deployment) Products which intentionally violate autonomy should not be developed.
    - (Design) If a product will either be marketed as a trusted information source, will plausibly be used as a trusted information source, or the business case for the product contains the expectation that users will treat it as such, the developer has a responsibility to promote the dissemination of accurate and balanced information via the product. This responsibility would include, for example, at the Testing and Evaluation phase, testing for biases, either algorithmic or human-caused, in favour of inaccurate information.
- *A product might violate autonomy by facilitating unjustified coercion, for example by enabling employers to apply punitive sanctions to their employees.*
    - (Design, Deployment) Products which intentionally violate autonomy should not be developed.
    - (Design) Developers tasked with creating tools with coercive potential should consider ways of mitigating that potential during the High-Level design stage, for example by making the surveillance capabilities of the product transparent by design to both managers and employees.
- *A product might violate autonomy by being designed or used to create addiction to the system or to the services it provides.*

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- Products intentionally designed to create addition to the system or the services it provides should not be developed.
- If there is a likelihood that the product will be used in a manner that creates addition, the innovation organisation must engage with the relevant field-specific state agencies, or European-level agencies, to ensure that there are adequate licencing regimes and other regulations in place to prevent addictive misuse. For example, it may be necessary to regulate access to the product by children and vulnerable adults.

Privacy

Right to privacy

- (Digital Product) A product might fail by making it more difficult for the user to withdraw consent to the sharing of personal data than it to opt in to sharing it.
  - (Design, Deployment) Products that infringe upon bodily, spatial, proprietary, intellectual, decisional, associational and behavioural privacy, should not be developed.
  - (Design) Products should include protections against acts of (virtual) physical interference, intrusive observation, and intrusive information collection.

Processing of personal data

- (Digital Product) A product might violate privacy by storing or processing personal data without prior informed consent, unless the company is under an overriding legal obligation to process such data, has a legitimate interest in processing such data, processing the data is in the public interest, or is in the vital interest of the data subject.
  - (Design) During the Detailed Design and Development phase, as far as possible, ensure that it is structurally impossible for the product to store or process personal data without prior informed consent.
  - (Design) During the Detailed Design and Development phase, as far as possible, ensure that it is structurally impossible for the product to store or process personal data, even with consent, that is not necessary for the functioning of the product.

- (Digital Product) Privacy may be violated through security weaknesses that result in data breaches, either with or without an intentional attack, leading to unauthorized access, acquisition, or disclosure of personal data.
  - (Design, Deployment, Use) Products must comply with relevant industry standards for data security. Consideration of standards must be implemented from the earliest stage of the design process.

- Privacy may be violated by failing to provide adequate protections against disclosure of personal data through deceptive or manipulative practices, including phishing and social engineering.
  - (Design) Consideration should be given to how to embed protections against deceptive or manipulative practices, including phishing and social engineering at the High-Level Design stage.
  - (Deployment) It is possible the risk of deceptive or manipulative practices, including phishing and social engineering, cannot be adequately mitigated through design. If the risk of such attacks is significant, companies should ensure the product is shipped with, or contains, sufficient supporting guidance to train users in how to guard themselves against the risk of such attacks.

- Privacy may be violated by failing to provide adequate protections against data theft through the deliberate theft of physical or digital devices containing sensitive data.

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- (Design) Consideration should be given to how to embed protections against risk of data breach via physical device theft at the High-Level Design stage, for example, multifactor authentication and remote encryption.
- (Deployment) It is possible the risk of data breach through device theft cannot be adequately mitigated through design. If the risk of such attacks is significant, companies should ensure the product is shipped with, or contains, sufficient supporting guidance to train users in how to guard themselves against the risk of such attacks.

Processing of sensitive data

- (Digital Product) Even with prior informed consent, a product might violate privacy by storing or processing personal data that does not serve the effective functioning of the product, the interest of the user, or the public interest. This is especially relevant for "sensitive data" including health data, biometric data, data about sexual orientation or relationships, membership of trade unions, data revealing racial or ethnic origin, political opinions, or religious or philosophical beliefs. Exceptions may exist for a small number of legitimate interests defined by law, but appeal to these should be minimized.
  - (Design) At the earliest possible stage, ideally at the Pre-Design and Conceptual Design phase, privacy should be embedded into the product by design, with careful consideration given to how to minimise the deliberate collection of sensitive data and the collection of data from which sensitive data could be inferred
  - (Design, Deployment) Products that deliberately collect unnecessary sensitive data should not be developed.

Entities with a private character

- A product might violate privacy by facilitating arbitrary interference, either by a state or a third party, with personal communications, family life or matters which may affect a person's reputation but which there is no public interest in revealing. This may include for instance, publishing, publicizing or collecting personal information without consent, surveilling private residences, or publicly broadcasting a person's image without their consent. Unconsented collection of personal data may be carried out though video recording, audio recording, photography, sensors, keystroke monitoring, biometric collection, among other methods.
  - (Design, Deployment) Products which intentionally violate privacy should not be developed
  - (Design, Deployment) Manufacturers should demonstrate good faith with respect to both legally binding privacy regulations, and non-binding ethical best practice, by building features to facilitate audits for privacy violations into the design.

Purpose-specific consent

- (Digital Product) A product might fail by failing to notify a user consenting to data sharing to the identity of the data controller and how the data will be used, or by allowing use of such data by persons or for functions other than those stated.
  - (Design, Deployment) Data sharing with third parties must always be subject to informed consent.
  - (Design, Deployment) Data segregation policies should be implemented ideally by independent specialists and should be subject to periodic internal and external audits, both pre and post-market launch.

Responsibility and Accountability

Definite responsibilities

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- A violation occurs if a "responsibility gap" emerges. This is when a lack of clarity regarding the responsibilities of various stakeholders allows domains of operation of the product system for which no one is *de facto* responsible, or for which there is an insufficient level of oversight, imposing risks on the wider public.
    - Comprehensive frameworks and protocols for product responsibility, accountability and liability should be put in place before a product is marketed. These should define the responsibilities of producers, as well as of users and other stakeholders.
- Violations may occur through a failure to design for post-market launch monitoring of a product for risks or defects and the ability to mitigate them.
    - (Design, Deployment) During the Detailed Design and Development phase, ensure that a plan for post-market surveillance is developed. During the Testing and Evaluation phase, ensure that the plan is validated through adequate testing, for example through simulation exercises.
    - (Deployment) The deployment process should involve risk assessment; procedures for mitigation after deployment should be in place as soon as the system is deployed.

- Violations might occur if a practice of high-risk off-label use or use other than intended occurs.
    - (Design, Deployment) During the High-Level Design phase, an assessment should be carried out by an independent advisor with the necessary field specific expertise as to whether a licensing regime is required to regulate the product. If necessary, deployment should be paused until a licencing regime is in place.

Precaution

- Violations may occur if a product introduces or creates the potential for irreversible changes to the physical or social environment in which the product is deployed (for example, geophysical changes, ecological changes or large-scale economic disruption), unless subject to appropriate, field-specific democratic governance.
    - (Deployment) At the High-Level Design phase, an independent ethics assessment should be made as to whether there is a need for formal governance in the field, and to assess the adequacy of industry led moves towards such regimes. If a movement towards governance among either industry bodies or civil society organisations is identified, the developer should work with industry bodies, state agencies, and other companies in the field negotiate a timetable for governance implementation. This should include consideration of a negotiated pause in development until such regimes can be agreed.
- Violations may occur if a product creates risks (including risks whose size cannot be easily estimated) when the public benefit it creates is not significant.
    - (Design) As early as possible, ideally in the Pre-Design and Conceptual Design phases, consider whether developing a risky product is justified at all, if the prospective benefits are not significant. It may be impossible to integrate ethical criteria with the business case for the product.

