IEEE Standard Model Process for Addressing Ethical Concerns during System Design

IEEE Computer Society

Developed by the
Systems and Software Engineering Standards Committee

IEEE Std 7000™-2021

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Developed by the

Systems and Software Engineering Standards Committee
of the
IEEE Computer Society

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Abstract: A set of processes by which organizations can include consideration of ethical values throughout the stages of concept exploration and development is established by this standard. Management and engineering in transparent communication with selected stakeholders for ethical values elicitation and prioritization is supported by this standard, involving traceability of ethical values through an operational concept, value propositions, and value dispositions in the system design. Processes that provide for traceability of ethical values in the concept of operations, ethical requirements, and ethical risk-based design are described in the standard. All sizes and types of organizations using their own life cycle models are relevant to this standard.

Keywords: case for ethics, concept of operations, ethical value requirements, ethical values elicitation, ethically aligned design, IEEE 7000™, software engineering, system engineering, value-based requirements, value prioritization

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Introduction

This introduction is not part of IEEE Std 7000™-2021, IEEE Standard Model Process for Addressing Ethical Concerns during System Design.

Organizations are becoming increasingly aware of the need to demonstrate socially responsible behavior when dealing with stakeholders, customers, regulators, and society in general. Socially responsible organizations recognize that their decisions and actions affect not just their financial bottom line but also society and the environment. One of the principles of social responsibility is ethical behavior.

Engineers, their managers, and other stakeholders benefit from well-defined processes for considering ethical issues along with the usual concerns of system performance and functionality early in the system life cycle. Consumers can be unaware of the ethical considerations regarding the products and services they use; it is only by rigorously examining ethical concerns that manufacturers, engineers, and technologists can align products and services with the results valued by acquirers, consumers, and users.

This standard aims to support organizations in creating ethical value through system design. Creating ethical value is a vision for organizations that recognizes their central role in society as shapers of well-being and carriers of societal progress that benefits humanity. Implementing IEEE Std 7000 can help them to strengthen their value proposition and avoid value harms. It is applicable to all kinds of products and services, including artificial intelligence (AI) systems.

IEEE Std 7000 is recommended for use by organizations engaged in concept exploration, requirements definition, or development of new or revised products or services. The standard requires consideration of values relevant to the culture where the system is to be deployed. It is applicable with any life cycle model or development methodology. IEEE Std 7000 is designed to work for all sizes and types of organizations (e.g., large, small, for profit, non-profit) aiming to deliver products that enable the ethical values of their customers and their own organization. The standard can help organizations to build better products with a more refined and nuanced value proposition and with less risk. This standard can be more easily applied in the context of organizational policies that are consistent with the organization's ethical values, such as the following:

- Readiness to include a wide group of stakeholders in the engineering effort
- An open, transparent, and inclusive project culture
- A commitment to quality
- A dedication to ethical values from the top of the organization
- A commitment to allocate sufficient time and resources for ethical requirements definition

IEEE Std 7000 is most effectively applied when organizational leaders and top management are involved in and assume responsibility for the products and services created. Through key roles defined for IEEE Std 7000 project teams, this standard seeks to help align management and engineering activities with stakeholder expectations for ethical values in the operational concept, value propositions, and design features being developed.

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IEEE Standard Model Process for Addressing Ethical Concerns during System Design

1. Overview

1.1 Scope

The standard establishes a set of processes by which engineers and technologists can include consideration of ethical values throughout the stages of concept exploration and development, which encompass system initiation, analysis, and design. This standard provides engineers and technologists with an implementable process aligning innovation management processes, system design approaches, and software engineering methods to help address ethical concerns or risks during system design.

IEEE Std 7000™ does not give specific guidance on the design of algorithms to apply ethical values such as fairness and privacy.

1.2 Purpose

The goal of this standard is to enable organizations to design systems with explicit consideration of individual and societal ethical values, such as transparency, sustainability, privacy, fairness, and accountability, as well as values typically considered in system engineering, such as efficiency and effectiveness.

Projects conforming to IEEE Std 7000 balance management commitments for time and budget constraints with the long-term values of social responsiveness and accountability. To enable this, the commitment of top executives to establish and uphold organizational values is important.

NOTE—A system is sometimes considered as a product or as the services it provides.[1]

1.3 Applicability and constraints

To reach its goal, this standard primarily supports organizations to identify stakeholder values and to engage in value-based system or service development. It is applicable within any life cycle model or set of methods for systems and software engineering. If organizations have running systems that cause ethical challenges, then the processes in this standard can be used for reiteration of value-based analysis.

[1]Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

The processes in this standard apply during system conception and design for organizations seeking to uncover, address and monitor value concerns for a system intended for a given context. When organizations use IEEE Std 7000, it is the respective project teams, stakeholder groups, and organizational leaders who determine the values that a system is supposed to address and sustain. The use of IEEE Std 7000 cannot guarantee that the system as designed and subsequently built is ethical, because the ethicality achieved in a system depends on the moral capabilities and choices of those who use the standard and the commitment of the organization offering the system to adhere to the recommendations made as a result of ethically aligned design as stated in the remainder of this clause.

This standard has a number of limitations to its scope, as stated in the remainder of this clause.

Some human values required of systems have been extensively treated in other standards (e.g., health, security, and safety) and are not further detailed in this standard on ethical values. Aesthetic characteristics (such as color or form) are in scope where they reflect social or cultural characteristics with ethical impact.

NOTE 1—The ISO/IEEE 11073 family of health informatic standards specifies numerous engineering solutions for interoperability of health information. The IEEE publishes many safety-related standards and codes, e.g., for electrical safety, nuclear power plant safety. In the area of systems and software engineering, IEEE Std 1228-1994 [B23][2] can be consulted. The ISO/IEC 27000 family of standards includes close to a hundred standards on information security techniques, including privacy engineering.

The processes described in this standard do not prescribe what is ethical and what is unethical. While the standard is intended to be consistent with the IEEE Code of Ethics [B24], it does not provide ethical guidance for individual engineers in their personal ethical judgements regarding their professional work or specific rights or wrongs, nor advice to whistleblowers on how to address ethical lapses in an organization. As further discussed in C.4, the IEEE code of ethics (one example of professional ethics) has general applicability, but no specific requirements for applying ethical values in system design.

This standard does not prescribe any specific organizational ethical policies. Organizations also commonly develop ethical principles related directly to workplace ethics, consistent with legal and regulatory employment requirements. This standard focuses rather on how to operationalize ethical values that are commonly at stake in technology design and deployment. The use of IEEE Std 7000 does not imply that an organization following its processes is ethical in all other aspects of its mission, product or service development, or discharge of its social responsibility. However, adoption and implementation of ethical value processes in the design and deployment of new products and services or modification of existing legacy systems are illustrative of an organization that is cognizant of its social responsibility and the impact of its endeavors on the values of its stakeholders.

IEEE Std 7000 allows organizations to make their value choices transparent to anyone who uses the system as well as to auditors, potential certifiers, or governmental agencies. Moreover, IEEE Std 7000 provides processes for organizations that assume accountability for the ethical decisions they take. This standard helps organizations in the following:

— Understanding and anticipating value implications and consequences of their systems and taking investment decisions based on them
— Identifying ethical value requirements (EVR) and priorities for system design to be integrated into system requirements
— Choosing system design alternatives according to value priorities while avoiding or mitigating value harms or ethical pitfalls
— Keeping control of the long-term value-based sustainability of a system through ongoing supervision and information management
— Creating transparency and responsibility for the choices made and the system's resulting functionality

[2]The numbers in brackets correspond to those of the bibliography in Annex J.

This standard is most applicable to organizations that are building a system for a known context or at least known typical use cases for the products, services, and systems they build.

NOTE 2—IEEE Std 7000 does not challenge the ethicality of fundamental research.

1.4 Process overview

This standard can also be applied during the enhancements or modifications of existing legacy systems. The enhancements and modifications to products, services, and systems can adopt and conform with the requirements depicted in this standard. For example, it can be used by a device manufacturer building a care robot for a nursing home. It can be used for an artificial intelligence (AI) chat system that is employed in a specific use context, such as medical advice, teaching a language, or recommending music. This standard can be less usable for building a generic product, service, or system for which the deployment context is indefinite, such as a generic camera system or a computer chip usable in multiple ways. This standard can be more effective in specific application of products, services, and systems where the context of application and the stakeholder impact is discernible and amenable to clearer specification and analysis.

This document establishes a set of processes for organizations and projects that address the ethical values of software-based systems (and services) during design and development. The processes can be aligned with any system or software engineering methods, life cycle model, and engineering management style that an organization or project uses for design and development. The processes can be used for new design and development and for improvement of the ethical attributes of existing systems. Systems of interest are not limited to particular industries, sectors, applications, or system sizes. The processes can be used by organizations of all types and sizes, including small and innovative organizations.

Engineers, technologists, and other project stakeholders need a methodology for identifying, analyzing, and reconciling ethical concerns of end users and other stakeholders at the beginning of systems and software life cycles. The processes in this standard enable the pragmatic application of this type of value-based system design methodology. This standard provides engineers, technologists, and other members of the organization with implementable processes aligning innovation management processes, IT system design approaches, and software engineering methods to address ethical concerns in their systems that can affect their organizations, stakeholders, and end users. The processes of IEEE Std 7000 provide organizations with ethical requirements and design activities that enable systems engineering to support human wellbeing. By positively addressing the values of direct and indirect system stakeholders, organizations can attain more than mere legal compliance. They can attain ethical practices that engage with the original spirit of laws, human rights, or other social values in the specific context of a system's use as detailed further in 5.7.

Figure 1 illustrates the processes presented in this standard. These processes occur during the concept exploration and development stages of the product life cycle and are detailed in Clause 7 through Clause 11 of this standard.

The importance of considering potential values and harms during concept exploration and development of the concept of operations (ConOps) sets the context for the remaining processes. This process supports initial identification of values and an extensive feasibility analysis, which can help to refine the ConOps as well as anticipate value-based system requirements.

During the Ethical Values Elicitation and Prioritization Process, a wide range of stakeholders identify potential positive and negative system consequences, stakeholder virtues, and ethical duties that are impacted by the system concept. These are typically expressed by stakeholders in unstructured form (e.g., in terms of harms and benefits) but have underlying values that people care about. Consequences, virtues, and duties are identified with the help of ethical theories; specifically, utilitarianism, virtue ethics, and duty ethics, along with other culturally appropriate value systems or ethical theories. Values are prioritized with the help of an activity where the top management of an organization evaluates the importance of the value to the system of interest

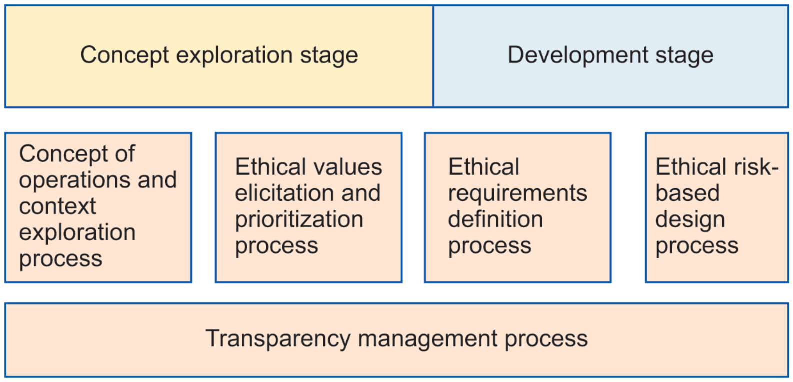

Figure 1—Relationship of processes and stages in IEEE Std 7000

(SOI). Once values are identified and prioritized, they are scrutinized again with a view to potential legal expectations and internationally applied ethical guidelines. The result is a list of value priorities for the system.

These value priorities are then analyzed more systematically and conceptually as the basis for the Ethical Requirements Definition Process, which generates EVR and value-based system requirements.

IEEE Std 7000 is compatible with many existing development practices, including iterative and incremental life-cycle models and agile methods. The Ethical Risk-Based Design Process translates value-based requirements into design characteristics and determines controls that can mitigate risks to values. Controls are system requirements or organizational policies and procedures. As EVRs are instantiated in the system design, the value dispositions are validated for incorporation of the specified values.

The value-based engineering processes include Transparency Management, based on the Information Management process of ISO/IEC/IEEE 12207:2017 [B40] and ISO/IEC/IEEE 15288:2015 [B41]. In this standard, the Transparency Management Process is refined to consider the special requirements of value-based engineering in communicating more openly with relevant stakeholders.

In this standard, the focus on concept analysis, requirements engineering, risk-based design, validation, and monitoring of a product's design, characterize it as deeply embedded into system engineering thinking. Its alignment with established system engineering processes is indicated in Annex A; the relationship of processes in IEEE Std 7000 and in ISO/IEC/IEEE 12207:2017 [B40] and ISO/IEC/IEEE 15288:2015 [B41]. Those standards provide processes without the special focus on ethical values.

1.5 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (shall equals is required to).[3,4]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred, but not necessarily required (should equals is recommended that).

The word *may* is used to indicate a course of action permissible within the limits of the standard (may equals is permitted to).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (can equals is able to).

[3] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.
[4] The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

2. Normative references

This standard has no normative references.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this standard, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause. [5]

NOTE—For additional terms and definitions in the field of systems and software engineering, see ISO/IEC/IEEE 24765 [B45], which is published periodically as a "snapshot" of the SEVOCAB (Systems and Software Engineering Vocabulary) database and is publicly accessible at <computer.org/sevocab>.

acquirer: Stakeholder that acquires or procures a product or service from a supplier.

NOTE—Other terms commonly used for an acquirer are buyer, customer, owner, purchaser, or internal/organizational sponsor.

acquisition: Process of obtaining a product, service, or system.

activity: Set of cohesive and purposeful tasks of a process.

agreement: Mutual acknowledgment of terms and conditions under which a working relationship is conducted. *Example:* Contract, memorandum of agreement.

architecture: <system> Fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution (ISO/IEC/IEEE 42010:2011 [B49]).

audit: Independent examination of a work product or set of work products to assess compliance with specifications, standards, contractual agreements, or other criteria (ISO/IEC/IEEE15288:2015 [B41]).

NOTE—The scope includes professional and industry codes of practice.

benefit: Positive outcome that is voluntarily or involuntarily created by a system or process.

NOTE—Benefits correspond to one or more underlying desired values.

concept of operations (ConOps): Verbal and/or graphic statement, in broad outline, of an organization's assumptions or intent in regard to an operation or series of operations (ISO/IEC/IEEE15288:2015 [B41]).

NOTE—The concept of operations ConOps frequently is embodied in long-range strategic plans and annual operational plans. In the latter case, the ConOps in the plan covers a series of connected operations to be carried out simultaneously or in succession. The concept is designed to give an overall picture of the organization operations. *See also:* **operational concept**.

concern: <system> Interest in a system relevant to one or more of its stakeholders (ISO/IEC/IEEE 42010:2011 [B49]).

NOTE—Concern pertains to any influence on a system in its environment, including developmental, technological, business, operational, organizational, political, economic, legal, regulatory, ecological, and social influences.

[5] *IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

consumer: Individual member of the general public purchasing or using products for private purposes (IEC/IEEE 82079:1:2019 [B22]).

context of use: Intended operational environment for a system.

NOTE 1—The environment determines the setting and circumstances of all influences upon a system, including not only other systems, but also people, settings, social, and ecological factors.

NOTE 2—Context of use can be captured using a Context of Use Description (ISO/IEC 25063.3 [B35]).

control: Ability to determine the nature, sequence and/or consequences of technical and operational settings, behavior, specific events, and/or experiences.

NOTE—Control includes cognitive control (that is, being informed about activities), decisional control (having choices over actions), and behavioral control (receiving feedback from actions).

core value: A value that is identified as central in the context of a system of interest.

NOTE—A core value is at the center of a value cluster of instrumental or related values and value demonstrators. A core value is a positive value. Typically, a system of interest (SoS) has several core values.

customer: Organization or person that receives a product or service (ISO/IEC/IEEE12207:2017 [B40]). *Example:* Consumer, client, user, acquirer, buyer, or purchaser.

NOTE—A customer can be internal or external to the organization.

dependability: Ability of a system to perform as and when required.

NOTE—A measure of a system's availability, reliability, and maintainability.

design: (verb) <process> To define the architecture, elements, interfaces, and other characteristics of a product, service or system, or system element (ISO/IEC/IEEE15288:2015 [B41]). (noun) Result of the design process (ISO/IEC/IEEE15288:2015 [B41]).

design characteristic: Design attributes or distinguishing features that pertain to a measurable description of a product or service (ISO/IEC/IEEE15288:2015 [B41]).

duty: Obligation or expectation to perform a specific action when certain circumstances occur.

duty ethics/deontology: Ethical theory that identifies universal moral laws to bound the actions of all rational individuals.

enabling system: System that supports a system of interest during its life cycle stages but does not necessarily contribute directly to its function during operation. *Example:* When a system of interest enters the production stage, a production-enabling system is required.

NOTE—Each enabling system has a life cycle of its own. Each enabling system can, in its own right, be treated as a system of interest.

environment: <system> Context determining the setting and circumstances of all influences upon a system (ISO/IEC/IEEE 42010:2011 [B49]).

NOTE—Also applies to products and services.

ethical: Supporting the realization of positive values or the reduction of negative values.