Transparency

- Violations may occur through undermining the capacity for individuals' or corporations to be held accountable for their actions, for example by obfuscating information that would inform audits or traceability of outcomes arising from the system.
- Violations may occur through undermining the capacity for individuals' or corporations to be held accountable for their actions, for example by concealing harmful impacts.
    - (Design) Ensure transparency, including traceability and auditability, is embedded in the design from the outset. This means giving transparency consideration ideally at the Pre-Design and Conceptual Design phase.

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- Violations may occur through undermining the capacity for individuals' or corporations to be held accountable for their actions by obfuscating cause-effect relationships involving the product, for instance by making it difficult to determine whether an accident was the result of malfunction, user error, or some other cause.
- Violations may occur if a product misrepresents the nature of the function it is providing to the user, for example by impersonating a human interlocutor, or allowing users to confuse real and artificially generated features of an environment.
    - (Use) In addition to ensuring transparency is embedded in the design from the earliest possible stages, use context interventions may also be necessary. These could include, for instance, instructions using language that avoids anthropomorphising the product, or instructions that clearly set boundaries for the contexts in which the product may safely be used.

- A product might fail by misrepresenting the effectiveness of the function it provides. If a product is intended to increase safety or augment personal abilities, this might encourage increased unjustified risk-taking among users.
    - If a product is intended to increase safety, including by carrying out diagnostic functions, or augment personal abilities, it is important that its level of functionality is accurately represented throughout the project lifecycle. This would include prior to market launch, for instance in any public-facing promotional materials aimed at generating capital investment or pre-orders, and post-market launch in marketing materials.

Social Criteria

Harmful environmental impact

Disposal and End-of-Life

- (deployment) A product might cause environmental harm by releasing hazardous materials during disposal, as seen in the case of old electronic devices, or the use of plastic.
    - Manufacturers should take into account that products need to be recycled after they have broken down or are no longer used by consumers, and should offer ways to recycle the product to prevent a negative impact on the environment. Possibly, this can include recalling the product and offering recycling services themselves (a product take-back program).
    - Where possible, closed-loop systems should be implemented to allow for the recovery and recycling of materials from disposed products.
- (design) A product might cause environmental harm if the disposal possible recycling options are not already taken into account in the design phase, for example by not designing for replacing parts of the products when these are broken.
    - At the design stage, manufacturers should take into account that the product needs to be able to be recycled easily to prevent a negative environmental impact. Refer to the ***ISO 14001 standard on environmental management*** (specifically the sections on disposal, end-of-life, and recycling).

Energy efficiency in product manufacturing and use

- (design) Products might cause environmental harm by consuming excessive energy during their manufacturing process, such as in the case of aluminum production.
- (design, manufacturing) Products might cause environmental harm by requiring energy-intensive materials in their production, like cement.

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- (use) Products might cause environmental harm by relying on energy-inefficient transportation during its production process.
- (design) Products might cause environmental harm by generating high levels of waste and pollution during their manufacturing, as in the case of the textile industry.
    - Products should be designed and manufactured in such a way that energy is used efficiently. Field-specific standards on energy efficiency or general guidelines such as the ***ISO 500001 standard on energy management*** can provide helpful insights.
    - Manufactures should educate consumers about the environmental impact of products and encourage responsible consumption and recycling.

Resource depletion

- (design, manufacturing) A product might cause environmental harm by depleting finite natural resources, such as in the case of petroleum-based plastics.
- (design, use) A product might cause environmental harm by requiring the use of scarce resources in order to operate.
- (design, disposal) A product might cause environmental harm if it is not possible to recycle the different components of the product, for example when the product is designed in such a way to prevent users from repairing or taking apart the product themselves.
    - Conduct a Life Cycle Assessment to identify and analyze the resources needed for a product, as well as the environmental impact of that product, and use the results from this assessment to prioritize areas for improvement, or determine where replacements can be made with less negative environmental impact.
    - Prioritize the use of renewable, recyclable, and biodegradable materials in product design.

Air and water pollution

- A product might cause environmental harm by emitting pollutants such as carbon monoxide, nitrogen oxides, and particulate matter, contributing to air pollution.
    - Install and regularly maintain emission control systems to capture and reduce air pollutants released during manufacturing and use.
- A product might cause environmental harm by releasing contaminants into water bodies, causing water pollution.
    - Consider using closed-loop water systems to recirculate and reuse water in manufacturing processes, reducing the demand for fresh water and minimizing wastewater generation.
- A product might cause environmental harm by releasing hazardous substances like lead and mercury into the environment during manufacturing and disposal, impacting both air and water quality.
    - Implement an environmental management system, such as ***ISO 14001***, to systematically manage and improve environmental performance.
- A product might cause environmental harm by contributing to indoor air pollution and contaminating water bodies through wastewater runoff when household cleaning products are used and disposed of improperly.
    - Replace or reduce the use of hazardous substances with safer alternatives for the use of consumers, to avoid polluting wastewater runoff from non-commercial sources.
    - Choose, where possible, materials that have minimal environmental impact when they are used.

Eutrophication

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- A product might cause environmental harm by promoting eutrophication when excessive use of chemical fertilizers in agriculture leads to runoff that carries nutrient pollutants into nearby water bodies, stimulating the overgrowth of algae and degrading water quality.
- A product might cause environmental harm by contributing to eutrophication when poorly treated sewage from households and industrial facilities discharges excess nutrients into aquatic ecosystems, causing the proliferation of harmful algal blooms and oxygen depletion.
- A product might cause environmental harm by accelerating eutrophication through the release of phosphorus and nitrogen in detergents and cleaning products, which can enter waterways via wastewater, exacerbating nutrient enrichment and the consequent ecological imbalances in aquatic environments.
    - Implement an environmental management system, such as ***ISO 14001***, to systematically manage and improve environmental performance.
    - Choose, where possible, materials that have minimal environmental impact when they are used.

Plastic waste

- A product might cause environmental harm by contributing to plastic waste when single-use plastic packaging is used, leading to the generation of non-biodegradable waste that can persist in the environment, harming wildlife and ecosystems.
    - Utilize biodegradable plastics that break down more easily in the environment and ensure that biodegradable plastics are compatible with existing waste management systems.
    - Minimize packing materials and adopt eco-friendly alternatives to plastic packaging, and explore innovative packaging designs that require less plastic without compromising product safety.
- A product might cause environmental harm by promoting plastic waste when disposable plastic products, such as cutlery and straws, are produced and discarded, adding to the accumulation of plastic debris in landfills and oceans.
    - Replace one-use disposable plastic products by encouraging the adoption of reusable alternatives, such as refillable containers or bulk options.
- A product might cause environmental harm by increasing plastic waste when microplastics, often released by products like personal care items containing microbeads, enter water bodies, posing a threat to aquatic life and potentially entering the food chain.
    - Adopt alternative materials that do not contribute to microplastic pollution or substitute microplastic ingredients, such as microbeads in personal care products, with natural or biodegradable alternatives.