NOTE—A system can be ethical or unethical in the sense that it bears value dispositions to cater to positive value creation or negative value prohibition.

ethical policy statement: A high-level declaration endorsed by the top management to explain and demonstrate the organization's commitment to respect core values in the conduct of its activities.

ethical principle: Shared proposition about ethical values that members of a community can pursue and uphold.

ethical requirement: Requirement that is either an ethical value requirement (EVR) or a value-based system requirement.

ethical risk: A risk to ethical values.

ethical value: Value in the context of human culture that supports a judgment on what is right or wrong.

NOTE—A virtue is an example of an ethical value.

ethical value requirement (EVR): Organizational or technical requirement catering to values that stakeholders and conceptual value analysis identified as relevant for the SOI.

ethics: Branch of knowledge or theory that investigates the correct reasons for thinking that this or that is right.

NOTE—Ethics are guidelines for conduct that help people in making a judgment about what is right or wrong.

functional requirement: Statement that identifies what results a product or process shall produce.

harm: (noun) Negative event or negative social development entailing value damage or loss to people. (verb) Acting with negative value effects for self or others, within a respective SOI, organization, or beyond.

NOTE—Harms correspond to one or more underlying values.

hazard: Source or situation with a potential for harm in terms of human injury or ill health (both short and long term), damage to property, damage to the environment, or a combination of these (ISO 31000 [B29]).

human rights: Rights to which every person is entitled.

incident: Anomalous or unexpected event, set of events, condition, or situation at any time during the life cycle of a project, product, service, or system (ISO/IEC/IEEE12207:2017 [B40]).

information item: Separately identifiable body of information that is produced, stored, and delivered for human use (ISO/IEC/IEEE 15289 [B42]).

legal feasibility: Determination that the system of interest is consistent with applicable laws and regulations.

life cycle: Evolution of a system, product, service, system, project, or other human-made entity from conception through retirement.

life cycle model: Framework of processes and activities concerned with the life cycle that may be organized into stages, which also acts as a common reference for communication and understanding.

nonfunctional requirement: Requirement that describes not what the system does, but how the system does it.

operational concept: Verbal and graphic statement of an organization's assumptions or intent in regard to an operation or series of operations of a system or a related set of systems.

NOTE 1—The operational concept is designed to give an overall picture of the operations using one or more specific systems, or set of related systems, in the organization's operational environment from the users' and operators' perspective. *See also:* **concept of operations** (ISO/IEC/IEEE 15288:2015 [B41]).

NOTE 2—The operational concept can include major product, service or system elements and/or system components, boundaries and directly adjunct elements beyond boundaries, internal and external input elements (i.e., databases and/or applications serving the system that are outside of the SOI's boundaries) and output elements (i.e., databases and/or applications serving the system that are outside of the SOI's boundaries).

NOTE 3—The operational concept can be visualized.

operator: Individual or organization that performs the operations of a product, service or system.

NOTE 1—The role of operator and the role of user can be vested, simultaneously or sequentially, in the same individual or organization.

NOTE 2—An individual operator combined with knowledge, skills. and procedures can be considered as an element of the service or system.

NOTE 3—An operator may perform operations on a SOI that is operated, or of a SOI that is operated, depending on whether or not operating instructions are placed within the SOI's boundary.

opportunity: A condition or state with a potential to lead to a benefit or gain.

organization: Group of people and facilities with an arrangement of responsibilities, authorities, and relationships. *Example:* Corporation, firm, enterprise, institution, charity, sole trader, association, or parts or combination thereof.

NOTE—An identified part of an organization (even as small as a single individual) or an identified group of organizations can be regarded as an organization if it has responsibilities, authorities, and relationships. A body of persons organized for some specific purpose, such as a club, union, corporation, or society, is an organization.

participatory design: System design process that aims at investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple system stakeholders and system developers in collective reflection-in-action.

NOTE—The participants in a participatory design practice typically undertake the two principal roles of users and designers where the designers strive to learn the realities of the users' situation/requirements, while the users strive to articulate their desired aims and identify appropriate technological means to obtain them.

persona: Archetypal user of a product, service, or system.

NOTE 1—Personas can represent the needs of a larger group in terms of their goals, expectations, and personal characteristics. They can help to guide decisions about system design and design targets.

NOTE 2—The term 'persona' stems from the field of usability design where personas are typically described in a storytelling exercise. They bring personas to life by giving them names, personalities, and photos.

personal maxim: Personal principle of what one wishes for, acts upon, and thinks that it should be applicable to everyone.

problem: Difficulty, uncertainty, or otherwise realized and undesirable event, set of events, condition, or situation that requires investigation and corrective action.

process: Set of interrelated or interacting activities that transforms inputs into outputs (ISO 9000:2005 [B30]).

process purpose: High-level objective of performing the process and the likely outcomes of effective implementation of the process.

NOTE—The purpose of implementing the process is to provide benefits to the stakeholders.

product: Result of a process.

NOTE—There are four agreed generic product categories: hardware (e.g., engine mechanical part); software (e.g., computer program); services (e.g., transport); and processed materials (e.g., lubricant). Hardware and processed materials are generally tangible products, while software or services are generally intangible.

program: Related projects, subprograms and program activities managed in a coordinated way to obtain benefits not available from managing them individually.

project: Endeavor with defined start and finish criteria undertaken to create a product or service in accordance with specified resources and requirements.

quality assurance: Part of quality management focused on providing confidence that quality requirements are fulfilled (modified from ISO 9000 [B30]).

quality management: Coordinated activities to direct and control an organization with regard to quality (ISO 9000 [B30]).

requirement: Statement that translates or expresses a need and its associated constraints and conditions (ISO/IEC/IEEE 29148:2018 [B48]).

NOTE—System design needs include system characteristics (such as data flows or data flow characteristics) and system elements.

resource: Asset that is utilized or consumed during the execution of a process. *Example:* Includes diverse entities such as funding, personnel, facilities, capital equipment, tools, and utilities such as power, water, fuel and communication infrastructures (ISO/IEC/IEEE 12207:2017 [B40]).

NOTE—Resources include those that are reusable, renewable, or consumable.

risk: Effect of uncertainty on objectives (ISO/IEC/IEEE 16085 [B43]).

NOTE 1—An effect is a deviation from the expected—positive or negative. A positive effect is also known as an opportunity.

NOTE 2—Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product, and process).

NOTE 3—Risk is often characterized by reference to potential harmful events and consequences, or a combination of these.

NOTE 4—Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.

NOTE 5—Uncertainty is the state, even partial, of deficiency of information related to understanding or knowledge of an event, its consequence, or likelihood.

security: Protection against intentional subversion or forced failure (NATO AEP-67 [B58]).

NOTE—A composite of four attributes – confidentiality, integrity, availability, and accountability—plus aspects of a fifth, usability, all of which have the related issue of their assurance.

service: performance of activities, work, or duties.

NOTE 1—A service is self-contained, coherent, discrete, and can be composed of other services.

NOTE 2—A service is generally an intangible product.

social responsibility: Obligation to wider society to respect the values reigning within it and to act in line with the organization's values, including legal, ethical, environmental, and financial responsibilities.

stage: Period within the life cycle of an entity that relates to the state of its description or realization.

NOTE 1—Stages relate to major progress and achievement milestones of the entity through its life cycle.

NOTE 2—Stages often overlap.

stakeholder: Individual or organization having a right, share, claim, influence or interest in a system or in its possession of characteristics that meet their needs and expectations. *Example:* Human beings using the system, organizations representing human beings using the system, supporters, developers, producers, trainers, maintainers, disposers, acquirers, supplier organizations, and regulatory bodies (ISO/IEC/IEEE12207:2017 [B40]).

NOTE 1—Some stakeholders can have interests that oppose each other or oppose the system.

NOTE 2—There can be direct and indirect stakeholders. Indirect stakeholders are not directly using a system but are indirectly influenced by it.

supplier: Organization or an individual that enters into an agreement with the acquirer for the supply of a product or service.

NOTE 1—Other terms commonly used for supplier are contractor, producer, seller, or vendor.

NOTE 2—The acquirer and the supplier sometimes are part of the same organization.

system: Combination of interacting elements organized to achieve one or more stated purposes.

NOTE—A construct or collection of different elements that together produce results not obtainable by the elements alone. The elements, or parts, can include people, hardware, software, facilities, policies, processes and documents; that is, all things required to produce systems-level results.

system boundary: Conceptual interface between a system and its environment.

system characteristic: Attributes or distinguishing features pertaining to a system.

system element: Member of a set of elements that constitute a system. *Example:* Hardware, software, data, humans, processes (e.g., processes for providing service to users), procedures (e.g., operator instructions), facilities, materials, and naturally occurring entities or any combination.

NOTE—A system element is a discrete part of a system that can be implemented to fulfill specified requirements.

system of interest (SOI): System whose life cycle is under consideration.

system of systems (SoS): System of interest whose constituents are themselves systems.

NOTE—A SoS brings together a set of systems for a task that none of the systems can accomplish on its own. Each constituent system keeps its own management, goals, and resources while coordinating within the SoS and adapting to meet SoS goals.

systems engineering: Interdisciplinary approach governing the total technical and managerial effort required to transform a set of stakeholder needs, expectations, and constraints into a solution and to support that solution throughout its life.

task: Required, recommended, or permissible action, intended to contribute to the achievement of one or more outcomes of a process.

trade-off: Decision-making actions that select from various requirements and alternative solutions on the basis of net benefit to the stakeholders.

transparency: Characteristic of the transfer of information to a stakeholder, which is honest; contains information relevant to the causes of some action, decision or behavior; and is presented at a level of technicality and in a form that are meaningful to the stakeholder.

top management: Person or group of people who direct and control the organization at the highest level.

NOTE—Top management can be the owner of an organization, majority shareholders, senior manager in the organization or members of the governing board.

user: Individual or group that interacts with a system or benefits from a system during its utilization (ISO/IEC 25010:2011 [B34]).

NOTE—The role of user and the role of operator are sometimes vested, simultaneously or sequentially, in the same individual or group.

utilitarianism: Ethical decision-making approach to consider the consequences of system design and deployment (harms and benefits).

NOTE—The aim of utilitarianism is to maximize positive consequences of an act and to minimize negative consequences so as to achieve the greatest satisfaction and happiness of direct and indirect stakeholders in life in the long term.

validation: Confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled (modified from ISO 9000:2015—Note to entry has been added).

NOTE—A system is able to accomplish its intended use, goals, and objectives (i.e., meet stakeholder requirements) in the intended operational environment. The right system was built.

value: A conception that influences the selection from available modes, means and ends of action:

— *Examples of positive values*: love, privacy, security, transparency, accountability, generosity, dignity, courage, fairness
— *Examples of negative values:* bias, absence of transparency, absence of privacy, selfishness, greediness

NOTE—A value can be positive or negative. A positive value is intuitively recognized because of its relatively high desirability. A negative value is marked by its undesirability.

value at risk: Value that is regarded as being undermined or threatened.

value-based system requirement: System requirement that is traceable from ethical value requirements, value clusters, and core values.

value bearer: System, person, thing, action, or relationship that carries values.

NOTE—If a system is a value bearer it carries values by the means of value dispositions.

value benefit: A positive state or activity fostering a value.

value cluster: Group containing one core value and several values instrumental to, or related to, the core value.

NOTE—A value cluster can contain value demonstrators.

value demonstrator: Potential manifestation of a core value, which is either instrumental to the core value or undermines it.

value disposition: System characteristic that is an enabler or inhibitor for one or more values.

value harm: A negative state or activity undermining a value.

value lead: Person assigned to coordinate and conduct tasks related to ethical values elicitation and prioritization and traceability of values through the requirements and design artifacts.

value register: An information store created for transparency and traceability reasons, which contains data and decisions gained in ethical values elicitation and prioritization and traceability into ethical value requirements.

verification: Confirmation, through the provision of objective evidence, that specified requirements have been fulfilled (modified from ISO 9000:2005—Note to entry has been added).

NOTE—Verification is a set of activities that compares a system or system element against the required characteristics. This includes, but is not limited to, specified requirements, design description and the system itself. The system was built right.

virtue: Positive value of human conduct.

NOTE 1—Habitual character quality of a person. Vice is the corresponding negative term.

NOTE 2—Virtue promotes not only individual, but also collective greatness. Virtue is typically marked by well-balanced golden-mean behavior, avoiding extreme behaviors (for example the virtue of generosity is marked by being the golden mean between greediness and lavishness).

NOTE 3—All virtues are values, but not all values are virtues.

3.2 Acronyms and abbreviations

AI	artificial intelligence
BAT	best available technique
ConOps	concept of operations
EVR	ethical value requirement
RACI	responsible, accountable, consulted, informed
SLA	service level agreement
SOI	system of interest
SoS	system of systems

4. Conformance

Conformance to this standard can be achieved in two ways: a) conformance to outcomes, by demonstrating that all of the outcomes from Clause 7 to Clause 11 have been performed; b) conformance to tasks, by demonstrating that all of the tasks from Clause 7 to Clause 11 have been performed. Organizations can also claim full conformance to both outcomes and tasks. Full conformance to outcomes permits greater freedom in the implementation of conforming processes and can be useful for implementing processes to be used in the context of an innovative life cycle model.

IEEE Standards cannot guarantee or ensure ethical system design, and conformance with the provisions of this standard does not imply conformance with any particular ethical principles or value system, which may vary from community to community, or over time. Users of the standard are responsible for being apprised of and referring to appropriate, applicable ethical criteria for consideration during system design.

NOTE 1—Options for conformance allow flexibility in the application of this standard. Each process has a set of required results (“outcomes”) consistent with its purpose and a set of high-level activities and more detailed tasks that represent one way to achieve the outcomes.

NOTE 2—Users who implement the activities and tasks of the declared set of processes can assert full conformance to tasks of the selected processes. Some users, however, might have innovative process variants that achieve the results (i.e., the outcomes) of the declared set of processes without implementing all of the activities and tasks. These users can assert full conformance to the outcomes of the declared set of processes. The two criteria—conformance to task and conformance to outcome—are not necessarily equivalent, since specific performance of activities and tasks can require, in some cases, a higher level of capability than just the achievement of outcomes.

NOTE 3—ISO/IEC/IEEE 24774 [B46] explains the concepts of outcomes, outputs, activities, and tasks.

5. Key concepts and application

5.1 General application

This standard is usable by organizations that engage in system and software engineering. This includes the following in particular:

- Organizations building a new generic or application specific product, service or system from scratch
- Organizations implementing a major revision on an existing product, service or system
- Organizations planning the acquisition of a tailored product, service or system
- Research organizations that build a new product, service or system from scratch or adapt an existing entity in the course of their research activities

An organization and its project team(s) can apply the requirements in this standard to help make value-based ethical system design and investment decisions.

This standard can be used in one or more of the following modes:

a) By an organization—to help establish an environment of value-based processes. These processes can be supported by an infrastructure of policies, methods, procedures, techniques, tools, and trained personnel. The organization may then employ this environment to perform and manage its projects and progress systems through their life cycles. In this mode, this standard is used to assess conformance of a declared, established environment to its provisions.

b) By a project—to help select, structure, and employ the elements of an established environment to provide products and services. In this mode, this standard is used in the project's requirements in the declared and established environment.

c) By an acquirer and a supplier—to help develop an agreement concerning processes and activities. Via the agreement, the processes and activities in this standard are selected, negotiated, agreed to, and performed. In this mode, this standard is used for guidance in developing the agreement.

d) By process assessors—to serve as a process reference model for use in the performance of process assessments that may be used to support organizational process improvement.

5.2 Specified context of use

In general, the context of use and the concept of operation of a system are relevant to the identification of ethical values. They affect the extent to which the direct or indirect human users are able to control the system and the extent to which the system has the capacity to inflict harm or promote well-being. Clause 7 provides a process for exploring and setting the ethical context of a system.

NOTE—Although the ConOps is defined before a system is developed, the context and the system are likely to change during the system life cycle, and continued iterations of value analysis may be needed.

Systems support values relevant to a context of use. For example, a speech assistant used in a car can contain some conversational skills that are different from those used in virtual worlds or at home. With different contexts (car, game, home) come different subject matters and, hence, different conversational subject domains with different ethical import. This standard assumes that systems can undermine and foster values relevant in certain use contexts.

5.3 The Organization

This standard is intended to be used in systems and software engineering organizations of all types and sizes, whether they apply a hierarchical or a relatively flat organizational model. It is also usable by components of an organization, such as a product development team, project, or a corporate division, although conformance to the standard likely requires participation across organizations in most cases. It is intended for international use with various cultural values and governance systems. In applying this standard, one person can assume many roles, and one role can be held by numerous individuals or subgroups within the organization. There are no requirements for independence of roles in this standard. For more on risk management for systems and software engineering, see ISO/IEC/IEEE 16085 [B43].

Ethical decisions are not the sole responsibility of top management, although top management has an undeniable role in setting expectations for values and policies and establishing control of performance and results. One of the premises of this standard is that the informed judgment of systems and software engineers need to be considered while making ethical decisions about a system under development. Another premise of this standard is that engineers and others in the organization can benefit from learning and regularly applying specific processes and methods to make ethical choices throughout the life cycle. Just as engineering analyses, decisions, and risk assessments have always involved balancing and trade-offs of values, in this context engineers participate as the organization weighs competing values and harms. Although involvement with internal or external ethics practitioners may improve outcomes and efficiency, it is not required to engage an ethics expert to conform with the standard.