Noise and light pollution

- Products might cause environmental harm by contributing to light pollution. For instance, poorly designed outdoor lighting fixtures, such as bright and unshielded streetlights or floodlights, can emit excessive light into the night sky.
- Products might cause environmental harm by contributing to light pollution in marine ecosystems. For instance, fishing vessels equipped with bright and uncontrolled deck lighting can disrupt the natural behaviors of marine animals like sea turtles and seabirds.
    - Implement smart lighting controls that allow for dimming and adjusting light levels based on ambient conditions or user preferences, or use shields, reflectors, or other design elements to focus light where it is needed.
    - Where possible, choose warm-colored lighting options, as they tend to have less impact on the night sky than cooler-colored lights.

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- Products might cause environmental harm by generating noise pollution; for example, gas-powered leaf blowers commonly used for landscaping. These machines produce high levels of noise, disturbing both wildlife and human communities.
    - Incorporate sound-absorbing materials and design features to reduce noise emissions during manufacturing and product operation.
    - Engage with local communities to address concerns related to noise pollution, and communicate proactively about the steps being taken to minimize noise pollution.

Habitat fragmentation

- Products might cause environmental harm by contributing to habitat fragmentation through infrastructure development.
- Products might cause environmental harm by promoting urban sprawl and suburban development.
    - Conduct biodiversity impact assessment during the product development phase to identify potential habitat fragmentation risks, and integrate the findings into design decisions to mitigate negative effects on local ecosystems.

Deforestation

- Products might cause environmental harm by driving deforestation for the production of consumer products or food. For example, the production of palm oil or soybeans has led to the clearing of vast tracts of tropical rainforests.
    - Source raw materials from sustainable and certified forestry practices, such as those certified by the ***Forest Stewardship Council (FSC)*** or other recognized standards, and establish responsible sourcing policies to avoid contributing to deforestation.
    - Minimize the use of paper and wood through digital alternatives, reduced packaging, and efficient use of materials.
    - Conduct thorough impact assessments before establishing new facilities or expanding existing ones to prevent inadvertent contributions to deforestation, and implement responsible land use planning to avoid the conversion of natural forests into agricultural or industrial areas.

Harm to property

Product malfunctions

- Products might cause harm to property by malfunctioning and, for example starting a fire, as seen with faulty electrical appliances.
- Products might cause harm to property by leaking harmful substances, such as a defective washing machine that leaks water and damages flooring or nearby possessions.
    - Manufacturers should implement quality assurance processes throughout manufacturing, and conduct regular inspections and testing to ensure that products meet or exceed quality standards.
    - Products should be accompanied by clear and comprehensive user manuals and instructions to guide consumers in the proper use and maintenance of the product.
    - Proactive recall and repair programmes should be set up to address any identified product malfunctions promptly.

Theft and cybercrime

- Products might cause harm to property by enabling theft through weak digital security, as exemplified by smart home devices like vulnerable smart locks.
- Products might cause harm to property by being used as tools for cybercrime, such as compromised Internet of Things (IoT) devices.

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- Secure coding practices should be implemented to minimize vulnerabilities, and software should be regularly updated to address bugs, security vulnerabilities, and to improve overall performance.
- Devices that collect, use, and protect data should come with clearly communicated privacy policies and user agreements for users.

Vandalism and damage

- Products might cause harm to public property by enabling vandalism, as exemplified by the use of spray paint cans.
- Products might cause harm to public property by facilitating destruction, as seen with the use of heavy construction equipment left unattended or accessible.
  - Incorporate tamper-resistant features into products to make it more difficult to manipulate or damage products.
  - Include information on the proper use of the product with the product packaging, to discourage vandalism.

Cyberattacks on (digital) infrastructure

- Malicious software targeting critical infrastructure systems, such as power grids or transportation networks, can contribute to harm to public property by disrupting essential services and compromising the functionality of key facilities.
  - Conduct regular security audits and vulnerability assessments to identify and address potential weaknesses in the software, to decrease the potential damage of malicious software.

Unauthorized use and access

- Products might cause harm to public property by enabling unauthorized access, as seen with the use of drones flying over restricted areas.
- Unauthorized use of shared mobility services, like electric scooters or bicycles, can contribute to harm to public property by causing congestion, accidents, and damage to urban infrastructure.
  - Incorporate protective features into public infrastructure to minimize vulnerabilities, and collaborate with local communities, law enforcement, and neighbourhood watch programs to identify possible weaknesses.
  - Implement access controls in products that are meant to be shared by the community, to ensure that they are used properly and not used without authorization.

Environmental damage

- Products might cause harm to real property by releasing harmful pollutants into the environment, as exemplified by the use of lead-based paints.
  - Explore and adopt alternative materials that have a lower environmental footprint, such as recycled, upcycled, or bio-based materials.
  - Invest in technologies that reduce water consumption and minimize water pollution.
  - Design products with a focus on circular economy principles; promoting repair, reuse and recycling. Additionally, ensure that the products can be disassembled to facilitate the recycling of components and materials.

Structural damage

- Products might cause harm to property by contributing to structural damage through water leakage, as seen with the use of low-quality or improperly installed roofing materials.

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- Products might cause harm to property by accelerating structural decay through the use of corrosive construction materials, such as certain types of pressure-treated wood.
    - Conduct thorough structural analysis and, where possible, testing to ensure that products meet or exceed safety standards, including when they are being used by consumers.
    - Choose high-quality and durable materials that are appropriate for the intended use and environmental conditions, and also use these materials for repairs if necessary.

Land use conflicts

- Products might cause harm to property by leading to land use conflicts due to visual intrusion, as seen with the installation of large billboards near residential areas.
- Products might cause harm to property by sparking land use conflicts when the extraction of natural resources disrupts local communities, as in the case of hydraulic fracturing (fracking) operations.
    - Conduct thorough and continuous environmental impact assessments to identify and mitigate potential harm to the land and local communities using the land.
    - Collaborate with local communities on the use of land, and ensure that agreements are made on the use of land.

Copyright infringement and counterfeiting

- Products might cause harm to intellectual property by facilitating unauthorized distribution of copyrighted digital media, as seen with peer-to-peer file-sharing software.
- Products might cause harm to intellectual property by promoting the sale of counterfeit physical goods, such as fake designer handbags or counterfeit DVDs.
    - Provide information and education on the importance of respecting intellectual property.
    - Where possible, minimize the options consumers have to infringe on copyright by implementing access controls.

Data theft

- Products might cause harm to intellectual property by enabling data theft, as seen with vulnerable Internet of Things (IoT) devices.
- Products might cause harm to intellectual property by facilitating data breaches through unsecured software applications. For instance, using outdated or inadequately protected office software can expose businesses to data breaches.
    - Use encryption protocols to protect sensitive data during transmission and storage.
    - Conduct regular code reviews and security audits to identify and address potential security flaws.

Data breaches

- Cloud storage services with insufficient encryption protocols may contribute to harm to digital property by exposing stored data to unauthorized access, potentially leading to corporate espionage or intellectual property theft.
- Inadequately secured IoT devices collecting personal information may contribute to harm to digital property by providing entry points for cybercriminals to orchestrate large-scale data breaches.
    - Use encrypted communication channels for sensitive information, both within organisations and external partners.
    - Conduct regular security audits and vulnerability assessments to identify and address potential weaknesses in data storage and engage third-party cybersecurity experts to perform penetration testing to uncover potential threats.

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Loss of digital assets

- Products might cause harm to digital property by facilitating data loss through unreliable storage devices, such as faulty external hard drives.
    - Implement regular and secure data backups to ensure quick recovery in the event of data loss or loss of digital assets. Store these backups in offsite locations to protect against physical damage or theft.

Data corruption and loss

- Products might cause harm to digital property by enabling data loss through insecure cloud storage services. If a cloud storage service lacks proper security measures, it can become vulnerable to hacking or data breaches.
    - Implement regular and secure data backups to ensure quick recovery in the event of data loss or loss of digital assets. Store these backups in offsite locations to protect against physical damage or theft.

Harm to social institutions

The economy

Job displacement

- Products might cause harm to the economy by contributing to job displacement through automation and technological advancements. For instance, the widespread adoption of automated assembly line robots in manufacturing industries can lead to a reduction in the need for manual labor.
    - Collaborate with labor unions to create agreements and frameworks that address job displacement concerns, and initiate conversations to mitigate the negative effects of job displacement.

Income inequality

- Products might cause harm to the economy by exacerbating income inequality through pricing and access disparities.
    - Offer affordable product variants to ensure accessibility to a wider range of consumers, irrespective of income levels.

Market disruption

- Products might cause harm to the economy by disrupting existing markets and displacing traditional businesses. For example, the widespread adoption of e-commerce platforms and online marketplaces can lead to a decline in brick-and-mortar retail stores.
    - Invest in programs that offer reskilling and upskilling of workers affected by market disruptions.
    - Conduct impact assessments to determine where products might cause the most harm to the economy, and determine how this could be mitigated.

Political institutions

Cyberattacks

- Products might cause harm to political institutions by enabling cyberattacks that compromise the integrity of elections and disrupt democratic processes. For instance, the use of vulnerable electronic voting machines can be exploited by hackers to manipulate election results.
    - Implement and enforce strict cybersecurity standards for products used in election processes, including electronic voting machines.

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- Conduct regular security audits and testing of election-related products to identify and address potential vulnerabilities. This includes ensuring that election-related products receive regular updates to address known vulnerabilities.

Misinformation and disinformation campaigns

- Products might cause harm to political institutions by facilitating the spread of misinformation and disinformation campaigns. For example, social media platforms that allow for the rapid dissemination of false or misleading information can be exploited by malicious actors to manipulate public opinion.
  - Implement and strengthen content moderation and fact-checking mechanisms on social media platforms and other information-sharing products. Refer for example to the ***EU Code of Practice on Disinformation***.
  - Implement educational campaigns to enhance user awareness and media literacy, helping individuals critically evaluate information and identify misinformation.
  - Encourage responsible user behavior by promoting ethical information-sharing practices.

Social fragmentation and political polarization

- Messaging apps that enable the rapid dissemination of politically charged content without proper fact-checking may contribute to the spread of false narratives and increasing political polarization.
  - Implement and strengthen content moderation and fact-checking mechanisms on social media platforms and other information-sharing products. Refer for example to the ***EU Code of Practice on Disinformation***.
- Online forums and echo-chamber communities that reinforce extreme political beliefs may contribute to harm to political institutions by isolating individuals from diverse perspectives, hindering constructive political discourse, and fostering a fragmented political landscape.
  - Encourage a diverse range of information sources to reduce dependence on single platforms and ensure that algorithms provide content from diverse perspectives.

Shift in political power and influence

- A product might harm political institutions by utilizing algorithms to prioritize specific political viewpoints or content from media conglomerates, therefore influencing public opinion in favor of those perspectives.
- A digital platform might harm political institutions by engaging in anti-competitive practices, favoring large companies by providing them with preferential treatment, better visibility, or unfair advantages over smaller businesses.
  - Ensure equal opportunities on online platforms for businesses of all sizes and establish and enforce policies that promote fair competition.

Educational institutions

Digital divide

- Products might cause harm to educational institutions by exacerbating the digital divide through the lack of access to affordable and reliable internet connections.
  - Develop and distribute educational content that can also be accessed offline, reducing the reliance on constant internet connectivity for learning.
  - Support community-driven initiatives to establish public WiFi hotspots in areas with limited internet access.
- Products might cause harm to educational institutions if (digital) educational products are available only to a limited number of students.

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- Implement programs to distribute affordable computing devices to students and educators, ensuring that a lack of hardware is not a barrier for accessing (online) educational resources.

Altered learning environments

- Products might cause harm to learning environments if they rely solely on technology without incorporating the importance of human interaction.
  - Implement hybrid learning models that blend technology-based tools with traditional classroom interactions.
  - Provide training and professional development opportunities for educators to effectively integrate technology into their teaching methods while emphasizing the importance of human interaction.

Standardized teaching methods

- Products might cause harm to educational institutions by perpetuating standardized teaching methods that do not account for individualized learning needs. For example, educational software that focuses solely on standardized test preparation may limit educators' ability to tailor instruction to students' unique strengths and weaknesses, potentially hindering their overall academic development.
  - Implement options in educational products and platforms that support personalized learning experiences, allowing educators to tailor content and activities to individual students.
  - Provide continuous professional development opportunities for educators to enhance their skills in implementing personalized teaching methods.
  - Implement learning analytics tools that provide insights into individual student progress, enabling educators to identify areas of strength and weakness.
- Products might cause harm to educational institutions if they prioritize superficial engagement and memorization over fostering critical thinking and deeper understanding.
  - Integrate ***project-based learning approaches*** that require students to apply knowledge in real-world scenarios, fostering a deeper understanding of concepts.

The healthcare system

Overreliance on automation

- Products might cause harm to the healthcare system by leading to an overreliance on automation, potentially affecting patient care and outcomes. For example, the use of automated diagnosis software in medical facilities may reduce the time healthcare professionals spend directly engaging with patients.
  - Design products and systems that facilitate collaboration between healthcare professionals and automation, ensuring that technology enhances human decision-making rather than replacing it.
  - Emphasize the importance of regular, meaningful interactions between healthcare professionals and patients, even when automation is integrated into the diagnostic process.

Overreliance on remote health products and services

- Products might cause harm to the healthcare system by fostering an overreliance on remote health products, potentially leading to gaps in patient care.
  - Provide comprehensive education to patients about the capabilities and limitations of remote health products, to ensure that they can make informed decisions about their healthcare.

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- To avoid undermining the effectiveness of preventive measures and interventions, (remote) health products should be integrated into traditional healthcare practices.
    - Establish protocols for regular monitoring and follow-ups, ensuring that both patients and practitioners using remote health tools are able to communicate and adjust their care where necessary.
    - Incorporate healthcare professional oversight into the use of remote health products, allowing for expert guidance and intervention when needed.

Medical device vulnerabilities

- Products might cause harm to the healthcare system by exposing vulnerabilities in medical devices, potentially jeopardizing patient safety and data security.
    - Integrate security measures into the design and development process of medical devices from the outset, following ***security-by-design principles***.
    - Conduct regular security audits and testing of medical devices to identify and address vulnerabilities.