NOTE 1—Numerous management system standards and value-based standards are already in use for various domains, such as quality, security, environmental impact, safety, asset management, risk management, and social responsibility and sustainability (e.g., ISO 9001 [B31], ISO/IEC 27001 [B37], ISO/IEC 19770 [B33], ISO 31000 [B29], ISO/IEC/IEEE 16085 [B43], and ISO 26000 [B28]).

The ethical decisions made in one organization can affect its suppliers and customers, the entire economy, and public well-being. Organizations can encourage their business partners and customers to make ethical decisions, to consider harm to users, and to promote certain values. However, in this standard the span of control of the organization is assumed to include its first-tier relationships: the internal or external contractors who agree to adhere to the ethical decisions and share the ethical values the acquirer has identified. While an organization acting as a supplier can often exert pressure on its customers (acquirers) to act in more ethical ways through the design of its systems, these customers and users are stakeholders not within its span of control. This standard also does not address how to determine the legal feasibility of designing a system nor how to effect changes in ethical values and cultures on a national level or changes in the legal environment.

Within the scope of this standard is the design of products, services, and systems in an organization. It does not address how an individual within the organization makes individual ethical decisions as to whether to participate in the engineering process and work on a product (or whether to be a whistleblower). This standard also does not address ethical considerations or establish requirements for non-engineering areas of organizational governance and ethical policies, such as various human relations policies, organizational structures, employment arrangements, work practices, team dynamics, or governance and financial management systems used in organizations where they do not directly affect the SOI. However, it is more likely that an organization can make ethical decisions and reduce its risks by applying the same ethical values it espouses for its systems to its own operations.

The use of this standard is facilitated if organizations have strong organizational principles. Such principles ease several of the normative activities in this standard in addition to providing an organization with a more coherent identity and shared purpose.

This standard does not require any specific set of principles but, recommends organizations to develop a set of core values, such as transparency or accountability.

NOTE 2—Organizations also commonly develop ethical principles related directly to work ethics and consistent with legal and regulatory employment requirements. These are not considered directly in this standard.

General organizational principles are an agreed set of guiding principles for planning and delivery of systems, products, and services when faced with activities that can have an ethical impact on internal or external stakeholders. The principles should be able to guide individuals, line managers, management, and leadership during decision-making, conflict situations, decision points, and prioritization calls. The organization's goals and strategy are developed on the foundation of the principles. The principles should be demonstrable in the organization's strategy, portfolio of systems, and future operating models.

Clear and evident collaboration, inclusion, and interaction should be present during the activities to create and implement principles. As principles are introduced into the organization they should be enacted as a formal change project including stakeholders. Principles should be included in the formal targets for product development and internal improvement projects.

NOTE 3—ISO/IEC TR 38504 [B39] includes guidance on alignment of principles to organizational governance.

5.4 Stakeholders

Concern for the interests of direct and indirect stakeholders is central to applying values to engineering design. This can include society at large as a stakeholder—for instance, when the value of environmental sustainability is an issue for system design. As for any engineering design effort, the interests of the project owners or the organization's top management along with the system architects and designers are typically predominant. The acquirers for a custom-built system, or whoever identifies the needs to be translated into requirements, such as business or market analysts, and portfolio managers, or product line managers, are also considered as major stakeholders. Depending on the organization's policies and team resources, the interests of other team members may also be considered, such as quality assurance, risk management, testing, logistics and sustainment, training, documentation, and disposal. Systems and software engineers do have a large stake in the system through their responsibility and control of the system concept; requirements; architecture; design; verification; and concepts and mechanisms for operations, sustainment, and disposal. However, the internal stakeholders can be least affected by areas where ethical concerns arise since they are often not the users of the system.

Along with these internal stakeholders and the customer, the class of stakeholders that is intrinsic to ethical risk-based design is the users. Users frequently are categorized by the levels or types of system access they need to perform various tasks or have services provided to them. These include hands-on system operators (often agents of the customer) as well as those who benefit from, or are harmed by, use of the system, both through direct transactions using the system and also through its impact on the environment and their culture. Users also include those whose personal data is held in a system, whether they have access to that data or are aware of that data or not. For many systems, users are not limited to skilled, trained, and educated workers and consumers who can be assumed to assess the risk or benefits of use of a system with sufficient information. Users can include the general public at large, both current and future users, and vulnerable populations, such as those unable to read, children, the aged, and people of different abilities.

A particular concern in ethical risk-based design can be implicit assumptions about user stakeholders that create bias against certain types of users. For example, designers need to take particular care that the system design and algorithms do not unjustly favor or select users in certain geographic areas, or of certain biometric or demographic characteristics, or based on unvalidated reports, or unfairly target or exclude other classes of users.

Because it can be difficult to interact directly with the broad scope of user stakeholders, development organizations may include user advocates or create personas that act as proxy stakeholders. However, just including a stick-figure user in a use case is unlikely to capture the variety of ethical concerns and values that the actual users may bring to the transaction and how it is handled by the system.

Another class of stakeholders may have interests that oppose the system or may interfere with its use. These include competitors; cybersecurity hackers; or opponents of the development organization, system owner, or customer. Other external stakeholders can offer divergent perspectives. Government regulators and external advocacy groups, whose cultural norms and ethical values may differ from the system owner, can expose a clash in values and constrain the decisions of the system owners. Third-party assessors, data brokers, and independent verification and validation (IV&V) contractors are stakeholders who can point out flaws or unstated assumptions that have skewed the organization's ethical choices.

These groups of stakeholders: internal, users, opponents, and external authorities, are treated differently when risks, ethical values, and impacts are evaluated. Information about potential system characteristics and performance, and the balance of ethical values and stakeholder interests are rarely shared openly with all stakeholders. Indirect stakeholders who are not users but are affected by the system also need to be considered. The success of a system can depend on indirect stakeholder opinions, which can shape public opinion.

Thus transparency, or open communication (the opposite of secrecy) is not uniformly applied. See Clause 11 for the Transparency Management Process, including typical transparency rules in Item a) 2) of 11.3. The ethical value of transparency in establishing decision-making processes, assessing risk, and involving stakeholders in making and validating decisions is applied differently to different stakeholders in practice. Transparency is hindered by too much technical detail beyond the capacity of the stakeholder to comprehend, as well as by other forms of non-disclosure. Transparency is not achieved through one uniform and pervasive approach for all stakeholders, e.g., for revealing how algorithms make decisions in AI systems, how an organization established its design priorities, and how an acceptable level of system accuracy was set. The level of transparency decreases according to how much the information owners trust the stakeholder to agree with their values and protect their proprietary resources and according to the type of technical detail they believe the stakeholder is capable of understanding and applying (the Need to Know or Explainability principle).

The range of stakeholders who can participate in the ethical risk-based design process may be recorded and managed using a RACI (Responsible, Accountable, Consulted, Informed) matrix for stakeholder involvement at various stages.

5.5 Human values

This standard addresses ethical concerns about an SOI by eliciting and implementing stakeholder values. Human values guide ethically aligned design. Human values are phenomena that are appreciated by human beings. Beauty, freedom, fairness, dignity, knowledge, friendship, control, privacy, *and* environmental sustainability, are examples of human values. The discrete list of phenomena that are called values is very long. All cultures make use of values to describe how people should behave or live, and values are often shared between cultures, but the lists of the most important values vary between cultures. A realization of ethical values is the desired outcome from all processes in this standard. Through the processes in this standard, an organization determines which values are relevant to stakeholders, which values may be affected by the SOI, which values can be created or supported by the SOI, and which values are reduced or discouraged by the SOI.

NOTE 1—Talking about "human" values does not preclude the recognition of animal rights or care for nature.

NOTE 2—Annex B provides a more detailed discussion of value concepts, including an extended example in B.2.

Although the terms are often conflated in colloquial usage, values are distinct from ethical theories (see Annex C). Values are independent phenomena, while ethical theories are interpretive frameworks that identify morally salient aspects of a context and can include values.

NOTE 3—A value is carried by a value bearer, including things, persons, relationships, or activities.

NOTE 4—Perception of a value is possible due to observable and/or sensible values that are carried by value bearers. However, a value does not need to be physically perceived or sensed to exist. Its existence is already constituted by its desirable nature that can be felt by humans more or less in the form of aspiration.

Socio-technical systems are assumed to affect many ethical values. In this standard, the goal of a project is to identify and prioritize the most relevant ethical values for a system, to conceptually understand the values and the feasibility of implementing them, and to then design the system with a view to enable and protect the desired values and to inhibit or prevent negative values from prevailing. Figure 2 depicts concepts related to values that are used in this standard.

For the sake of clarity and efficiency, the potentially lengthy list of elicited values and value demonstrators can be condensed to a limited number of core value clusters. Each value cluster takes the name of one positive "core value" that is prominent in the value space. Typically, a core value materializes in the form of various related and instrumental value demonstrators. These are mapped out as part of the value analysis in value clusters. For instance, the core value of privacy is enabled by a value called "confidentiality" or a value demonstrator "right to be left alone." Other positive or negative values can be identified as related to an aspect or attribute of the core value.

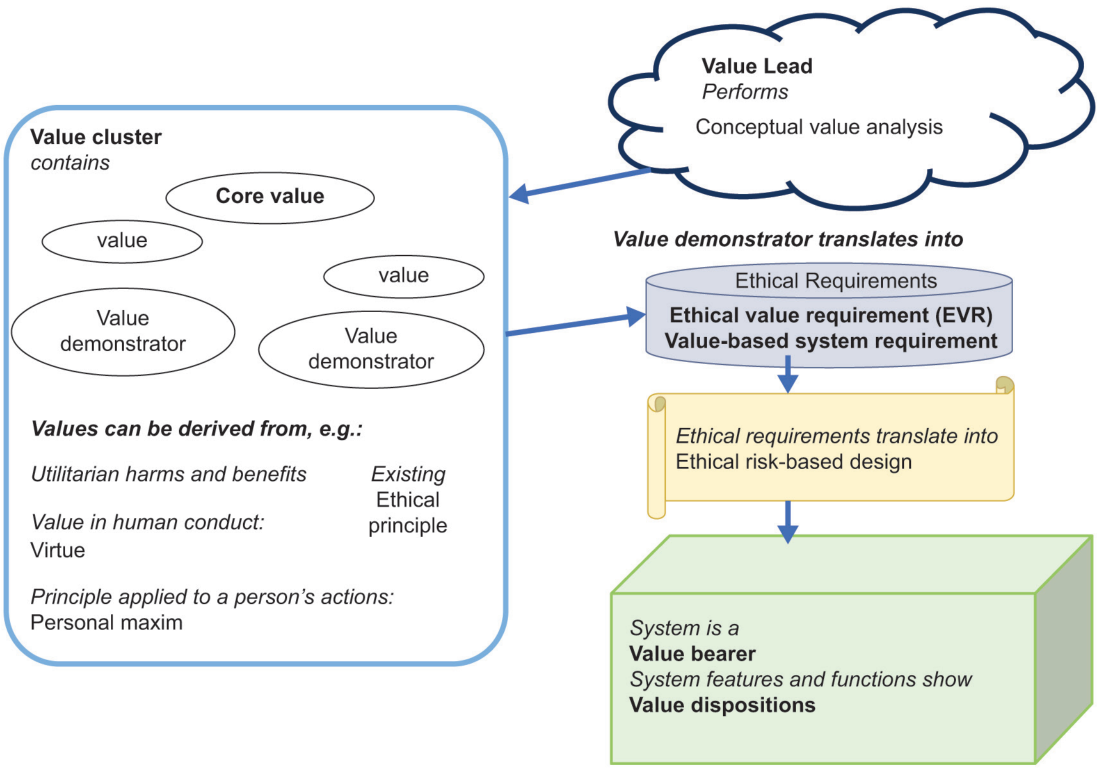

Figure 2—Relationships of value concepts

Value demonstrators are associated with and instrumental to the core value, constituting the core value's meaning in the context of the SOI. These are akin to stakeholder needs as they reflect a result valued by the stakeholder that the system should achieve. A value demonstrator is a way in which a value can be made more concrete and can be translated into an EVR.

Although a value and value demonstrator may be appropriately inhibited or discouraged in one system, in other systems the same value or value demonstrator may be encouraged. The priority of a value is related to the purpose of the system and the context of system use. Clause 8 describes activities for eliciting which values are pertinent to an SOI in a specific context and determining from a wide range of stakeholders and contextual analyses which values should be encouraged and which should be inhibited.

Value demonstrators are rendered as engineering targets in the form of EVRs, which are expressed in technical terms as value-based system requirements. Value dispositions are created in systems when designs are created that fulfill the ethical requirements. An analysis of the EVR and value-based system requirements can reveal which requirements are likely to be difficult to achieve and guide engineering decisions on the tradeoffs between the ultimate achievement of an ethical value and system feasibility. In designing a system, using models, prototypes, algorithms, and other design tools, engineers can focus on the system features and components where the ethical value needs to be realized.

The Ethical Risk-Based Design Process aims to create an optimal system. This is achieved by engineers who are working (at least in many respects) on the value dispositions at the level of the system. Value dispositions inhere in the features, functions, and elements that are engineered in systems. In the system, values are enabled by value dispositions at the technical or organizational level. These dispositions can come in the form of positive drivers of values or negative inhibitors (controls) of negative values (harms).

5.6 Ethical theories used to elicit values

This standard utilizes well-established ethical theories to identify salient aspects of the system that are relevant to designing for values.

NOTE—See Annex C, especially C.4, for more detailed discussion of ethical theories.

Three ethical theories are applied to help identify and prioritize values in this standard: utilitarian ethics, virtue ethics, and duty-ethics.

— *Utilitarian ethics* helps collect and judge positive and negative outcomes (synonyms: benefits and harms) in a broad and egalitarian manner. They ask: "What benefits or harms would arise if everyone were to build and/or deploy the SOI in the way we envision it?"

— *Virtue ethics* focus on system effects on individuals' habitual character and wellbeing; in particular they ask for virtues affecting one's role in a community: "What are the effects of the respective SOI for the virtues of stakeholders affecting their community behavior?"

— *Duty ethics* tap into the responsibility of stakeholders by calling for the use of value priority judgments (personal maxims) and refraining from the use of people as means only. They ask: "What are the potential personal value maxims that can be undermined or fostered by the respective system?" Duty ethics are also important for prioritizing values identified.

These three theories do not determine what is ethical or not. In this standard, they solely contribute three complementary questions that help team members to think about a broad set of values that are relevant for the respective organization to think about. Different cultures answer these questions differently. Therefore, the stakeholder groups involved in the Ethical Values Elicitation and Prioritization Process also need to accommodate representatives of those markets, nations, or world regions in which a system is going to be deployed. That said, the emphasis on these three ethical theories should not be taken as an exclusion of any other ethical theory or of consideration of a type of harm not accounted for in these theories. Users of IEEE Std 7000 are encouraged to ask additional widely used ethical questions warranted in their cultures to elicit values and thereby potentially consider even more global and local variations warranted by the conditions of the SOI.

These theories are not intended to be an exhaustive accounting of how to determine the ethical status of an action, decision, or system but, instead, reflect the belief that these complementary approaches capture *most* of the ethically relevant characteristics of a product, service or system. This standard treats these core types of ethical analysis as essential for due diligence. Although the names of these ethical theories as referenced here are distinctly Western, their core commitments (consequences, character, and duty) are found globally under different traditions and variations.

The decision to invest in a system is not determined by simply counting positive and negative value effects across the SOI at an early stage. Rather, the preliminary determinations provide input to later processes where values are ranked and can guide designers to make values-sensitive design decisions to improve the values effects of the SOI. Again, different cultures rank and prioritize values differently. Therefore, stakeholders of the respective market regions should be included in the design of the system (versions) rolled out in their markets. The prioritized value list of an envisioned system is taken also as a decision basis to decide for or against investment in the SOI.

5.7 Stages and processes

This standard allows any organization or systems developer to achieve the requirements in this standard by means of their own particular set of standard system development processes, methods, and practices. IEEE Std 7000 has distinct processes that can be applied to systems and software engineering and relate to the general processes in ISO/IEC/IEEE 15288:2015 [B41] and ISO/IEC/IEEE 12207:2017 [B40] (see Annex A). The point of an ethically aligned design is to be realized and delivered in the form of a system.

This standard is intended to be suitable for use by organizations and projects using iterative approaches and methods as well as in those using other engineering approaches.

The activities and tasks in this standard are not sufficient by themselves to produce an SOI. They are intended to be an integral part of an organization's comprehensive approach to managing the development of a sociotechnical system. Communication, coordination, and collaboration in an integrated and timely manner are expected within any group that uses this standard in a system development effort.

Continued reiteration of the processes allows for adaptation and reprioritization of the evolving requirements and design. Monitoring of the design can result in reiteration of the processes. The processes take various classes of data; information; human and technical resources, such as knowledge of preliminary harms, legal requirements, and initial concept of operation for the SOI; and stakeholder views as inputs. The inputs inform and empower the activities and tasks in each process and, in turn, result in the generation of various classes of physical and virtual outputs from the processes such as a Value Register (a project ethical value repository), EVR, and a Case for Ethics. The outcomes are the insights and work products generated as a result of activities and tasks. A result of applying this standard to the design of a product, service, or system can be a more ethically aligned artifact that is more responsive to and inclusive of ethical values of the stakeholders and society at large.

This standard does not prescribe any particular sequence of processes within the life cycle model. Subject to possible restrictions applicable to the selected life cycle model, the processes, activities, and tasks described in Clause 7 to Clause 11 may overlap with each other and with other systems or software engineering processes. However, many of the activities and tasks logically apply outputs from other tasks, so there is an inherent sequence of activities, which can be applied iteratively. The sequence of the processes is determined by project objectives and by selection of the life cycle model. Also, outputs of one iteration of a process can be inputs for the next iteration of the process.

The process model for this standard does not include process assessment and control as a separate process or use process views.

Decisions to proceed or reiterate a process are needed at numerous key decision points and at the end of processes.

The ethically aligned processes described in this standard are performed during two stages in the system life cycle:

— Concept exploration
— Development

NOTE—The stages are adapted from ISO/IEC/IEEE 24748-1 [B44], which uses the following exemplary set of stages: concept, development, production, utilization, support, and retirement.

Other stages (utilization, sustainment, and retirement) are beyond the scope of this standard.

Not all values are identified as the result of interactive activities with stakeholders. In addition, some EVRs can originate from awareness of regulations or other social-responsibility frameworks. While completing the list of system level requirements, teams continuously collect ideas on value-related needs and outcomes, which inform the ConOps. These ideas are noted as ideas for the ConOps of the envisioned system.

The result of a risk and opportunity analysis and assessment is that risks are evaluated. When controls are integrated in a system, they further refine and detail the operational concept. The result is a design solution for reduced risk (improved opportunity) for bearing the values needed by the system users.

After an ethically aligned designed product, service, or system is put into operation, the need for reiteration of the processes described in this standard can be determined through performance monitoring and maintenance. Adverse deviations from the expected performance, emergence of new undesirable behaviors, or adverse user or operator feedback can necessitate a reiteration of ethical analysis, evaluation, assessment and appropriate redress. The overall aim is to sustain the originally achieved ethical profile within the concept and context of operation and seek opportunities to enhance the SOI's ethical attributes during upgrades.

6. Key roles in Ethical Value Engineering Project teams

6.1 General

The following roles and associated competencies should be included as project team members involved in value-based engineering efforts. The roles may be combined and delivered by one person taking into account workload and competence. In applying this standard, one person can assume many roles, and one role can be held by numerous individuals or subgroups within the organization. There are no requirements for independence of roles in this standard. For these competencies and roles, it is not necessary to have one unique team member each. It is feasible that one person may be competent in more than one of the above areas, so that the project team size can vary depending on the organizational processes, roles, and staff. Organizations may designate a project leader with responsibility and accountability for achieving the objectives.

Nothing in this standard, neither the vocabulary nor the techniques, should be understood to require or even suggest the need for a group of specialists whose workflow is separate from the organization's chosen engineering workflow. For example, the same people who perform the activities and tasks in this standard may have responsibility for other engineering activities also. It is expected that personnel who carry out the activities and tasks and achieve the outcomes, in this standard collaborate with their coworkers in a team-like, integrated, synergistic manner. Team members should get sufficient time to be engaged in the roles. Project team members should be present or send a designee for meetings required for the project.

6.2 Role descriptions

6.2.1 Top Management Champion

The Top Management Champion sets strategic policy and enables work as a leader in the organization, e.g., part of the executive board, Chief Technology Officer, Chief Information Officer, Chief Operating Officer, or someone who is responsible for the unit or area in which the system is developed. In the case of a Very Small Entity, the role of the top-management champion may be filled by the entity's owner.

The responsibilities of the Top Management Champion include the following:

a) Motivates project teams to uphold value priorities

b) Resolves conflicts in strategies and value priorities

c) Upholds the ethics of decisions taken throughout the system's life cycle

d) Directs communications with leaders of customer, deploying, or acquiring organizations regarding ethical and technical decisions made in system design

e) Receives and directs responses to concerns and information from project team members or stakeholders about project decisions

f) Communicates with the team both regularly and when needed

g) Continuously explains the link between ethically aligned design and the individual's role in achieving the objectives of ethically aligned design

6.2.2 System Expert

The System Expert contributes understanding of existing systems, potential capabilities for new systems, and the context for operation of the SOI (the installed base of legacy systems and technologies with which the new system is to be interoperable), e.g., a systems engineer, software engineer, hardware engineer, requirements engineer, business analyst, or systems architect.

The responsibilities of the System Expert include the following:

a) Listens to stakeholders and team members to understand concerns rather than jumping to a readily available technical solution
b) Develops system requirements that enable EVR
c) Evaluates alternatives and trade-offs for suitability to the context of operation and the organization's long-term strategy
d) Optimizes technical solutions to support values among a range of system requirements

6.2.3 Value Lead

The Value Lead focuses on the identification, analysis, and prioritization of ethical values and their incorporation in the system design. The Value Lead is not "the person in charge of ethics" in a project but contributes subject matter expertise and facilitative skills, bridging gaps between engineering, management, and ethical values in a constructive way.

The responsibilities of the Value Lead include the following:

a) Organizes, analyzes, communicates, and records ethical and/or value related concepts, concerns, activities and decisions in a project
b) Facilitates discussions and value-related activities to accompany a project in its design efforts
c) Builds compromises through practices like participatory design

6.2.4 Risk Lead

The Risk Lead coordinates the identification, evaluation, and treatment of risks and opportunities related to ethical values for a system.

The responsibilities of the Risk Lead include the following:

a) Establishes activities for the organization or team to identify, evaluate and prioritize, and treat (mitigate, avoid, or accept) risks related to the ethical values, EVR, and value dispositions
b) Facilitates, records, organizes, and communicates decisions on risks, risk assessments, and risk treatments related to ethical values
c) Reinforces awareness of how each role is involved in risk-related activities

6.2.5 User Advocate

The User Advocate represents future direct and indirect users of the system, working with functionally oriented members of the design team.

The responsibilities of the User Advocate include the following:

a) Applies a market view or societal perspective to system or value conflicts
b) Represents stakeholder groups that cannot be directly involved in project team meetings
c) Advocates the reduction of the social and economic impacts of the system on indirect stakeholders

6.2.6 Senior Product Manager

The Senior Product Manager in an organization directs the development, supply, or sustainment of one product or a portfolio or product line at some part of the product's life cycle.

The responsibilities of the Senior Product Manager include the following:

a) Leads the application of knowledge of the target market and context of use for the product to value-based decisions on ConOps and to product design
b) Directs the implementation of value-based decisions with the engineering, marketing, or customer support teams

6.2.7 Moderator

The Moderator brings sufficient knowledge of the technical domain and system context to lead productive team discussions and meetings with stakeholders.

The responsibilities of the Moderator include the following:

a) Elicits information, viewpoints, and recommendations from stakeholders in meetings and discussions
b) Encourages fair consideration of different views without allowing individuals to dominate the discussion
c) Mediates between different viewpoints and helps participants reach consensus decisions

6.2.8 Transparency Manager

The Transparency Manager leads the communication of technical decisions and system functions to stakeholders in a way that is understandable to them.

The responsibilities of the Transparency Manager include the following:

a) Records decisions and those who are accountable in a consistent and as easily retrievable form
b) Tracks and reports related decisions to adhere to transparency
c) Maintains the Case for Ethics

6.3 Team competency

In addition to the individual roles and responsibilities needed to carry out the activities in this standard, there are competencies that should be demonstrated by each individual and the team as a whole while engaged in ethically aligned design. It is prudent to select individuals for team roles on the basis of their competence. In this context, competence is the ability to perform a task correctly, efficiently, and consistently to a high quality under varying conditions to the satisfaction of the end client. Competency may also be attributed to a group or a team when a task is performed by more than one person in view of the multidisciplinary nature, complexity, or the scale. A competent person or team requires a number of requisite qualities and capabilities, including the following:

a) Technical domain knowledge: empirical, academic, or a blend of both
b) The experience of application (knowing what works) in different contexts and the requisite skills
c) The drive: motivation to achieve the goals and strive for improvement or excellence
d) Sharing appropriate behaviors, such as teamwork, leadership, and compliance with professional codes
e) The ability to adapt to changing circumstances and demands by creating new know-how
f) The ability to perform the requisite tasks efficiently and minimize waste of physical and virtual resources
g) The ability to sense what is desired and to consistently deliver high quality to the satisfaction of the end client(s)

The right blend of these abilities renders a person or group of people (a team) competent in that they can achieve the desired outcomes consistently, efficiently, satisfactorily, or exceeding the expectations of the clients over varying circumstances. In this spirit, competence is the ability to generate success, satisfaction, value, and excellence from the application of knowledge, skill, and know-how.

7. Concept of Operations (ConOps) and Context Exploration Process

7.1 Purpose of the Process

The purpose of the ConOps and Context Exploration Process is to define how a system is expected to operate from the users' perspective and its context of use, its stakeholders, and its potential for ethical benefit or harm. A ConOps is a broad outline of an organization's intent regarding an operation or a series of operations that are intended to occur within the same SOI. The Context Exploration Process develops an understanding of the ethical environment in which the SOI and its operations impact stakeholders. When context is explored and envisioned for a system's future, it should be done under the assumption that the system will be implemented at scale, that is, having a significant impact on target stakeholders and markets.

The ConOps and Context Exploration Process identifies stakeholders involved with the system throughout its life cycle and chooses representatives. It also analyzes control over the envisaged SOI. It gathers relevant information on the social, legal, and environmental feasibility of the SOI.

NOTE—Annex D provides a sample questionnaire for a legal, social, and environmental feasibility analysis.

Actual use cases or possible use cases (scenarios) should be chosen that are likely to unveil representative values relevant in human interaction with the SOI. Market research has provided potential insights into existing use cases of a system—especially when it is already deployed. For example, it may turn out that human beings using a general conversational agent have typical conversation domains with these agents, such as healthcare, scheduling appointments, or education. Such specific use cases should determine the context that is explored in the project and addressed ethically.

IEEE Std 7000 is recommended even for generic system manufacturers where the context of the SOI may not be obvious, because any system context has stakeholders. For example, database manufacturers who think their systems do not have any effective context with users. However, database design determines the capabilities of systems interacting with users; for instance, the capability to fully delete data for privacy reasons.

Descriptions of use cases or concepts of operation should consider a long time-horizon (i.e., 10 to 20 years), assume significant market share of the envisaged SOI, and consider those regions of the world in which the

SOI is or will be marketed. Use cases should include demographically diverse groups who may use the system, such as elderly people, minors, racial minorities, differently abled people, and different language speaking populations.

If several use cases or contexts are available, the choice of scenario should be guided by those social, legal, and environmental issues that turn out most problematic with respect to enhancing positive values or prohibiting negative values.

7.2 Outcomes

As a result of the successful implementation of the ConOps and Context Exploration Process, achievement of the following outcomes shall be demonstrable:

a) The SOI's intended context of use is described.

b) Stakeholders involved with the envisaged system throughout its life cycle are identified and their representatives are chosen.

c) Concepts of control over the SOI are identified and analyzed.

d) Relevant information on the social, legal, and environmental feasibility of the SOI is gathered.

e) The activities and tasks of this process are integrated with other tasks that define the context and the initial ConOps for the SOI.

f) The need to further explore potential harms and benefits to ethical values from the system concept is determined.

7.3 Activities and tasks

The project shall implement the following activities and tasks in accordance with applicable organization policies and procedures with respect to the ConOps and Context Exploration Process.

NOTE—These activities can benefit from close co-operation with stakeholders and the guidance of the value lead.

a) Develop an understanding of the system's intended context(s) of use. This activity consists of the following tasks:

    1) Describe the context of current operations to be replaced or changed by the future system.

    2) Identify and suitably represent one or more actual or possible system use contexts.

    Example contexts: a robot to be used in a nursing home, a social network to be used among students, a software suite to do office work. These are cases where there is direct interaction between human beings and systems in known contexts.

b) Identify stakeholders who may be interested in or affected by the system at some point. This activity consists of the following tasks:

    1) Identify relevant stakeholders, including:

        i) Organizational representatives driving the innovation effort

        ii) A diverse spectrum of stakeholders that are both critical and widely distributed across technical ability and ethical value orientation

        iii) Stakeholder advocates for indirect stakeholders

        iv) Professionals who understand the social context of the SOI

v) Professionals who understand the technical capabilities of the SOI

vi) Stakeholder advocates selected in a transparent way

vii) Potential users of the system participating in the processes, as appropriate; in particular, end-users from the market or world regions in which the system is or will be deployed

viii) Institutions that are affected by the SOI or their advocates, as appropriate

ix) Civil society and legal advocates, as appropriate

2) Identify stakeholder groups

c) Describe and analyze technical and organizational control over the envisaged system. This activity consists of the following tasks:

1) Aggregate the SoS elements potentially relevant for the concept.

2) Identify the owner of the SoS elements.

3) Analyze control over the envisaged SOI and its elements.

NOTE 1—Controllability can become a challenge if the system operates in system of systems (SoS) or depends on systems with a long legacy and/or high complexity. Organizations create insight for themselves to the degree in which they have control over system elements to understand: a) whether they have sufficient influence to change/design elements that turn out to be relevant and b) whether they can be consistent with their own ethical policies. Annex E outlines what level of control is appropriate for organizations when their SOI is embedded in a wider SoS.

NOTE 2—A RACI cross-reference matrix of stakeholders to decision points is helpful in analyzing controllability and advancing through the project.

NOTE 3—This analysis should include elements within the SOI and its SoS. It investigates whether and how potential system elements can be accessed and controlled with reasonable effort. It specifies whether SoS relationships are virtual, collaborative, acknowledged, or directed. Sufficient control is more readily achieved in “acknowledged” and “directed” forms of SoS.

NOTE 4—Annex E and Annex F provide guidance on control over SoS and AI systems.

NOTE 5—Where possible, control over the SoS elements can be considered.

4) Record the controls needed to preserve ethical values in the concept.

NOTE—The supporting analysis should consider the need for control of each aspect of the concept. As extended to the resulting system, controls affect control of the supply chain, as well as control of the design through recognized methods such as system models, architecture descriptions, and interface specifications or data flow diagrams documenting control of personally identifiable data.

d) Obtain access to the enabling systems or services to be used.

e) Gather available social, legal, and environmental information on SOI feasibility. This activity consists of the following tasks:

1) Gather available information on relevant legal boundaries for the system.

2) Gather available information on prevalent social or environmental concerns potentially impacting the system.

3) Identify initial value harms and benefits related to the system.

f) Identify and suitably represent one or more system concepts of operations.

NOTE 1—Annex E gives an overview and further examples of system use contexts.

NOTE 2—Actual use cases or possible use cases (scenarios) can reveal representative values relevant in human interaction with the SOI. Potentially market research has provided insights into existing use cases of a system, especially when it is already deployed.

NOTE 3—If several use cases or contexts are available, the choice of scenario should be guided by those social, legal, and environmental issues that are most problematic with respect to fostering positive values or prohibiting negative values.

NOTE 4—The ConOps can include value-related aspects of operations as noted by the users and other stakeholders.

g) Identify and resolve gaps and discrepancies between the assumptions and outcomes of the value-based ConOps and alternative ConOps descriptions.

h) Complete concept and context analyses. This activity consists of the following tasks:

   1) Identify and record potential technical and organizational risks and improvements affecting the ConOps.

   2) Decide whether the potential ethical benefits and harms in the system concept need further treatment in requirements and system design. Determine if the ethical impact of the concept should receive explicit value analysis and risk assessment.

   NOTE—Based on the available documentation of control of elements in the ConOps, the exercise to obtain access to the enabling systems, the list of stakeholders, as well as the initial gathering of information on the social, legal, and environmental system constraints, the organization determines if it can expect to effectively control the SOI and its design. If not, the organization can modify the project scope of work to exclude the EVR; or alternatively terminate the project.

   3) As information is developed regarding prioritized values, EVRs, and ethical risk-based design characteristics, refine the ConOps.

7.4 Inputs

The following resources constitute a suitable, but not exhaustive, suite of the process inputs:

a) A potential problem for which the concept is a possible solution

b) An initial service and/or product idea

c) Organizational ethical principles

d) An initial ConOps for the SOI

7.5 Outputs

The following work products constitute a suitable, but not exhaustive, suite of the process deliverables:

a) Context description

b) Lists of stakeholders to be consulted and direct and indirect stakeholders affected by the ConOps

c) Refined SOI concept of operation

d) Outcomes of feasibility studies

8. Ethical Values Elicitation and Prioritization Process

8.1 Purpose of the Process

The purpose of the Ethical Values Elicitation and Prioritization Process is to obtain and rank values and value demonstrators for approval by management and other stakeholders as a basis for the requirements and the design of the SOI.

In this process, the direct and indirect, internal, and external stakeholders whose values are to be elicited are chosen. Utilitarianism, virtue ethics, and duty ethics are used to elicit from stakeholders the ethical issues, values, and potentials that may influence the requirements and the design of the SOI. Furthermore, any alternative ethical theory may be used that is considering the culture where the SOI will be deployed. From the collected values, issues, and potentials, core values are identified which are then described in the form of value clusters including the ethical issues, values, and potentials raised in the form of value demonstrators. The value clusters are confirmed by the stakeholders. The core values are prioritized and compared to value priorities that are suggested by authoritative external sources. In consideration of incompatibilities between the value priorities, the priorities and value clusters are adjusted. The resulting value clusters can be conceptually refined by the value lead. Value clusters are approved by selected stakeholders and management.