Media

Misinformation and 'fake news'

- Digital products which prioritize sensational content and engagement over accuracy can inaccurately amplify misinformation and 'fake news'.
- Products might cause harm to the media by providing tools spread misinformation and fake news.
    - Integrate robust fact-checking mechanisms within media platforms to verify the accuracy of information before dissemination.
    - Establish user-friendly systems for flagging and reporting misleading content, encouraging community participation in content moderation.

Disinformation campaigns

- Design features in certain (digital) products, such as clickbait articles or deceptive user interfaces, can encourage the rapid spread of false information online.
    - Introduce user-friendly mechanisms for reporting deceptive content and providing feedback on misleading design features.
    - Enforce and periodically update platform policies to explicitly prohibit deceptive design practices, including clickbait and misleading user interfaces.

Online harassment

- Products can contribute to an increase in online harassment and cyberbullying if people can communicate anonymously, without further accountability.
- Inadequate privacy settings and security measures in products may lead to the unauthorized sharing of personal data, exposing users to harassment and cyberbullying.
- Digital products without moderation may enable users to send harmful messages and cyberbully others, fostering a toxic online environment.
- Products might cause harm to the media through online harassment by providing tools for malicious users to target and threaten journalists or media organizations.
    - Establish anonymous reporting systems on online platforms to allow users to report incidents of harassment without fear of retaliation.
    - Engage community moderators to actively monitor and address instances of cyberbullying on social media platforms and online communities.
    - Establish and communicate clear guidelines that explicitly prohibit cyberbullying and define consequences for violations.

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- Provide resources and support networks for individuals who experience cyberbullying, including counselling services and helplines.

Cultural institutions

Cultural appropriation and misrepresentation

- Products might cause harm to cultural institutions through cultural appropriation and misrepresentation by perpetuating harmful stereotypes and taking elements of a culture out of context. For example, fashion brands that produce clothing or accessories featuring sacred symbols or designs from indigenous cultures, without proper cultural understanding or consent.
- Digital products, such as filters or virtual accessories, that trivialize sacred cultural practices or traditional attire without genuine understanding can perpetuate cultural appropriation.
    - Provide cultural sensitivity training for designers, product developers, and other stakeholders involved in the creation of products.
    - Seek guidance from cultural experts, representatives, or elders when incorporating elements from a specific culture.

Digital divide and access to cultural institutions

- Products can cause harm when they limit access to those unable to afford or use the necessary technology, as can be the case when cultural institutions focus on digital exhibits or require visitors to use a smartphone to access information.
    - Adopt a user-centric approach to ensure products are accessible to diverse user groups, including those with disabilities, and work together with stakeholders to continuously update and improve these (digital) products.
    - Where possible, ensure that products can be adapted to varying user needs, by for example ensuring that there are several different options for getting access to information.
    - Design products in compliance with accessibility standards, such as the ***Web Content Accessibility Guidelines (WCAG)***.

Preservation challenges

- Online marketplaces for cultural artifacts and antiquities without stringent authentication measures can exacerbate preservation challenges by facilitating the illicit trade of valuable cultural items.
    - Enforce stringent authentication measures for cultural artifacts listed on online marketplaces, including comprehensive documentation, provenance verification, and expert evaluations.
    - Develop red flag indicators for online platforms, identifying characteristics of potentially illicit transactions or artifacts.
- Digital products that do not adhere to international standards for metadata and archival practices may contribute to preservation challenges by creating fragmented and incompatible digital collections.
    - Provide education and training programs for digital content creators, archivists, and preservationists on the importance of adhering to international metadata standards.
    - Implement quality assurance processes to verify the accuracy and completeness of metadata, identifying and rectifying inconsistencies.

Commercialization of cultural products

- Products might cause harm to cultural institutions by commercializing cultural products in a way that diminishes the cultural and historical significance of those items. For example, the

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mass production and sale of traditional indigenous crafts as tourist souvenirs can dilute the cultural and artistic value of these items.

- Educate consumers about the cultural and historical significance of products, encouraging them to make informed and respectful purchasing decisions.
- Limit mass production of cultural products to prevent oversaturation in the market, maintaining the uniqueness and value of each item.
- Develop and adhere to cultural protocols that guide the production, marketing, and sale of cultural products, respecting the wishes and values of the cultural community.
- Establish revenue-sharing agreements or community benefit programs to ensure that a portion of the profits from the sale of cultural products directly benefits the communities of origin.

Cultural imperialism

- (digital) products that prioritize Western-centric content and design principles can (inadvertently) contribute to cultural imperialism by marginalizing and overshadowing diverse cultural perspectives.
  - Conduct extensive user research that includes diverse demographics and cultural groups to understand their preferences, needs, and values.
- Standardization of user interfaces in software products without customization options for diverse linguistic and cultural preferences may perpetuate cultural imperialism by imposing a dominant cultural framework.
  - Embrace inclusive design principles that prioritize accessibility and consider the needs and preferences of users from different cultural backgrounds.

Cultural censorship

- (digital) products that prioritize Western-centric content and design principles can (inadvertently) contribute to cultural imperialism by marginalizing and overshadowing diverse cultural perspectives.
  - Embrace inclusive design principles that prioritize accessibility and consider the needs and preferences of users from different cultural backgrounds.
- (digital) products and services that heavily edit or restrict content based on cultural sensitivities without considering diverse perspectives may contribute to cultural censorship by homogenizing the representation of narratives.
  - Conduct cultural impact assessments during the design process to evaluate how products may influence or be perceived by different cultural groups.
  - Emphasize the importance of understanding the contextual nuances of content, taking into account historical, cultural, and social factors.

Exploitation and misappropriation of indigenous knowledge

- Products that are marketed as an immersive journey into indigenous rituals or that claim to offer indigenous wisdom, such as video games or e-books, can misappropriate indigenous knowledge if these practices are oversimplified or distorted, contributing to misrepresentation.
  - Engage in meaningful collaboration with indigenous communities, knowledge holders, and cultural experts throughout the development process, and continually update knowledge where necessary.
  - Seek informed consent from indigenous communities before incorporating their rituals or wisdom into digital products, ensuring that the portrayal aligns with their cultural values.

Harm to the provision of basic needs and socio-economic security

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Food

- Products that are not labelled accurately or provide misleading nutritional information on product labels can lead to uninformed choices about the nutritional value of the food people consume.
    - Encourage or require third-party certification for nutritional information. Independent organizations can verify and validate the accuracy of product labels.
    - Launch public awareness campaigns to educate consumers about reading and understanding food labels. Provide resources to help individuals make informed choices.
    - Advocate for clear and standardized labeling formats that highlight key nutritional information. Use easy-to-understand symbols or color-coded systems.
- Food products that include excessive amounts of unhealthy additives, preservatives, or artificial ingredients can compromise the nutritional quality of the food.
    - Reformulate products by reducing the use of unhealthy additives and replacing them with healthier alternatives.
    - Launch educational campaigns to raise public awareness about the health risks associated with excessive additives and artificial ingredients. Provide information on making healthier food choices.
- Food products that are priced unrealistically – especially essential and nutritious food items – can become unaffordable for certain populations and can hinder access to a balanced diet.
    - Support and promote local and community agriculture initiatives to increase the availability of affordable, fresh, and nutritious produce.
- A violation occurs if a product system in deployment, including its supply chains, undermines food security for any community, in particular marginalized communities and global south communities.
    - (Design) from the initial Pre-design and Conceptual Design phases, and throughout the development process, ensure consideration is given to the effects of scaling up deployment of the product. If deployment of the product or the product category at large scale can be anticipated to place pressures on global supply chains in a way that could food security – for instance through increasing demand for biofuels - consider ways of modifying the functionality or material of the product to minimise impacts of scaling.
    - (Deployment) If there is judged to be a likelihood that scaling of deployment will impact on food security via supply chains, innovation organisations should seek to foster cooperation with state and international agencies to mitigate this likelihood through new regulation.