NOTE—B.4 discusses a philosophical approach to value ranking (prioritization). Annex C presents more information on ethical theories as applied to ethical values elicitation. Annex G identifies typical ethical values associated with systems design. Annex H discusses the application of ethical values at the organizational rather than the system level. Annex I outlines the contents of a complete case for ethics that includes the Value Register.

8.2 Outcomes

As a result of the successful implementation of the Ethical Values Elicitation and Prioritization Process, achievement of the following outcomes shall be demonstrable:

a) Stakeholder values, ethical issues, and potential harms and benefits with respect to the SOI are elicited.

b) Using conceptual analysis, values and value demonstrators are refined and organized into value clusters.

c) Value clusters are prioritized.

d) Concurrence of management with the prioritized values is obtained.

e) The activities and tasks of this process are integrated with the other tasks that develop the SOI.

8.3 Activities and tasks

The project shall implement the following activities and tasks in accordance with applicable organization policies and procedures with respect to the Value Elicitation and Prioritization Process:

NOTE—These activities can benefit from close co-operation with stakeholders and the guidance of the value lead. Many of the following activities and tasks may be most successfully conducted by the value lead who verifies and adjusts conclusions with the stakeholders.

a) Choose the stakeholders in the SOI whose values are to be elicited. This activity consists of the following tasks:

   1) Identify relevant stakeholders for ethical values elicitation and prioritization [See 7.3 b) 1)].

   2) Designate the stakeholder group.

   NOTE—The list of stakeholders is maintained in the case for ethics that is outlined in Annex I.

b) Elicit and record stakeholder values relevant to the ConOps. This activity consists of the following tasks:

1) Conduct a detailed benefits and harms-based value analysis (utilitarian ethics) as follows:

i) Identify benefits for individual stakeholders that can be provided by the SOI if the system were implemented at scale.

ii) Identify harms for individual stakeholders that can be caused by the SOI if the system were implemented at scale.

iii) Elicit the ethical values that underlie the identified potential harms and benefits.

NOTE—Benefits and harms should be elicited against the background of the question "What benefits or harms would arise if everyone were to build and/or deploy the SOI in the way we envision it?"

iv) Identify and record potential technical and organizational improvements affecting the ConOps.

2) Conduct a detailed and critical analysis of how the SOI or features within the SOI potentially change user character (virtue-ethical analysis), identifying the potential damage to the character of individual stakeholders that can occur if the system were implemented at scale.

NOTE—The potential damage to a person's character can mean that either a virtue of that person is undermined or a vice is developed.

3) Conduct a detailed and critical analysis of how the SOI or features within the SOI potentially challenge the perceived ethical duties of the stakeholders, as follows:

NOTE 1—Ethical duties can be expressed as personal value maxims. Personal value maxims are highest personal rules or, in other words, personal principles of what one wishes for and acts upon in one's own life and thinks that they should be universal laws. All personal principles are values, but not all values are personal maxims.

NOTE 2—Elicitation of values should be performed along with eliciting stakeholder needs for the SOI.

i) Identify the potential personal value maxims of project team members, which can be undermined if the system were implemented at scale.

NOTE—To say that a SOI can undermine a personal value maxim means that the nature of the SOI or its behavior does not accord with the personal maxim.

ii) Identify the potential personal value maxims of project team members that can be fostered if the system were implemented at scale.

NOTE—To say that an SOI can foster a personal value maxim means that the nature of the SOI or its behavior is in accord with the personal maxim.

4) Identify any additional ethical theories in the culture of SOI deployment that can provide additions to the list of values and elicit values via those theories that reflect the ethical expectations of that culture.

NOTE—An additional ethical framework added for value analysis should be one that is widely used in the culture of SOI's deployment, and it should ask different questions or have different foci than the utilitarian, virtue or duty ethics.

5) Capture core values, associated values, issues, and value demonstrators in the Value Register.

c) Analyze and organize the elicited values. This activity consists of the following tasks:

NOTE—This activity should be performed by the Value Lead.

1) Perform a conceptual analysis of the elicited values.

2) Identify value demonstrators based on stakeholder responses to ethical values elicitation and the elicited values.

NOTE—Name the elicited value demonstrators precisely enough to capture the associated harms or benefits.

3) Create value clusters that group identified core values with related values and value demonstrators.

NOTE 1—Detailing the value cluster simplifies traceability of the design and the requirements to the values.

NOTE 2—Relevant value demonstrators are considered in conceptually completing and refining the value clusters.

4) Verify that distinct values are not inappropriately aggregated and lost.

5) Confirm with the project stakeholders that the value clusters and their descriptions are representative of the elicited values.

6) Record confirmed value clusters and their descriptions in the Value Register.

NOTE—The Value Register is a part of the case for ethics that is outlined in Annex I.

d) Prioritize the core values for the SOI. This activity consists of the following tasks:

NOTE—In principle, all core values identified are important. Their priority and feasibility of implementation can change as the SOI matures. The core value prioritization decided in this activity gives guidance on the development priorities.

1) Prioritize the core values based on the extent to which they are important to enable the ConOps to satisfy the following ethical considerations.

i) Stakeholders agree that the SOI is good for Society and avoids unnecessary harm.

ii) The organization does not use people merely as a means to some end.

iii) Organizational leaders can accept responsibility for the value priorities chosen according to their own personal maxims.

iv) The organization respects its own stated ethical organizational principles if there are any.

v) The organization can commit to the value priorities in its business mission.

vi) The environment is maximally preserved.

vii) The organization considers existing ethical guidelines.

NOTE 1—All of the criteria in 8.3 d) 1) are equally important.

NOTE 2—When there are conflicts about value priorities, an alternative method of prioritizing values can be used, as presented in Table B.1.

2) Compare the value priorities with external sources, such as the following:

i) Relevant legal precedent that may affect whether the SOI is likely to be in compliance with legal or regulatory authorities in the area of SOI deployment

ii) Records of prior substantively similar systems, if available

iii) International agreements on ethical conduct

NOTE—Examples for applied ethics literature can found in Annex J.

3) Record in the Value Register incompatibilities between the value priorities and external sources.

4) Identify inconsistencies and conflicts among values and value demonstrators that affect the prioritization of core values.

e) Identify and record potential technical and organizational risks and opportunities affecting the values.

NOTE—Risks and opportunities can be recorded in the Case for Ethics as detailed in Annex I.

f) Perform a conceptual value analysis and refine the prioritized value clusters, including the following:

   1) Add value demonstrators derived from external sources.

   2) Refine the value demonstrators to increase the potential for technical and organizational benefits and reduce technical and organizational risks from opportunities to implement the core values.

   3) Refine the value demonstrators to support the management of technical and organizational risks to implementing the core values, and to increase the potential for technical or organizational benefits from opportunities to implement the core values.

   4) Exclude values demonstrators from further analysis that the organization cannot influence through any technical or organizational means.

   5) Annotate conflicts among values that affect their priority to be realized in the system requirements and design.

   Example: Values that conflict in this way include privacy versus provision of private information to a government entity legally authorized to require the information. See Annex G for additional examples.

g) Obtain approval for the prioritized values. This activity consists of the following tasks:

   1) Review with top management and relevant stakeholders the identified core values, value clusters including value demonstrators, and related risks and opportunities to validate their acceptability as a basis for requirements and design.

   2) As needed, repeat the activities to obtain acceptable value clusters.

   3) Record the approved value clusters, the decision, the authority and the rationale in the Value Register or preliminary case for ethics.

8.4 Inputs

The following resources constitute a suitable, but not exhaustive suite of the process inputs:

a) Applied ethics literature with conceptual frameworks for individual value's taxonomy (if available)

b) Human rights frameworks or other value lists

   NOTE—Annex F identifies typical ethical values.

c) An initial ConOps for the SOI

d) The outcome of any feasibility studies initiated during project preparation (if available)

e) A preliminary case for ethics

8.5 Outputs

The following work products constitute a suitable, but not exhaustive, suite of the process deliverables:

a) Value Register or case for ethics with selected and prioritized value clusters, core values, and value demonstrators

b) List of potential technical and organizational risks and improvements for the value clusters

c) Updates to the ConOps

d) Updated list of stakeholders to be consulted

9. Ethical Requirements Definition Process

9.1 Purpose of the Process

The purpose of the Ethical Requirements Definition Process is to formulate EVRs and value-based system requirements that define how the prioritized core values and their value demonstrators are reflected in the SOI. Ethical requirements are proposed risk mitigation treatments to protect and preserve the core values within the SOI. The process analyzes the EVRs and value-based system requirements for ethics-related risks and identifies mitigations in revisions to the requirements set. This process engages those responsible for the SOI and records their commitment to value-based requirements through validation.

NOTE 1—B.2 provides an example for ethical requirements definition.

NOTE 2—ISO/IEC/IEEE 12207:2017 [B40], 6.4.2.3 (stakeholder requirements) and 6.4.3.3 (system or software requirements) from ISO/IEC/IEEE 15288:2015 [B41], and ISO/IEC/IEEE 29148 [B48] have more detailed explanations of requirements engineering.

9.2 Outcomes

As a result of the successful implementation of the Ethical Requirements Definition Process, achievement of the following outcomes shall be demonstrable:

a) Ethical requirements of the SOI, consisting of EVRs and value-based system requirements traceable from the prioritized core values and value clusters, are specified for ethically aligned design, development, and validation.

   NOTE—EVRs can be satisfied not only through physical and functional features of the system design, but also through provisions for warranty, recall, replacement, repair, update, or upgrade of the system.

b) Value-based requirements are evaluated for feasibility and control of the SOI.

c) Ethical requirements are validated with stakeholders to protect and preserve the prioritized values.

d) Value-based requirements are harmonized and integrated with other requirements for the SOI that are derived from other sources that are not necessarily value-based.

e) The activities and tasks of this process are integrated with other tasks that define the stakeholder requirements and the system requirements for the SOI.

9.3 Activities and tasks

The project shall implement the following activities and tasks in accordance with applicable organization policies and procedures for the Ethical Requirements Definition Process.

For purposes of explanation, this process and others are presented as an ordered set of activities (see Figure 3). However, in practice, incremental and iterative development of value-based requirements and their realization, in continuous interaction with general system development, should be the norm.

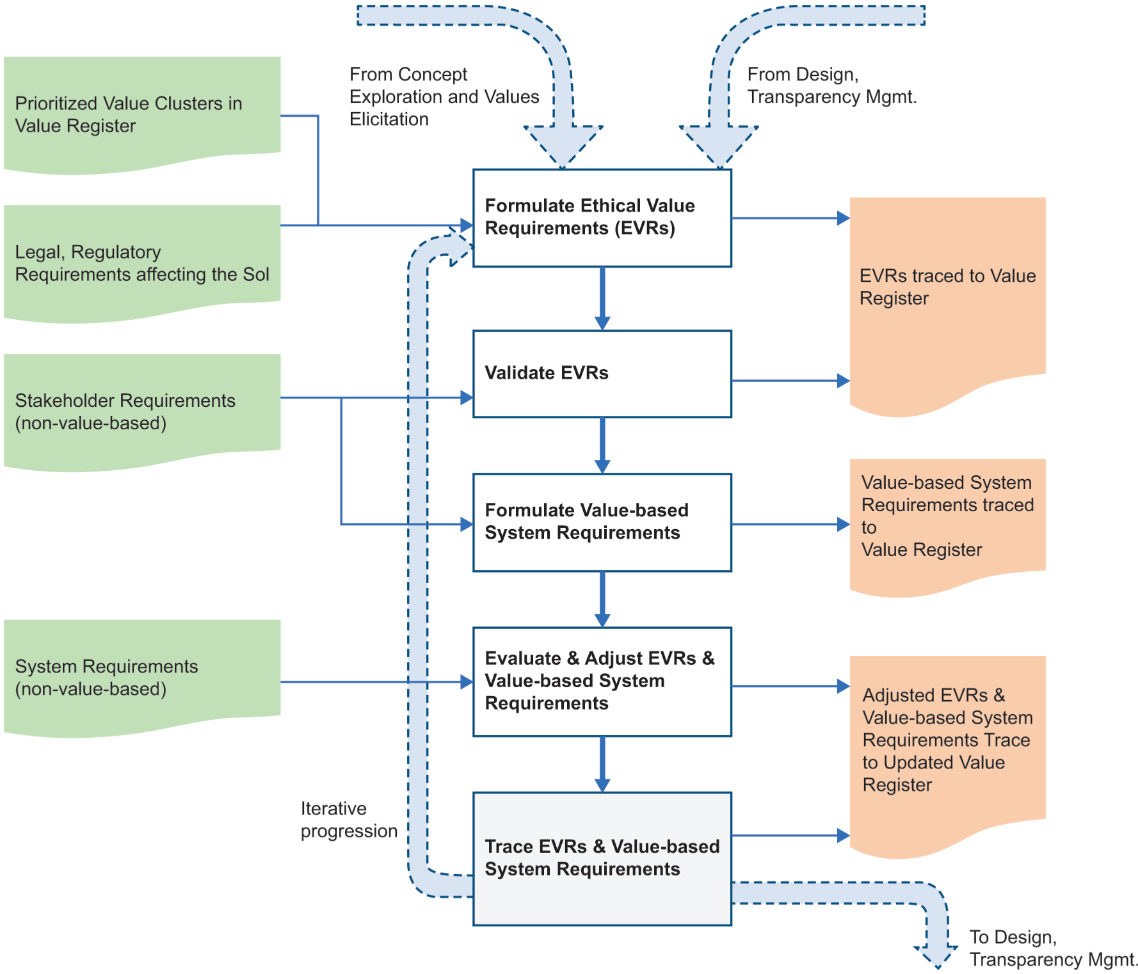

Figure 3—Ethical Requirements Definition Process

NOTE—Many of the following activities and tasks may be most successfully conducted by the value lead who verifies and adjusts conclusions with the stakeholders.

a) Formulate and record EVRs. This activity consists of the following tasks:

NOTE 1—EVRs can be expressed in formal requirement statements, use cases, user stories, scenarios, or other forms.

NOTE 2—EVRs can be used to translate the prioritized core values into the system's value dispositions.

1) Identify one or more EVRs as socio-technology statements that describe possible risk treatment options that may promote and protect the prioritized core values and realize the value demonstrators. Treatment options are technical, organizational, or social.

NOTE—Each high-priority core value and value demonstrator has at least one EVR. Normally there are one or more EVRs for each core value. It is not necessary that for every identified value there is an EVR, the number of EVRs generated should reflect only high-priority items.

2) Identify related assumptions and constraints identified with the EVRs.

3) Evaluate and, if necessary, mitigate the risks of incorrect or incomplete EVRs.

4) Record each EVR with a unique reference number, its associated risks, prioritized core values, and related assumptions and constraints.

NOTE—A simple requirements register contains a table associating each EVR with one or more value clusters.

b) Validate the EVRs along with other stakeholder requirements in cooperation with selected stakeholders, including top management and the project team.

NOTE—Any risks associated with a proposed EVR that cannot be validated are identified and mitigated.

c) Formulate and record the system requirements arising from each EVR. This activity consists of the following tasks:

1) Analyze the value demonstrators and risk mitigations in the EVRs to identify potential value dispositions.

2) For each EVR or related EVRs, formulate one or more associated value-based system requirements (functional or non-functional) that realize the EVR within the SOI.

3) Identify qualitative or quantitative measurement targets and acceptance criteria associated with each system requirement.

4) Record each value-based system requirement with a unique reference number, its traceability to an EVR, its associated risks, and related assumptions and constraints.

NOTE 1—Various techniques for determining socio-technology system requirements can be used, including research, stakeholder consultation and collaboration and experimentation (e.g., prototypes).

NOTE 2—System requirements for machine learning systems may include quantitative and qualitative data-oriented specifications that include identifications for collection of data, data formats, diversity, ranges of data, data provenance (sources), performance measures (accuracy, precision), explainability, evidence of fairness or discrimination according to legal/societal values, and regulatory use of training data (see Vogelsang and Borg [B76]).

NOTE 3—System requirements for organizational or societal systems may include personas, business capability analysis, and process modeling.

NOTE 4—Requirements records typically include and describe the structure, elements, attributes, traceability, priority, metadata, hierarchy, relationships, provenance, and other components.

NOTE 5—Registers containing EVRs and associated system requirements can be modeled in matrix format, and can also capture other requirement elements, including diagrams, formal requirement statements, use cases, user stories, scenarios, acceptance criteria, measurable conditions, constraints, assumptions, personas, business rules, organizational roles, activity flows, prototypes, data models, or other forms and descriptive components.

NOTE 6—Possible risks include an inability to formulate acceptance criteria that are measurable and sufficiently accurate.

d) Evaluate and adjust the EVR and the value-based system requirements in cooperation with stakeholders and the project team. This activity consists of the following tasks:

NOTE—This activity is stated at the level of EVR and value-based system requirements, but it can be performed at the level of subsystems, elements, and components.

1) Evaluate technical, operational, legal, and economic feasibility of the EVR and value-based system requirements.

2) Analyze and harmonize the EVR and value-based system requirements with requirements derived from non-value driven means, identifying and rationalizing competing or supportive requirements for the SOI.

3) Analyze EVR value-based system requirements in conjunction with the requirements derived from non-value driven means for technical and organizational control over the system.

NOTE—Annex F presents specific considerations for control over AI systems.

4) If needed, modify the EVR and system requirements on the basis of evaluation and risk analysis, including feedback from the design process, and record adjustments in the Case for Ethics and requirements register.

NOTE—Possible risks associated with evaluating and adjusting the ethical requirements include:

— An inability to harmonize and rationalize ethical requirements with requirements derived from non-value driven means, thereby creating two separate domains within the project

— As value-based system requirements are integrated with system requirements that have not been derived from ethical reflections, functional system requirements are prioritized over value-based system requirements for further SOI construction.

e) Analyze, trace, and record the further handling of value-based requirements in agreement with the project team and stakeholders. This activity consists of the following tasks:

1) Recheck the traceability of value-based system requirements to EVR and prioritized core values in the Value Register, showing relationships between each entity.

2) Identify and record potential changes affecting the ConOps from the ethics-based requirements.

3) Determine further handling of ethical requirements in cooperation with the project team and stakeholders, and update the risk register and Value Register.

4) Validate and record the approval of the value-based requirements by those responsible for the SOI and relevant stakeholders in the Case for Ethics.

9.4 Inputs

The following resources constitute a suitable, but not exhaustive suite of the process inputs:

a) Prioritized core values and value demonstrators (value clusters) as identified in the Value Register for the SOI

b) The SOI concept of operation

c) References to related legal and regulatory requirements affecting the SOI

d) Current or previous versions of value-based requirements

e) Other (non-value driven) stakeholder and system requirements

f) Previous feasibility studies

g) Risk register

9.5 Outputs

The following work products constitute a suitable, but not exhaustive, suite of the process deliverables:

a) EVR and value-based systems/software requirements for the SOI traceable to one or more prioritized core values

b) Potential technical and organizational risks and opportunities for the EVR

c) Improvement ideas for the concept of operation

d) Updated Value Register or Case for Ethics with traceability of values to EVR and value-based system requirements

10. Ethical Risk-Based Design Process

10.1 Purpose of the Process

The purpose of Ethical Risk-Based Design is to realize ethical values and required functionality in the system or software design. Ethical Risk-Based Design includes functionality that helps mitigate or control identified risks to EVR and value-based system requirements. This is a design activity that is fundamental to the realization of value-based system requirements and the relevant risk treatment options.

NOTE 1—As this standard aims to result in ethically aligned systems, organizations should have sufficient control over the system for which they assume responsibility.

NOTE 2—6.3.4 in ISO/IEC/IEEE 12207:2017 [B40], 6.3.4 in ISO/IEC 15288:2015 [B41], and ISO/IEC/IEEE 16085 [B43] include additional guidance on general risk management, including risk identification, risk analysis, and risk mitigation.

10.2 Outcomes

As a result of the successful implementation of the Ethical Risk-Based Design Process, achievement of the following outcomes shall be demonstrable:

a) Ethically aligned design and value dispositions are traceable to the EVRs and value-based system requirements.

b) Control over the SOI is demonstrable through design features.

c) The activities and tasks of this process are integrated with other tasks that define the design of the SOI.

d) System design treatments are identified for value-based system requirements and prioritized in response to identified risks.

10.3 Activities and tasks

The project shall implement the following activities and tasks in accordance with applicable organization policies and procedures with respect to the Ethical Risk-Based Design process:

a) Prepare for and produce a SOI ethically aligned design. This activity includes the following tasks:

   1) Identify and plan design activities and select methods and tools.

   2) Analyze and harmonize design features that realize EVRs and value-based system requirements with other design features, identifying and rationalizing competing or supportive requirements for the SOI.

   3) Incorporate the ethically derived functional, operational, procedural, organizational, or structural dispositions into the SOI design specifications.

   4) Identify and specify the system elements that embody and deliver value dispositions.

   NOTE 1—Use of participatory design techniques (often connected with iterative methods) can aid in understanding whether design alternatives are consistent with user values and EVR.

   NOTE 2—In the engineering context, prioritization of value dispositions includes determining to what extent an EVR can be satisfied through the system design, and to what extent realizing the EVRs can be balanced with achieving (or modifying) other functions and performance requirements of the system. Doing this kind of trade-off analysis is essential to realizing the ethical values in the SOI.

NOTE 3—In the case of an iterative system development, the initial prototype can be a "Minimum Viable Product" (MVP) that addresses only selected requirements.

NOTE 4—Design considers not only the deployment and operation of the system, but also its sustainability and eventual disposal or reuse.

b) In consultation with stakeholders, identify risks and risk contexts associated with the feasibility of implementing the design. This activity consists of the following tasks:

   1) Estimate the probability or likelihood of the hazard or harm to occur.

   2) Estimate the consequence (impact, degree of hazard or harm) or a benefit caused by opportunities.

   3) Combine the probability (likelihood) of hazards or harms with the degree of harm to derive the risk level for the value.

   4) Prioritize the risk.

c) Analyze and specify technical and organizational control over the system. This activity consists of the following tasks:

   1) Aggregate the system elements potentially relevant for control of the SOI.

   2) Identify the owner of the system elements.

   3) Analyze control over the SOI and its elements.

   4) Include control mechanisms in the value dispositions for system functions that can impact value-based requirements.

   5) Where feasible, simulate or prototype the related system functions and features to verify the effectiveness and acceptability of the implemented controls and risk reduction options, in consultation with the stakeholders.

   NOTE—To support incorporation of EVRs in design characteristics, the system design description contains a list of system elements relevant for a system, records the owner of this system, the owner(s) of system elements, lists how the SOI interfaces with other systems and whether SLAs are in place that can be changed (for instance in a SoS), records whether the SOI and its elements (including those residing within a wider SoS) can be manipulated with reasonable effort and within what time-frame. It contains a final judgment or scale as to degree of controllability of each system element and for the overall system.

   6) Document an ethical value control analysis.

   NOTE—Annex E outlines what level of control is appropriate when the SOI is embedded in a wider SoS. Annex F outlines principles for control over AI systems.

d) Identify and select pragmatic treatment options for work products that can reduce their respective risks or positively foster opportunities

   NOTE—Consider risk avoidance for the values through control of the supply chain as well as control of the design through recognized methods such as system models, architecture descriptions, and interface specifications or data flow diagrams documenting control of personally identifiable data.

e) Perform ethically aligned system design verification and validation. This activity consists of the following tasks:

   1) Verify that value-based requirements specifications have been fulfilled through the value dispositions of the design. Trace value-based requirements to value dispositions and SOI design features, showing relationships and dependencies between requirements and design, and showing how the design fosters or inhibits the ethical values.

   2) Determine whether risks to value-based requirements are at a level within the system design that stakeholders find tolerable (acceptable) without the need for further treatment.

   3) Document key value opportunity enhancements that are realized within the system design.

4) Identify more effective (enhanced) risk avoidance, mitigation, or treatment options when a value risk is not validated as tolerable by the stakeholders under existing treatment option(s).

5) Confirm the acceptability of the enhanced risk treatments in the design and realize value enhancement opportunities.

6) Update the system design documentation based on the implemented value risk treatment and opportunity enhancement options.

7) Capture the final state of the risk treatments and opportunity enhancement options and the final validation results in the Case for Ethics.

8) Through design verification and continued monitoring, determine when the design needs to be modified to accommodate changing contexts, different value priorities, or changes in technical needs, and reiterate the applicable processes.

10.4 Inputs

The following resources constitute a suitable, but not exhaustive suite of the process inputs:

a) Functional and non-functional system requirements including value-based requirements

b) The SOI concept of operation

c) The Value Register and preliminary Case for Ethics for the SOI

d) The Risk Register

10.5 Outputs

The following work products constitute a suitable, but not exhaustive, suite of the process deliverables:

a) An ethically aligned design for the SOI

b) A refined concept of operation and operational concept

c) An updated Value Register

d) An updated Case for Ethics

11. Transparency Management Process

11.1 Purpose of the Process

The purpose of the Transparency Management Process is to share with internal and external, short-term, and long-term stakeholders sufficient and appropriate information about how the developer has addressed ethical concerns during SOI design. This process shares information about the stakeholder values that the project has elicited and about how the project has implemented those values in the SOI. It maintains the information for retrieval both during system development and afterward.

Transparency is linked to accountability; the information to be shared should include the roles and the affiliations of the people involved in the project decisions (i.e., project team members and stakeholders).

The principle of explainability may be more relevant to the needs of stakeholders than full transparency into large data stores of complex technical specifications. Explainability implies presenting technical information in a form understandable to, and meeting the needs of, a specific user category.

11.2 Outcomes

As a result of the successful implementation of the Transparency Management process, achievement of the following outcomes shall be demonstrable:

a) Sufficient appropriate information about the ethical aspects of the SOI is made available during system development and afterward.

b) Stakeholder and project communications reflect principles of transparency, accountability, and explainability.

11.3 Activities and tasks

The organization shall implement the following activities and tasks in accordance with applicable organization policies and procedures with respect to the Transparency Management Process.

a) Prepare to manage transparency. This activity consists of the following tasks:
   1) Identify and record organizational rules for transparency that include but are not limited to the following:
      i) Information to be shared shall be available and consistent with identified stakeholders' interest and need to know.
      ii) Information to be shared shall be maintained.
      iii) Each item of information to be shared shall be approved by the managers who are directly responsible for the activities of the project that produced the information.
   2) Enforce the organizational rules for transparency and stakeholder communication.

      NOTE—Typical stakeholder communication rules include the following:
      i) Arguments are truthful, right, intelligible, and sincere.
      ii) All stakeholders are allowed equal and fair participation in a discourse.
      iii) Everyone is allowed to question any claims or assertions made by anyone else.
      iv) Anyone is allowed to express their own attitudes, desires and needs.

b) Share information about the ethical content of the SOI. This activity consists of the following tasks:
   1) Share information regarding the ConOps, Context Exploration, and related feasibility studies, as follows:
      i) A representation of each context in which the SOI is used or is likely to be used
      ii) Identity of the identified stakeholder group or groups
      iii) Potential social, legal and environmental benefits and harms to the stakeholder values to be elicited
   2) Share information about the elicitation and prioritization of core values and value demonstrators related to the SOI, such as the following:
      i) Potential benefits to stakeholders if the SOI were implemented at scale
      ii) Potential harms to stakeholders if the SOI were implemented at scale
      iii) Values that underlie the perceived benefits and harms
      iv) Potential damage to the character of individual stakeholders if the SOI was implemented at scale

v) Personal maxims of project team members that can be undermined if the SOI was implemented at scale

vi) Personal maxims of project team members that can be fostered if the SOI was implemented at scale

vii) Values not already recorded that are related to implementation of the SOI at scale in one or more particular regions of the world

viii) One or more representative clusters that group the recorded (elicited) values and the values and value demonstrators contained in them.

3) Share information regarding the EVRs and value-based system requirements

4) Share information regarding value dispositions in the design

5) Share information regarding identified risks, risk profiles, and risk treatments related to ethically aligned design.

c) Share information about the availability of collected information both during system development and afterward through the Case for Ethics.

NOTE—6.3.6.3 of ISO/IEC/IEEE 15288:2015 [B41] provides additional details [6.3.6.3 b) 2) clarifies information maintenance].

11.4 Inputs

The following resources constitute a suitable, but not exhaustive, suite of the process inputs:

a) Project decisions

b) Outputs of each process

c) Contents of the requirements, risks, and value records

11.5 Outputs

The following work products constitute a suitable, but not exhaustive, suite of the process deliverables:

a) Value Register

b) Case for Ethics

NOTE—Annex I outlines the contents of a complete Case for Ethics extending through the Ethical Risk-Based Design process.

Annex A

(informative)

Relationship of processes in IEEE Std 7000 to processes in ISO/IEC/IEEE 12207:2017 [B40] and ISO/IEC/IEEE 15288:2015 [B41]

Although the processes in this standard are related to typical systems and software engineering processes as described in ISO/IEC/IEEE 12207 [B40] and ISO/IEC/IEEE 15288 [B41], this standard has distinct processes, activities, and tasks that are unlikely to occur unless the engineering organization explicitly commits to incorporation of ethical values. The processes in this standard can be performed concurrently with the processes in ISO/IEC/IEEE 12207:2017 [B40] and ISO/IEC/IEEE 15288:2015 [B41]. Table A.1 maps the relationships on a process level.

Table A.1—Relationship of processes in IEEE Std 7000 to those in ISO/IEC/IEEE 12207:2017 [B40] and ISO/IEC/IEEE 15288:2015 [B41]

IEEE Std 7000 clause	ISO/IEC/IEEE 12207:2017 [B40] and ISO/IEC/IEEE 15288:2015 clause [B41]
7 Concept of Operations (ConOps) and Context Exploration	6.4.1 Business or mission analysis
8 Ethical Values Elicitation and Prioritization Process	6.4.1 Business or mission analysis 6.4.2 Stakeholder needs and requirements definition
9 Ethical Requirements Definition Process	6.4.2 Stakeholder needs and requirements definition 6.4.3 System requirements definition
10 Ethical Risk-Based Design Process	6.4.4 Architecture definition 6.4.5 Design definition
11 Transparency Management Process	6.3.6 Information management

Annex B

(informative)

Value concepts

B.1 Philosophical basis for value concepts

The term value is derived from the Latin word “valere,” which means “to be strong” or “to be worthy.” As a consequence of this origin of the word, a value is a conception of the desirable—what is worthwhile pursuing. The concept of value in this standard is based on Material Value Ethics, a stream of philosophy (phenomenology) developed throughout the Twentieth Century (Kelly [B51]). In this context an appropriate definition is that “a *value* is a conception …of the desirable which influences the selection from available modes, means and ends of action.” (Kluckhohn 1962, p. 395 [B52]). For example, we have a conception of the value of honesty: a phenomenon we perceive as desirable and which influences our mode of actions vis-à-vis an honest or dishonest person or slot machine. With this definition, “values are not the characteristics of things” (Scheler, p.10 [B64]), nor are they individual preferences of people. Instead, “values are clearly perceivable phenomena” (Scheler, p. 11 [B64]) that are noticed in a situation and are carried by a SOI as a result of it possessing certain “value dispositions.”

Values can be expressed in positive terms (benefits) and in negative terms (harms or hazards). Beauty, for instance, can result from the many positive value drivers an SOI can have, such as an appealingly shiny surface, attractive icon design, or an attractive sound. It can also suffer from dispositions such as clumsy form factor or an ugly color. These dispositions that “value bearers” (systems or things) can possess are enablers of “values” (i.e., beautiful hardware or a beautiful interface), which, in their entirety, cause the value of beauty to be perceived and/or appreciated (in different ways) by the world of users.

Values can be associated or mapped in groups or networks. Kelly (in referencing Hartmann) writes: “...values condition each other, in that it is not possible to grasp one value without having grasped some others” [B51]. This is the reason why value clusters are created to capture different aspects of a value that may need to be embedded in the system design. Values are extrinsic or instrumental to the core value that a system should possess. Taken together, values and value demonstrators are clustered to support one or more overall core values.

Values are related in different ways for different stakeholders, due to the stakeholder’s cultural background, as well as to their preferences, professions, upbringing, or what Scheler calls their “milieu” [B64]. Relationships as well as systems are also value bearers. For example, a marriage as a form of relationship bears different values than a normal friendship. For these reasons, value clusters are analyzed for distinct stakeholder groups and stakeholder relations.

This standard emphasizes how ethical values can be affected by technology. Values borne by people and reflected in their conduct are called virtues. Most comprehensive lists of values relevant for person’s character development are the virtues recognized in respective cultures. Virtues are the values we appreciate in the behavior of persons. And they are, at the same time, value traits in a person’s character that lead to his or her long-term eudemonia (well-being) in life.

Systems can undermine virtues. For example, playing violent computer games can influence the virtue of “dama” (temperance). But computer games can, at the same time, entrain and foster values, such as “charity.” by integrating and remunerating such a virtue in their story line.

Across cultures, virtues are generally marked by well-balanced golden-mean behavior(s); hence avoiding extreme behaviors. For example, the virtue of generosity is marked by being the golden mean between greediness and lavishness. Examples of “golden-mean”-virtues (as identified by Aristotle in his *Nichomachean*

*Ethic*s [B5]) are prudence, temperance, courage, high-mindedness, gentleness, generosity, humor, kindness, and justice or truthfulness. Roman virtues reflected some cultural differences: mercy, dignity, discipline, prudence, sternness, spiritual authority, respectability, and industriousness (see Marcus Aurelius [B56]). Buddhism's four brahmavihara ("Divine States") are not identical, but similar to virtues in the European sense (see Gethin [B16]). The four states are as follows:

— *Metta/Maitri:* loving-kindness toward all; the hope that a person is well; loving kindness is the wish that all sentient beings, without any exception, be happy.

— *Karuṇā:* compassion; the hope that a person's sufferings are diminished; compassion is the wish for all sentient beings to be free from suffering.

— *Mudita:* altruistic joy in the accomplishments of a person, oneself or other; sympathetic joy is the wholesome attitude of rejoicing in the happiness and virtues of all sentient beings.

— *Upekkha/Upeksha:* equanimity, or learning to accept both loss and gain, praise and blame, success and failure with detachment, equally, for oneself and for others. Equanimity means not to distinguish between friend, enemy or stranger, but to regard every sentient being as equal. It is a clear-minded tranquil state of mind; not being overpowered by delusions, mental dullness or agitation.