Water and sanitation

- Water purification devices or systems that fail to effectively remove contaminants can provide a false sense of security and can potentially allow unsafe water to be consumed.
    - Encourage or mandate independent third-party certification and testing of water purification devices to verify their effectiveness in contaminant removal.
    - Provide clear guidelines on the regular maintenance and replacement of purification device components to ensure continued effectiveness.
- Products or technologies that contribute to poorly designed wastewater treatment systems can lead to the release of untreated or inadequately treated wastewater into water sources.
    - Conduct independent audits and inspections of wastewater treatment systems to ensure compliance with established regulations and identify areas for improvement.
    - Adopt integrated water resource management approaches that consider the entire water cycle, emphasizing the sustainable use and treatment of water resources.

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- A violation occurs if a product system in deployment, including its supply chains, undermines the secure access to water of any community, in particular marginalised communities and global south communities.
    - (Design) from the initial Pre-design and Conceptual Design phases, and throughout the development process, ensure consideration is given to the effects of scaling up deployment of the product. If deployment of the product or the product category at large scale can be anticipated to place pressures on global supply chains in a way that could harm water security – for instance through increasing demand for biofuels - consider ways of modifying the functionality or material of the product minimise impacts of scaling.
    - (Deployment) If there is judged to be a likelihood that scaling of deployment will impact on water security via supply chains, innovation organisations should seek to foster cooperation with state and international agencies to mitigate this likelihood through new regulation.

Housing and shelter

- Products or housing where substandard or unsafe building materials are used can compromise the structural integrity and put residents at risk.
    - Invest in research and development to identify and promote innovative, safe, and sustainable building materials as alternatives to substandard options.
    - Promote transparency in the supply chain by requiring builders and manufacturers to disclose the sources and specifications of construction materials.
    - Conduct regular inspections and oversight of construction projects to ensure compliance with building codes and material standards.
- Housing products that lack proper insulation and energy-efficient features can lead to increased energy consumption, discomfort, and higher utility costs for residents.
    - Encourage the integration of renewable energy sources, such as solar panels or wind turbines, in housing designs to further reduce energy consumption.
    - Encourage or mandate green building certifications, such as LEED (Leadership in Energy and Environmental Design), for housing products that meet specific energy-efficiency and sustainability criteria.

Work

- Products incorporating automation technologies can lead to mass unemployment without adequate plans for job transitions and support for affected workers.
    - Develop and implement comprehensive workforce planning strategies that anticipate the impact of automation on employment and proactively address potential job displacements.
    - Establish skill development and training programs to equip workers with the skills needed for roles that complement or emerge from automation technologies.

Social services

- Products manufactured under exploitative labor practices, such as low wages and poor working conditions, can lead to increased reliance on social services by workers.
    - Promote supply chain transparency, requiring partners to disclose information about their supply chains and the labor conditions of workers at every stage.
    - Support and promote certification and labeling programs that identify products manufactured under fair labor conditions.
- Products or technologies that contribute to stress, burnout, or mental health issues in the workplace can increase the need for mental health services.

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    - Integrate automation features to streamline repetitive or time-consuming tasks, allowing employees to focus on more meaningful and complex aspects of their work.
    - If performance monitoring features are included, ensure they are designed with sensitivity to avoid creating a stressful surveillance environment.
- Products or technologies that contribute to the digital divide by excluding certain populations from accessing online services may limit their access to essential social services.
    - Offer digital literacy training programs to empower individuals with the skills needed to navigate online services, use digital tools, and understand online information.
    - Design user interfaces that are intuitive and accessible, catering to diverse user needs, including those with limited digital literacy.

Utilities and infrastructure

- Products that are not environmentally sustainable can lead to resource depletion, which in turn can affect access to essential utilities.
    - Conduct comprehensive environmental impact assessments during the product development phase to identify and address potential resource depletion and environmental harm.

Information and communication

- Products can contribute to the digital divide by excluding certain groups from accessing reliable internet connectivity and information.
    - Support community Wi-Fi projects that provide free or low-cost internet access in public spaces, community centers, and underserved neighborhoods.
    - Establish public computer centers equipped with internet-connected devices, providing access to those without personal devices or reliable connectivity at home.
- Products should be readily available for different population groups; not only in densely populated areas while rural or remote areas cannot access the products.
    - Develop strategic distribution networks that prioritize reaching both urban and rural areas, ensuring products are accessible across diverse geographical settings.
    - Collaborate with local businesses in rural or remote areas to serve as distribution points or retail partners, leveraging existing networks and knowledge of the local market.

Harm to social cohesion and social stability

Fragmentation and isolation

- (digital) Products might cause harm to social cohesion by fostering social fragmentation through excessive use of social media platforms.
- Products might cause harm to social stability by promoting isolation through the proliferation of virtual reality (VR) and augmented reality (AR) technologies.
    - Explore the integration of AR features that blend physical and digital experiences, encouraging users to interact both in the virtual and real worlds.
- Products working with content recommendation algorithms may contribute to fragmentation to tailoring content to individual tastes, potentially isolating users from broader cultural and societal narratives.
    - Integrate algorithms that prioritize diverse content recommendations to expose users to a variety of perspectives, cultures, and interests.
    - Include information on the benefits of exploring content outside of their usual preferences.

Disinformation and polarization

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- (digital) Products might cause harm to social cohesion by facilitating the spread of disinformation and polarization, exemplified by social media platforms that allow the rapid dissemination of fake news and extreme views.
    - Create, support, and/or promote media literacy programs that educate users on critical evaluation of misinformation, recognizing misinformation, and understanding the implications of media consumption. Refer for example to the ***Audiovisual Media Services Directive*** from the European Union.
- (digital) products working with content recommendation algorithms (for example in news apps) that reinforce existing user preferences may contribute to disinformation and polarization by limiting exposure to diverse perspectives and alternative viewpoints.
    - Integrate algorithms that prioritize diverse content recommendations to expose users to a variety of perspectives, cultures, and interests.
    - Include information on the benefits of exploring content outside of their usual preferences.
    - Implement measures to detect and mitigate algorithmic biases that may contribute to fragmentation or exclusion.

Disconnect from real-life communities

- Products might cause harm to social cohesion by fostering a disconnect from real-life communities, as observed with the widespread use of personal electronic devices and social media.
- Virtual reality (VR) technologies that offer immersive online experiences at the expense of physical presence in local communities may contribute to harm to social cohesion by detaching individuals from these communities.
    - Explore the integration of AR features that blend physical and digital experiences, encouraging users to interact both in the virtual and real worlds.
    - Implement features that suggest real-life connections based on shared interests, locations, or activities, and facilitate introductions and interactions between users who may share interests.
- Remote work tools that eliminate the need for physical office spaces and in-person collaboration can contribute to harm to social cohesion by reducing the sense of community within workplaces.
    - Implement features that allow colleagues to schedule virtual coffee breaks or informal meetings, fostering social interaction and team bonding, for example through an online 'common room'.
- Online (dating) apps that emphasize virtual connections without facilitating meaningful real-world interactions can contribute to harm to social cohesion by perpetuating a culture of superficial relationships.
    - Integrate event calendars or platforms that allow users to discover and attend social events, fostering opportunities for real-world interactions.
    - Design features that prompt and facilitate meaningful conversations, encouraging users to share more about their interests, values, and life experiences.

Harm to social relations

Isolation and disconnection

- Social media platforms that prioritize online connections at the expense of face-to-face communication can contribute to harm to social relations by fostering a sense of disconnection and weakening interpersonal bonds.
    - Ensure that (digital) products or digital platforms include a space for (offline) local events, activities, and community initiatives.

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- Virtual reality (gaming) platforms that encourage prolonged solo engagement can contribute to harm to social relations by diverting individuals from in-person interactions and shared activities.
    - Explore the integration of AR features that blend physical and digital experiences, encouraging users to interact both in the virtual and real worlds.
    - Implement features that suggest real-life connections based on shared interests, locations, or activities, and facilitate introductions and interactions between users who may share interests.

Distraction

- Products with constant connectivity features can contribute to harm to social relations by blurring the boundaries between work and personal life, leading to increased distraction and reduced quality time spent with loved ones.
- Smartphone applications that promote constant notifications and interruptions may contribute to harm to social relations by diverting individuals' attention during in-person interactions, leading to a sense of disconnection.
    - Products should include features that allow users to set weekly or daily limits on the time spent with these products. Additionally, optional reminders or notifications can be included to encourage users to take a break from digital engagement.

Loss of shared experiences

- Virtual reality (VR) entertainment platforms that prioritize solitary immersive experiences may contribute to harm to social relations by diminishing opportunities for shared real-world activities among friends or family.
- E-learning platforms that replace traditional classroom interactions with isolated online learning experiences may contribute to harm to social relations by reducing the shared educational journey and interpersonal connections among students.
    - Combine online education platforms with real-life activities, for example combining theoretical material with in-class experiments.
- Social media algorithms that curate personalized content may contribute to harm to social relations by creating online bubbles, limiting the sharing of common experiences and discussions within larger communities.
    - Implement features that suggest real-life connections based on shared interests, locations, or activities, and facilitate introductions and interactions between users who may share interests.

Cyberbullying and online harassment

- Social media platforms that inadequately address cyberbullying and harassment may contribute to harm to social relations by fostering a hostile online environment that deters open and respectful communication.
- Anonymous messaging apps that allow unchecked bullying and harassment can contribute to harm to social relations by creating a platform for toxic behavior without accountability.
- Dating apps that lack robust safety features may contribute to harm to social relations by exposing users to cyberbullying and harassment, eroding trust in online dating communities.
    - Implement clear and user-friendly reporting mechanisms for inappropriate content or abusive behavior.
    - Integrate educational pop-ups or notifications that inform users about the consequences of cyberbullying and online harassment, to make people aware of what can be shared on a particular online platform.
    - Clearly communicate community guidelines and policies that explicitly prohibit cyberbullying and online harassment.

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    - Provide users with easy-to-use blocking features to control their interactions and mitigate harassment.

Impoverished communication and miscommunication

- Text-based communication apps that lack non-verbal cues and facial expressions may contribute to harm to social relations by limiting the emotional richness of interactions.
    - Allow users to incorporate multimedia elements such as images, videos, and GIFs into their messages.
- Automated customer service chatbots that fail to comprehend complex queries may contribute to harm to social relations by frustrating users and diminishing the quality of communication between businesses and customers.
    - Provide users with the option to escalate to human customer support when the chatbot is unable to address complex queries satisfactorily.
    - Clearly communicate the chatbot's capabilities and limitations upfront, managing user expectations regarding the types of queries it can handle.
- Products such as language translation tools that do not capture cultural nuances may facilitate misunderstandings in cross-cultural interactions.
    - Implement contextual analysis specifically for phrases, idioms, and expressions with cultural significance, ensuring accurate translation.

Increasing number of human-machine interactions

- Social robots designed for companionship that replace human interaction may contribute to harm to social relations by potentially isolating individuals from meaningful connections with other people.
    - Emphasize in the design and marketing of social robots that their role is supplementary and supportive, not a replacement for human interaction.
    - Conduct regular surveys to gather user feedback on their social experiences and the impact of social robots on their social lives.
- Automated communication tools in workplaces that replace face-to-face interactions may contribute to harm to social relations by fostering a sense of isolation among employees and reducing opportunities for team building and collaboration.
    - Actively encourage face-to-face interactions by organizing regular team meetings, events, and workshops.
    - Encourage scheduled breaks for informal chats and social interactions, recreating the spontaneous conversations that occur in physical workplaces.
    - Implement digital wellness initiatives that emphasize the importance of taking breaks, avoiding constant connectivity, and maintaining a healthy work-life balance.

Harm to the development of communication skills

- Educational products or software that rely heavily on automated feedback without encouraging human interaction may negatively impact students' communicational development.
    - Incorporate synchronous communication tools like chat, video conferencing, or discussion forums to enable real-time interaction between students and educators.
    - Include collaborative projects that necessitate teamwork and communication, promoting skills essential for real-world scenarios.
- Social media platforms that prioritize visual content over textual communication may contribute to harm to social relations by reducing the emphasis on written expression.
    - Introduce features that enable users to tell stories through text, fostering a culture that values narrative and written expression.

Depersonalization and dehumanization

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- Online gaming environments that permit toxic behavior and harassment may foster dehumanization, where individuals are reduced to usernames and subjected to harmful treatment without real-world consequences.
    - Implement effective reporting systems that allow players to easily report toxic behavior. Enforce strong moderation to review and address reported incidents promptly.
    - Apply in-game consequences for toxic behavior, such as temporary bans, loss of privileges, or restricted access to certain features.
    - Implement regular surveys or feedback mechanisms to gather insights from the gaming community regarding their experiences and suggestions for improving the gaming environment.
- Social media algorithms that prioritize engagement metrics over individual expression may dehumanize users, reducing them to data points, and fostering a competitive environment for attention.
    - Increase transparency in algorithmic decision-making by providing users with insights into how content is prioritized and explaining the factors considered.
- Automated customer service systems that replace human representatives may contribute to harm to social relations by depersonalizing interactions and creating a sense of detachment between businesses and customers.
    - Clearly communicate when customers are interacting with automated systems. Set transparent expectations about the role of automation and the availability of human representatives if needed.
    - Establish feedback mechanisms that allow customers to provide input on their experiences with automated systems. Use this feedback to continuously refine and improve the automation.

Harm to human and civic capabilities

Decline in critical thinking and problem-solving skills

- Products might cause harm to critical thinking and problem-solving skills by fostering information bubbles.
- Products might cause harm to critical thinking and problem-solving skills by promoting clickbait and sensationalism.
    - Develop comprehensive user training programs that emphasize critical thinking and problem-solving skills related to product use and provide materials that encourage the user to engage with the product thoughtfully.
    - Collaborate with stakeholders (for example from educational institutions) to include ways to develop cognitive skills in (educational) products.
    - Incorporate interactive design features in products that encourage users to think critically about their choices.
    - Explore the use of VR and AR technologies to create immersive learning experiences that require critical thinking and problem-solving. (digital product)

Decline in emotional intelligence

- Products might cause harm to emotional intelligence by fostering cyberbullying and toxic online environments.
    - Conduct user research, including interviews and observations, to gain insights into user emotions and experiences.
    - Establish feedback loops that allow users to share their emotional responses and experiences with products, and use these to improve the product.