B.2 Example of value concepts applied to Ethical Risk-Based Design

Figure 2 illustrates the layered value terminology used in this standard. This example traces use of value concepts through a design case.

A systems engineering organization anticipates that a full-body scanner at an airport should protect the value of privacy. Privacy requires a number of ethical value demonstrators to be respected: for instance, avoidance of exposure of genitals, avoidance of exposure of passengers' figures, and the related value of confidentiality, with the value demonstrator of avoiding exposure of individuals' data to other passengers. This standard's methodology helps project teams to identify privacy as a relevant ethical value along with other related and unrelated values and value demonstrators.

In the Ethical Values Elicitation and Prioritization process (see Clause 8), the goal is to identify the higher values for a system so they can be prioritized in the EVR and system design. In this example of the scanner, the highest value is air safety (value demonstrator: no dangerous articles carried onboard). The value of privacy also has a high value. (People complained to authorities and refused to use a previous generation of body-imaging X-ray technology that displayed precise images of naked bodies to the security agent.) Efficiency (saving passengers' time) is a lower-level value in prioritization for the airport scanner.

If the organization accepts privacy as a high-ranking core value for the system, it should be formulated in an EVR, e.g., "The system shall protect the privacy of body images of scanned passengers." The EVR can then be translated into explicit value-based systems requirements, e.g., "The system shall display images of suspected contraband metal, plastic, ceramic, and explosive items positioned on a generic body outline." Clause 9 of this standard describes the process of translating prioritized values into concrete EVRs and value-based system requirements. The system requirements are applied to produce a design that incorporates the relevant value dispositions (see Clause 10).

As a value bearer, the scanner system has some "value dispositions" (enablers or inhibitors of the privacy value) that fulfill the value-based system requirements. the security screens depicting passengers don't display the passengers' exact body contours or genitals. The generic body outline shown on the system display thus becomes a value disposition. These privacy-preserving dispositions at the level of the system (the scanner) lead to the negative value of exposure being prevented. Another disposition is the encryption and immediate deletion of passengers' scanner profiles once the passenger has cleared security. This data deletion disposition in the scanner system protects the confidentiality of the collected passenger data and thereby enables the value of passenger privacy. The core value of privacy can then be engineered into the scanner (the value bearer) through its physical design, software functionality, and operational procedures, and become part of its value proposition.

This standard's risk-based approach helps an organization to systematically look into the relative importance of values like privacy, exposure, and confidentiality when prioritized in comparison with other competing values like air safety, right to bear arms, efficiency, and accuracy. In risk assessment, an issue like exposure of data (as well as exposure to hazardous radiation) is identified as a risk of harm. This standard prescribes that system development teams should engage in risk assessment and think about the extent to which such harms should be mitigated by technical or procedural/organizational approaches. It asks organizations to identify effective control techniques for prioritized harms and to transparently record and communicate their decisions. However, this standard does not prescribe any specific design solutions, implementations, test approaches, interfaces, or data structures, for specific negative values or risks since these are highly context sensitive. This level of detail (e.g., the use of millimeter wave technology or X-ray backscatter technology for scanning) is left to other domain-specific standards and the competence of the designers.

B.3 Value axioms

The conception of something positive can only materialize if there is at the same time the presence and awareness of the non-desirable from which the positive can differentiate. Consequently, scholars embrace the existence of "negative values" as well.

Positive and negative values interrelate in the following way (Axioms of Material Value Ethics):

a) The existence of a positive value is itself a positive value.
b) The non-existence of a positive value is itself a negative value.
c) The existence of a negative value is itself a negative value.
d) The non-existence of a negative value is itself a positive value.

The value axioms become specifically clear when thinking about human virtues. A virtue is a specific type of value: it is the value borne by a person. When a person bears a value, such as courage or generosity, we talk about a "virtue." The existence of the virtue of courage is itself a positive value. The undermining or increasing non-existence of courage in society is itself a negative value. The existence of the vice of cowardice is itself a negative value. The non-existence of cowardice is itself a positive value.

B.4 Value-ranking criteria in Material Value Ethics

Sometimes values appear to be in conflict. When this happens, it is helpful to know some criteria that can support a rational value ranking from a philosophical perspective. Material Value Ethics offers some indication as to what makes one value more important or 'higher' than another. These ranking criteria are summarized in Table B.1. and include the persistence of a value, its divisibility, the degree of integrity it has, the depth of satisfaction it gives to humans and its relative independence from a value bearer.

Table B.1—Principles for value ranking

Values are higher…	Examples
… the more they endure (has nothing to do with absolute time, but with the *persistence* of a value, the eternality of a value	Love is higher than enthusiasm; happiness is higher than convenience.
… the less they are extensible or divisible	A piece of art cannot be divided, which is why it is of higher value than a piece of bread; beauty as a phenomenon is of higher value than an attractive haircut.
…the less they are founded through other values (classical distinction between intrinsic and extrinsic values)	Dignity is a higher value than amusing, which caters to dignity.
… the deeper the satisfaction connected with feeling them	A deep life satisfaction is of higher value than feeling happy while on a walk.
…the less the feeling is relative to the positioning or existence of a specific bearer of feeling or preferring	Moral values (e.g., fairness) are higher than a value such as convenience, which needs a bearer (a situation or thing that is convenient).

For example, take the value of privacy for a virtual-world gamer. Privacy can be undermined when players are generally not anonymous in games for security reasons. What value is higher: privacy or security? Privacy is an ongoing boundary regulation value with higher *persistence* than security. Security is not an ongoing regulation value present in some social processes. Instead security in some contexts is considered relevant only in those cases where the safety of a person or the integrity of a system is threatened. The level of security is also determined by other values, such as confidentiality, integrity, or authenticity; so, it is a highly extrinsic value and it is even instrumental to the higher value of privacy. A right to privacy can be considered intrinsic, a fundamental need of any free person. So, in this situation, the value of privacy would be held higher than the value of security and a gaming platform would be therefore designed such that it prioritizes privacy over security. That said: This *default* prioritization of the value of privacy does not mean that there can be no exceptions to the rule. In this case, even if the gaming company worked toward the prioritized default privacy of its users, it can still revoke anonymity and player privacy if the context requires it; for instance, when the police are legitimately searching for a specific player. Ideally, organizations set higher values as defaults and prioritize them, but they can have mechanisms to revoke this order when needed.

Often it is questioned where money or financial gain is placed in the hierarchy of values. According to Material Value Ethics, the answer is simple: money or financial gain is always only instrumental to some other value; it is a means to buy something, it is divisible. Its reception gives a person a temporary pleasure (perhaps one is extremely happy to win the lottery, but this happiness is not persistent). Money does not give as deep a satisfaction as other values such as love, dignity, or health. And money does not exist as a value if there is not a trusted monetary bearer for it, such as coins or a banking system supporting its existence. So the value of money or financial gain is relatively low regardless of the sum. Human life is considered priceless and cannot be directly compared to financial gain.

Ranking and prioritization of values according to Material Value Ethics is a philosophical exercise that involves holistic thinking to come to terms with ethical dilemmas. The ethical dilemma can be eased by distinguishing between system defaults and system exceptions. This exercise of philosophical reasoning for defaults and determination of exceptions can be expected in organizational decision-making in those cases where few of the criteria listed in 8.3 are working effectively.

Annex C

(informative)

Ethical theories applied to Ethical Values Elicitation

In Clause 8, ethical theories are used to help unveil relevant values for a technical service or product. An ethical theory is a formalization of insights regarding how people can judge right from wrong. Whether promulgated by religious or philosophical texts, an ethical theory is the result of people distilling a sense of how to distinguish moral action from immoral action into behavioral guidance that can be applied broadly and perhaps even universally. Ethical theories are fundamentally a way of designating what features of a context are most salient to making a moral judgment about people's actions or about technology's likely effects. For example, if we were to tell someone that stealing a pair of shoes is morally wrong, we certainly do not think it was salient whether the shoes were red or blue or high-heeled or flat-soled. We instead ask what other features are salient or most important to our moral judgment? The harm done to the shoe-seller on an individual basis? The harm done to the community or society in general through disorder? The reflection of the thief's poor character? The violation of a law forbidding stealing?

Because ethical theories are abstractions and do not themselves provide context-specific guidance (e.g., no ethical theory is focused on shoe-stealing specifically), a significant amount of interpretation is required to guide concrete decisions about whether a particular action is ethically permissible, required, or forbidden in a given context.

Ethical Value Elicitation Activities are organized to produce a common output across the diversity of available ethical theories and maintained in a Value Register. The goal of the Ethical Values Elicitation and Prioritization Process is to identify leverage points to improve outcomes through the Ethical Risk-Based Design process. The ethical theories underlying this standard indicate where system designers are likely to find the most productive indicators of values. Whereas from a philosophical or anthropological perspective different ethical theories may be considered incompatible with one another, in this standard's values-oriented framework, ethical theories and principles function primarily as a robust method for noticing and articulating the most relevant set of values whose absence results in harms to the system and its users. The values that can be elicited via utilitarian perspectives focused on harms and benefits are different from those that can be elicited via the virtue ethical method. The focus on character, duty, harms, and benefits should be understood by users that these can provide a broad preliminary basis for an Ethical Values Elicitation and Prioritization Process. These three Western philosophical theories should be treated as non-exhaustive and complementary approaches to effectively eliciting and tracking the values relevant to design of the SOI.

C.1 Utilitarian ethics

Utilitarian ethics is the most common subset of consequentialism: it asserts that the outcomes (benefits and harms) of an action are the most important feature when judging whether an action (or ConOps of a system) is ethical (Mill [B57]). "Utility" is simply one common way of measuring consequences and is typically treated as a synonym for "happiness," "pleasure," or "well-being," with the opposite state of "disutility" being synonymous with "unhappiness" or "pain." The core goal of utilitarianism has been expressed as: "Everyone ought to act so as to bring about the greatest amount of happiness for the greatest number of people," or similarly: "Always act to create the most good consequences and least bad consequences." Put most simply: utilitarianism is the belief that the overall good created by an action is the most ethically relevant feature of that action. Using utilitarianism means to believe that the overall good created by an SOI is the most ethically relevant for a system.

In General Utilitarianism, which we apply in this standard, utility is considered globally and universally: the utility of everyone affected by the action is considered in an egalitarian fashion, and everyone's happiness is considered to be of equal type and importance without regard to a person's station in life. In the context of system design, utilitarianism has the value of connecting national and business interests in welfare macroeconomics with the long-term happiness of individual human beings. A rationally economically self-interested organization should invest in understanding and tracking the utility consequences of its actions broadly, and not only in monetary terms because, in the long run, harms done to society reduce the viability of the organization. In the context of this standard, this goal is transferred to project teams who should act to bring about the greatest amount of happiness to the greatest number of human beings impacted by the system under development. Project teams should approach this goal by asking, "What benefits or harms arise if everyone were to build and/or deploy our SOI in the way we envision it?" This question is derived from the original philosophical question of John Stuart Mill: "What would happen if everyone were to do so-and-so in such cases?" [B57]. In doing so they should consider the consequences for both direct and indirect stakeholders in the short, middle, and long terms.

This standard is intended to help organizations track utility by translating harms and benefits into values that can then be weighed as to their importance. For example, if stakeholder ethical values elicitation indicates that the most harmful aspect of using public transit is stress induced by uncertainty about whether the train will arrive on time, then designers should understand that the value of "certainty" should be ranked highly when designing an app or signage for the transit system.

C.2 Virtue ethics

A specific form of values are the virtues. Virtues are the values carried by a person or, in other words, the personal characteristics of a person that make him or her a "good" person and allow him or her to achieve long-term satisfaction and wellbeing in life (Aristotle [B5], MacIntyre [B55]). Examples are courage, patience, kindness, and honesty. Virtue ethics in this engineering context aim to help humans using the system as well as other stakeholders to flourish upon long-term system use—flourish in the sense that their characters can maintain or even increase in virtuousness and hence wellbeing. Therefore, the virtue ethical approach tries to anticipate how an envisioned system influences a person's habitual character and virtuous behavior in the long term. It should be assumed that systems affecting human behavior encourage certain personal character qualities and discourage others, and the theory of virtue ethics functions to account for those effects.

Virtues can be regarded as habitual character qualities that make a human being a good and moral community member and decision maker. This definition of virtue in relation to one's community implies that ethical system design practices should be open for both global and culture-specific virtue priorities, because every cultural community has its own priorities regarding what is good and moral behavior that is embedded in regional and global cultures. System design teams should reflect on how their envisioned system impacts the virtuousness of human beings using a system over a longer period and, for this purpose, consider the culture or region into which the system is to be deployed.

This standard is intended to help organizations track the virtues shown in their systems. As a result of virtue ethical analysis, the project team accumulates a list of virtues that stakeholders want to foster in human users of the envisioned system. It likewise has a list of virtues that can be undermined as a result of using the envisioned system. For example, if a social networking SOI encourages users to habitually behave cruelly to other persons, the discouragement of the virtue "kindness" is considered a virtue harm to be weighed against that particular design. Similarly, if a system design is found to cause users to behave habitually in a cooperative manner, then that is weighted as a value benefit. Comparing virtues fostered and undermined, project teams can rank their importance, set system design priorities, and make the decision whether to invest in a system.

While some virtues may be culturally specific or weighted more heavily by one culture compared to another, an emphasis on personal character appears to be nearly universal in human cultures. "What would a good person do?" is a common criterion for determining whether an action is ethically praiseworthy and is a useful proxy question in the virtue ethics activities of the Ethical Values Elicitation and Prioritization Process. Role models are a common feature of moral reasoning and a core feature of understanding virtue ethics. Virtues are the positive traits of role models in a society; however, users of this standard should be aware that what is virtuous to one person may appear non-virtuous to another, even if both value the same set of virtues. Therefore, a wide set of stakeholders should be involved in an ethical value activity, to develop a joint common sense on the virtues prioritized in a project.

C.3 Duty ethics

Duty ethics (also called "deontology") aim to identify universal rules that place boundaries on everyone's actions (Kant [B50]). Ethics identifies the fulfillment of such expectations as the salient aspect of judging whether an action or decision is ethical. Duty ethics typically asks questions from an impersonal distance, reasoning backward from what it is rational for any person to do in a circumstance or set of circumstances without reference to contingent aspects such as happiness or character. The Western philosopher most strongly associated with duty ethics, Immanuel Kant, sought to identify universal moral laws that should place limits on every rational person's actions. By strongly associating abstract reason with moral judgment he sought to show that acting unethically was fundamentally irrational in a way that no rational person should choose. Furthermore, this association between reason and morality implies that all people, simply because we are capable of reason, should treat other people as beings with inherent value that should not be diminished.

In the context of systems design, duty ethics aims to align design teams' and top management's personal ethics (or value maxims) with the expectations of stakeholders. Top management can be owners of an organization, majority shareholders, and/or senior managers in the organization, ideally including members of the board. Many organizations also have written values statements or ethics codes written in part by the organization's leadership that can be referred to as evidence of their leadership's principles.

This standard is intended to help organizations track and articulate relevant duties to identify values that are relevant to the Ethical Risk-Based Design Process. This is accomplished by enquiring into top management's, the design teams' and stakeholders' personal "maxims." A maxim is a person's intention or reason for acting in a particular way. Personal maxims are personal values with universal validity, which (in an ideal scenario) should govern a person's life. For example, if a designer refused to deceive a client, this may be due to his or her value maxim of "honesty." This again translates into a duty or rule "never act dishonestly in order to achieve economic gain." This maxim is rational because it is ultimately to everyone's benefit to act honestly in economic transactions—if everyone acted dishonestly then commerce would collapse. Therefore, according to duty ethics, we have a duty to always act honestly in commerce regardless of near-term outcomes that may reduce our own economic status. In the context of an organization, maxims are personal principles that the leaders and stakeholders wish for themselves and therefore have the duty to act upon in the interest of others.

According to Kant [B50], all the personal principles that can be rightfully willed for are derived from the so called "categorical imperative" (synonym: "universal command"), an overarching rule of ethical behavior that describes all the others. The categorical imperative as proposed by Kant is typically stated in two philosophically equivalent fashions:

a) Act only according to that maxim whereby you can, at the same time, will that it should become a universal law." In other words, always act in a manner that your reasons for acting can be adopted by everyone in every situation. If you would not choose to live in a world where everyone lived by the same maxim you are acting by in this moment, then your action is immoral and irrational.

b) So act that you use humanity, whether in your own person or in the person of any other, always at the same time as an end, never merely as a means." In other words, because all people have an inherent dignity, we should never treat each other as a mere means to get what we want. Even when we have an instrumental relationship to another person (such as an economic relationship), we should treat each other with the respect due to other rational, autonomous persons because a world without such respect would be irrational and unlivable.

The second formulation is typically considered the easiest to apply to a practical situation, such as situations found in system design. Notably, duty ethics are typically not concerned with the detailed specifics of what would count as respect but are instead stated as negative principles that tell us what we should never do. They set wide boundaries on the range of acceptable behavior rather than specifying precisely which behavior is preferred. The categorical imperative should be understood as the underlying framework by which duty ethics operates and are therefore the inspiration for the duty ethics activities described in Clause 8.