Diminished civic knowledge and media literacy

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- Products might cause harm to civic knowledge and media literacy by facilitating the rapid spread of misinformation and disinformation.
    - Create, support, and/or promote media literacy programs that educate users on critical evaluation of misinformation, recognizing misinformation, and understanding the implications of media consumption. Refer for example to the ***Audiovisual Media Services Directive*** from the European Union.
    - When working with information processing, ensure that it is clearly communicated how information is sourced, verified, and presented.
    - Integrate fact-checking features within digital platforms or products to empower users to verify information.

Manufacturers should avoid creating products that might contribute to the erosion of ethical decision-making skills. This involves steering clear of design features, such as persuasive technologies aimed at maximizing user engagement, that may inadvertently prioritize profit over ethical considerations.

- Products might cause harm to ethical decision-making skills by promoting deceptive design practices and manipulative features.
    - Ensure that products meet ethical design guidelines. The ***IEEE Ethically Aligned Design*** can provide important input.
    - Do not employ tactics that force users into opting in for features or services without clear and informed consent.

Reduced learning skills

- Products might cause harm to learning skills by fostering passive consumption overactive engagement.
- Products might cause harm to learning skills by promoting gamification without substantive educational content.
    - Combine online education platforms with real-life activities, for example combining theoretical material with in-class experiments.

Weakened social networking abilities

- Products might cause harm to social networking abilities by prioritizing quantity over quality in online interactions.
    - Avoid overemphasizing superficial metrics such as the number of connections or likes in user profiles.
- Products might cause harm to social networking abilities by fostering addictive design patterns. Apps or platforms that employ features such as infinite scrolling, constant notifications, and other addictive elements can contribute to weakened social networking abilities.
    - Provide users with control over their experience by allowing them to customize notification settings, control the frequency of updates, and opt-out of certain addictive features.

Lack of cultural understanding

- Products might cause harm to cultural understanding by perpetuating stereotypes and cultural misrepresentations. For instance, a video-sharing app featuring content that reinforces stereotypes or misrepresents cultural practices may perpetuate ignorance and hinder genuine cross-cultural appreciation.
- Products might cause harm to cultural understanding by facilitating digital divides and exclusivity. For example, an algorithm-driven news feed that predominantly shows content aligned with users' existing beliefs may create divides.

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- Work together with stakeholders to correctly identify cultural nuances in marketing materials and product design to avoid unintentional emotional impact.
- Implement cultural sensitivity training for marketing, design, and customer services teams.

Reflection Stage 3

- For each of the violations listed, reflect on whether the system under consideration could be developed, deployed or used in a way that violated the mid-level guideline in this way. In your own words, explain how.
- For each mid-level guideline, are there ways in which your system could violate this guideline that are not listed? In your own words, state them here.
- For each violation identified as possible, including violations just added, state whether you would assess a violation of this kind as a) **an unacceptable impact**, b) **a significantly detrimental impact** or c) a **mildly detrimental impact** *if it occurred.*

An impact is **unacceptable** if any of the below conditions hold:

The impact is both significant and has transboundary (international) scope, the impact would constitute a violation of human rights, the impact would violate statutes, the impact involves significant novel dual use risk, the impact would be irreversible, the impact involves the cognitive behavioural manipulation of people or specific vulnerable groups including children, the impact involves 'social scoring', the impact involves real-time and remote biometric identification systems.

An impact is **significantly detrimental** if any of the below conditions hold, but none of the conditions for unacceptable impacts holds:

the impact would represent a significant cost in terms of individual wellbeing, the impact does not itself constitute a rights violation but makes it more difficult for such violations to be identified, the impact would represent a serious threat to social cohesion, or the impact relates to any of the following - biometric identification and classification of natural persons, management and operation of critical infrastructure, access to essential services and benefits including healthcare, migration, or the application of the law.

An impact is **mildly detrimental** if none of the conditions for seriously detrimental impacts or moderately detrimental impacts hold, and the impact is intuitively mild, comparable to commonplace acceptable risks associated with extant systems. If there is any doubt about the severity of possible impacts, the user should err on the side of caution and classify the violation as moderately or seriously detrimental.

Reflection Stage 4

For each for each violation identified as possible, note the relevant mitigations. For each of these mitigations, state:

- Have you implemented, or do you plan to implement, a mitigation of this kind? State what concrete steps you have taken, or plan to take.
- Are the mitigations listed adequate for each violation, including any violations added at Reflection Stage 3? What further mitigation actions are needed?

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Next, assess the adequacy of all planned or implemented mitigations, including those just added:

- Do any of the violations of the mid-level guidelines remain **likely**? Give details here.
- Do any violations remain **plausibly foreseeable**? Give details here.

A violation is **likely** if: the user makes an intuitive assessment that the chance of the violation occurring on upon the full operational deployment of the product in its final state is high, for instance because there is an clear causal connection between the product's design, deployment strategy or anticipated product environment, and the violation in question.

A violation is **plausibly foreseeable** if: there is a known mechanism in the technical literature according to which deployment of the product could trigger the impact in question, and that mechanism has not been positively determined to have been ruled out, via technical testing and evaluation.

- If violations of mid-level guidelines remain **plausibly foreseeable** or **likely** after mitigations have been taken into account, were any of these identified as **unacceptable impacts**? If you answer yes, follow the instructions for go to *Further Mitigations Required*, below.
- If violations of mid-level guidelines remain **likely** after mitigations have been taken into account, were any of these identified as **significantly detrimental impacts**? If you answer yes, follow the instructions for *Further Mitigations Required*, below.
- If any violations remain **likely** after mitigations have been taken into account, but these were identified as **mildly detrimental impacts**, go to *Proceed with Caution*, below.
- If any violations remain **plausibly foreseeable** after mitigations have been taken into account, and these were identified as **significantly detrimental impacts**, go to *Proceed with Caution*, below.

If all potential violations were judged to have been adequately mitigated, or potential violations were judged to be *both* mild *and* only plausibly foreseeable, but *not* likely, self-assessment indicates the Societal Readiness Level is currently assessed to be safe to proceed towards launch. Self-assessment is a reiterative process, regular reassessment is advised.

Further Mitigations Required:

- If it is not possible to mitigate impacts through either modification of the design, modification of the deployment strategy, or interventions in the context of use, companies must urgently cooperate with regulators to ensure the regulatory environment is ready respond to remaining risks. Engagement with regulators may be done via professional associations for the specific field.
- Only when relevant agencies are *positively* satisfied that remaining risks have been adequately mitigated should development proceed towards launch.
- In the case of **unacceptable impacts**, relevant agencies must be satisfied the risk has been eliminated. In the case of **significantly detrimental impacts**, relevant agencies must be satisfied that the balance of benefits and risks is acceptable, taking into account the baseline scenario in which the product is not deployed, and any risks associated with non-deployment.
- Systems for post-launch monitoring of impacts are essential.
- Care should be taken to ensure any impacts associated with deployment are reversible.

Proceed with Caution:

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