In systems design it is important to understand how both respect and disrespect for people can be concretely built into a system. For example, if a machine-learning system routinely associated a group of people with an insulting epithet due to social bigotry incorporated into the historical learning data, that would be considered a “dignitary harm” violating the duty to always treat people with respect. The most common way a technical system can undermine a person’s dignity is by not respecting their autonomy to make their own choices over matters that are important to their own lives, such as data privacy or medical decisions. This document assumes that all people responsible for a system should endeavor to ask whether that system treats individuals as a mere means at any point. If such a harm is discovered, it is a primary point to look for alternative design priorities.

Eliciting value priorities as the personal maxims of members of responsible management, design teams, stakeholders, and respected moral leaders from outside an organization illuminates the common expectations about how a system should treat people. The work of eliciting and aligning these expectations functions to identify what these groups of people value, providing useful parameters for the SOI’s value priorities.

C.4 Other ethical theories and models

As stated above, utilitarian, virtue and duty analyses are not exhaustive accounts of how people and communities can be harmed. These three core theories are emphasized because they identify salient, widely familiar features of ethical reasoning: consequences, character, and duties. However, there are numerous alternative models and traditions, which an Ethical Values Elicitation Activity can accommodate, as long as the output of those analyses are consistent and rankable ethical values.

For example, a non-exhaustive list of other ethical theories may be of use in identifying relevant values, as follows:

- *Ethics of care:* In contrast to the universalism of other theories, ethics of care emphasizes the particularity of close interpersonal and social relationships as the foundation of human empathy (see Held [B20])
- *Pragmatism:* Morality develops in a similar manner to scientific knowledge, with refinements and improvements over time, and without the expectation that there is a final state of perfect knowledge. Creedence should therefore be given to well-considered social norms and be open to reasoned arguments about how norms should change (see Legg and Hookway [B54])
- *Culturally-appropriate theories:* Relevant ethical theories that are widely used in the SOI’s target market (see Baghramian and Carter [B6])
- *Natural law:* Determinations of right and wrong should be derived from the natural or divine order of the world (see Finnis [B14])
- *Casuistry:* We should primarily rely on precedents when making an ethical judgment, reasoning from a paradigmatic case for guidance about how to respond to similar cases in the present. Casuistry is often utilized in applied ethics contexts, such as hospital ethics boards. Rigorous use of casuistry requires access to precedents, subject-matter experts, and case studies (see Schmidt [B66])

Furthermore, there are approaches to ethical reasoning that rely on no theory but rather emphasize specific principles that have proven contextually useful. This is sometimes called “principlism” (see Beauchamp and DeGrazia [B7]) Such an approach is familiar in scientific and technological communities, where a set of principles can be derived from the common goal of generating empirical knowledge in an effective and trustworthy manner. A well-functioning scientific community requires that participants adhere to principles such as the following:

a) Communicate and debate openly
b) Attribute prior research and labor fairly
c) Be transparent with data and methods
d) Rely on replicability and peer-review of findings

In such a case, the relevant ethical values identified are openness, fairness, transparency, and replicability. It is possible to articulate why violation of those norms is a harm to the scientific community and its common goals without referring to any traditional ethical theory.

Similarly, biomedical research is often associated with three core ethical principles, as articulated by the Belmont Report: respect for persons, beneficence, and justice (Belmont Report [B9]). Most scientific research ethics review processes are governed by some variation of these principles, such as Institutional Review Boards (IRB) in the United States or Research Ethics Committees (REC) in the European Union. Similarly, most nations have signed on to sets of principles that protect universal human rights in medical research, such as the Nuremberg Code (see Weindling [B77]) and Helsinki Declaration [B79]. Furthermore, many professional societies to which the designers of an SOI may belong to have codes of professional ethics that should be considered, such as the IEEE Code of Ethics [B24] or the Association of Computing Machinery's Code of Ethics and Professional Conduct [B1]. Any given SOI may have similar widely accepted principles at stake, which should be considered within the analysis. The processes defined by this standard encourage consideration of these widely helpful principles as a way to check on the priorities of the organization designing the SOI relative to common norms of science and engineering.

Ethical theories occupy an intermediate space between cultural specificity and global universality that poses challenges for the global mandate of IEEE standards. Each of the ethical theories described in this standard was developed in a specific historical and cultural context and, therefore, make use of the linguistic and conceptual resources available to it. Unavoidably, Western philosophical literature uses different terminology than philosophical traditions of the Indian subcontinent or the Confucian philosophies of East Asia. Yet despite the local influence present in ethical theories, all of them make some degree of claim upon what is right and wrong for every person, in every culture, and in every time (Vallor [B75]). Therefore, a globally applicable standard that invokes the most robust resources of ethical reasoning should also acknowledge some degree of localized and culturally specific concepts and terminology.

The ethical activities outlined in Clause 8 on ethical values elicitation emphasize three approaches directly derived from the Western philosophical canon. But they were framed such that they are culturally sensitive: Personal character (virtue ethics, Aristotle [B5]) is something that all cultures care about with different emphases. Moral duty (deontology, Kant [B50]) is known in all cultures even if these duties can vary (duty ethics or deontology, Alexander and Moore [B2]). Harms and benefits (utilitarianism, Mill [B57]) is also known to all cultures. In addition, users of this standard can identify the relevant value space in their own culturally adaptive way [see activity 8.3 c)]. The process can return different and culturally sensitive value results and value priorities for its distinct users.

Annex D

(informative)

Legal, social, and environmental feasibility analyses

A legal, social, or environmental feasibility analysis allows further consideration of the potential intended or unexpected system impacts. Analyses can be performed at the stage of concept exploration or during system development. The open-ended questions in Table D.1 are intended to result in organizational conversations across domains because they are not context specific. Questions are presented as an illustration of the approach to this mode of feasibility analysis. These questions are not complete and sufficient in all cases but illustrate a typical approach for a 360-degree view of the context as part of a triple-bottom-line approach (financial, social, environmental).

The legal questions can be applied to already enacted laws and regulations, as well as to cross-jurisdiction and cross-functional considerations and to potential laws and regulation, that may affect the SOI, its users and other stakeholders, and the broader international context.

The social and environmental feasibility questions pertain to how the ConOps and the SOI can impact the social and cultural lives and geographic contexts of the stakeholders and users. The social feasibility analysis can be significant in developing a concept of operation and in the design of an SOI, because potential severe adverse impacts may be unintended and unknown to communities of affected stakeholders. Social feasibility can involve risk management and mitigating the risk of those impacts in the ConOps and system design.

New IT systems and other SOI's can also have significant environmental impacts arising from construction and system operation, which can be both positive and negative. The Precautionary Principle is often applied: when an activity raises threats of harm to human health or the environment, precautions should be taken, even if causality is not fully scientifically established. The impacts may also include follow-on effects beyond the immediate legal, social, or environmental impacts, as well as beyond the stakeholders directly associated with the SOI (secondary impacts). Secondary impacts can be addressed independently in further conversations and analyses.

Table D.1—Legal, social, and environmental feasibility study and analysis guidelines

Analysis topic	Legal	Social	Environmental
Definition	Legal feasibility study and analysis includes the identification and analysis of pertinent laws and regulations that may affect the SOI, its stakeholders, users, society, and broader international policy.	Social feasibility study and analysis includes the identification and scrutiny of the community and cultural aspects that may be affected by the SOI design.	Environmental feasibility study and analysis includes the identification and analysis of pertinent or natural laws and regulations that may affect the natural environment, its stakeholders, ecosystem, life forms, and biodiversity.
Description	Due diligence is relevant for civil law, criminal law, and precedent case history that may affect the SOI design and also how the SOI design may affect the legal rights and status of stakeholders, users, society, and broader international policy.	Analysis should address a broad set of issues related to changes in the social, economic, political, and cultural conditions in which stakeholders/users live and work. Specific types of social issues and cultural impacts associated with an SOI can vary considerably. Thus, different SOI's result in different levels and depths of analysis depending on the social issues.	The environmental feasibility study and analysis determines the impacts the SOI can have on natural systems, including climate change, biodiversity, resources, water, waste, life cycles, recycling, contamination, or overt abuse of scarce resources.

Table continues

Table D.1—Legal, social, and environmental feasibility study and analysis guidelines *(continued)*

Analysis topic	Legal	Social	Environmental
Question 1	Who are the leaders, managers, consultants, individuals, or groups, legally accountable and responsible for the design milestones across the concept exploration and development stages? Record the full chain of command in the design custody.	What different kinds of demographics, geographies and cultures are impacted by the SOI as designed?	What is the project/SOI's approach to compliance with international environmental standards such as ISO 26000 [B28] and ISO 14001 [B27]?
Question 2	What local, regional, national, and international regulatory bodies should be consulted or enhanced to evaluate a full 360 view of the SOI's legal responsibilities to its stakeholders, users, society, and international policy?	Are any special interest groups or stakeholders differentially impacted by the SOI's design? If so, how are these to be identified and addressed?	What is the scope and scale of the environmental impact?
Question 3	Are any special interest groups or stakeholder legal rights differentially impacted by the SOI's design? If so, how ae these to be identified and addressed?	Are there significant social, economic, political, or cultural issues among the stakeholders and users and their geographies/ cultures that should be analyzed using the precautionary principle? If so, they should be described in writing as a social feasibility baseline report.	How is the Precautionary Principle being applied? Describe how risks and threats are being identified and mitigated.
Question 4	What legislation relates to the granting of ownership/ control of the SOI design, data, use, storage and final disposition?	How can the SOI design be adapted to be more socially and culturally relevant for stakeholders and users?	What actions and policies are being taken for the SOI's use of rare earth materials, avoidance of contamination, recycling of waste materials, protection of habitats and wildlife?

Table continues

Table D.1—Legal, social, and environmental feasibility study and analysis guidelines *(continued)*

Analysis topic	Legal	Social	Environmental
Question 5	What are the laws regulating current and future income streams related to SOI design, assets, and stakeholder data derived from designs across international boundaries?	How can a two-way public conversation be opened to assess the social impact of the SOI to promote the active engagement of individuals, groups, and organizations who have a stake in the SOI design and its outcomes?	Describe the environmental plan developed for the design of the SOI and the associated resources?
Question 6	If the SOI's impact on stakeholders, society, and the broader international policy are considered "legal," provide three points of reference as evidence that its impact can also be considered "ethical."	If the SOI's impact on stakeholders, society, and the broader international policy are considered "ethical," provide three points of reference and ask how the SOI design can surpass the ethical considerations.	Name the person responsible and describe the contingency and emergency response plan for the environmental aspects of the SOI?
Outputs	a) Accountability report of full chain of custody for the design, including individual contact information. b) Communication report with regulatory bodies and a descriptive report of the differential impact on stakeholders, users, society, and relevant international policy making organizations such as the GDPR. c) SIG (special interest group) demographic report and action plans for addressing SIGS legal requirements. d) In-depth Data Life Cycle use evaluation, including a description of the income stream analysis. e) Gap analysis report between legal and ethical imperatives and requirements.	a) Descriptive impact report of the demographic, geographic, and cultural stakeholders. b) SIG (special interest group) action plans for addressing SIGS legal requirements. c) Precautionary principle evaluation as described in a social feasibility baseline report. d) Communication report of two-way public conversation on SOI adaptation for added relevance to stakeholders and users, including three reference points for exceeding ethical considerations.	a) ISO environmental compliance report. b) Precautionary Principle report, including identification of risks, threats, and description of the actions being taken for use of rare and vulnerable earth resources and the policies in place to protect habitats and wildlife. c) Environmental plan, including a description of the contingency response actions to be taken in an emergency.

Annex E

(informative)

Control considerations in systems of systems (SoS)

Many systems of interest build on system elements sourced from outside an organization's managerial boundaries. The SOI, for example, may consume cloud services, web services, storage, data processing, components, and other system elements under external control. It is not always a given that organizations have control over these system elements—at least not to a degree that ethical guarantees can be given for them. Organizations with low control and observability over external system elements can only be partially effective in addressing ethical concerns in the system development lifecycle.

The following aspects of system control should be analyzed (which ethical issues identified in the ethical issues register are connected to the system element):

— Organizational measures and system requirements to ensure observability of the ethical issues

— Technical measures and system requirements for the controllability of the ethical issues

— A judgment on the observability of ethical issues in the system element or constituent system

— A judgment on the controllability of ethical issues in the system element or constituent system

Controllability can become a challenge if the system operates in system of systems (SoS) or depends on systems with a long legacy and/or high complexity. Organizations create insight for themselves to the degree to which they have control over system elements to understand the following:

a) Whether they have sufficient influence to change/design elements that can turn out to be relevant

b) Whether they can live up to their own ethical policies

The organization needs to address control and observability over system elements both in systems in their first lifecycle and in further lifecycles. Systems in their first lifecycle are designed from zero not having existed before. Designing an SOI in a further lifecycle means the SOI exists already or is a piece within a larger system environment that is already operating. In such a situation it is vital to understand the level of control an organization has over existing system elements that are parts of or input factors to the SOI.

Depending on the strength of the governance relationships between the constituent systems and the SoS, ISO/IEC/IEEE 15288:2015 [B41] and ISO/IEC/IEEE 12207:2017 [B40] characterize and distinguish four forms of SoS (see Table E.1). The level of observability and control over ethical concerns of the constituent system determines the maximum degree of ethical risk that can acceptably be influenced by or connected to the constituent system. Because of the non-existing or very low observability and control over ethical issues in constituent systems characterized as virtual systems, these systems should only be related to insignificant or very low ethical risks. If an ethical risk is influenced by a constituent system that is characterized as a virtual system, the connected ethical risk should not be higher than insignificant or very low. Constituent systems that are collaborative in nature should not expose the SOI to an ethical risk that is greater than low. In case of an acknowledged type of a constituent system, ethical issues should be controlled through defined service level agreements (SLAs) that outline the expectations and requirements of the organization using this standard, including mechanisms for monitoring the ethical values of service fulfillment. Constituent systems of directed nature provide the highest level of observability and control over ethical issues. In a directed SoS, procedures can be established for constituent systems to help control risks to ethical values.

Table E.1—Types of systems of systems (SoS)

Type of SoS	Character as described in ISO/IEC/IEEE 15288:2015 [B41]	Observability of ethical issues	Control over ethical issues	Maximum risk of ethical value at stake that can be treated
Virtual systems	Lack a central management authority Lack of centrally agreed upon purpose Emerging behaviors that rely upon relatively invisible mechanisms to maintain it	None/very low	None/ very low	Insignificant/ very low
Collaborative systems	Component systems interact voluntarily to fulfill agreed upon purposes Collectively decide how to interoperate, enforcing and maintaining standards	Low	Low	Low
Acknowledged systems	Recognized objectives, a designated manager, and resources for the SoS Constituent systems retain their independent ownership, management, and resources	Medium	Medium	Medium
Directed systems	Integrated SoS built and managed to fulfill specific purposes Centrally managed and evolved Component systems maintain ability to operate independently Normal operational mode is subordinated to central purpose	High	High	High
NOTE—Based on Figure G-1 from ISO/IEC/IEEE 15288:2015 [B41].				

In general, a higher observability of and control over ethical issues in constituent systems, as in a directed SoS, increases the organization's capability to include consideration of ethical values during system design and other systems and software engineering processes.

Annex F

(informative)

Control over AI systems

System control is essential for the preservation of ethical values in an AI system, even if the exact internal mechanisms for system learning are not fully understood. The system design includes controls so that a system's behavior has known limits and is in response to human instructions. Where the system's use is contrary to expectations or it creates unforeseen new ethical value harms, engineers use a feedback loop to recalibrate system decisions or adjust the system's design, control, and operational options accordingly.

Where AI systems are concerned, there should be control over the following:

- The quality of the data used in the AI system
- The selection processes feeding the AI
- The algorithm design
- The evolution of the AI's logic
- The best available techniques (BATs) for a sufficient level of transparency of how the AI is learning and reaching its conclusions"

Where there is potential or actual harm from the use of a system, it is in the public interest to know who is responsible under the law. Responsibility concerns who has a duty to fulfil a certain task/function and, if they fail to do so, what the legal sanctions are for any resulting harm. That is, who should be attributed with responsibility for the consequences of the use of the system. This differs from accountability, where someone has a designated function/role/task which they fail to fulfil or do so inadequately, but for which there are no legal sanctions; the person merely accounts for their actions (i.e., provides an explanation) and nothing more. Responsibility involves more than simply explaining actions; it is about accepting any legal sanctions that may follow.

To have control over the quality of the data used by the AI system means to be able to judge the accuracy, timeliness, consistency and completeness of the data used and to be able to judge the legitimacy (and legality) of data provenance (if personal data is used, for instance, the question is whether this data has been collected in a legally compliant way). Finally, the controller should have the ability to shape the data such that it can later be optimally catered to the values that the system is supposed to have for business or ethical reasons.

To have control over the selection process feeding the AI means to have sufficient degrees of freedom to ignore/exclude certain data sets, the use of which turn out to be ethically problematic in the later project (i.e., sensitive personal data); to be able to consciously and carefully specify the AI starting structure; and to be able to dispose of a sufficiently large number of data dimensions to allow for choice (to allow for later adaptation and refinement of training results).

Control over algorithm design means that the AI's internal logic [algorithm(s)] is, as system elements are as follows:

a) The general mathematics on which the algorithm is based is openly published
b) The algorithm's logic is put into simple words so that lay people can get a notion of what the mathematics is doing

c) The training of an algorithm should strive to avoid bias and if such biases evolve, document their potential existence

d) Testing of algorithms should allow time for testing on different data sets as the algorithm is trained

NOTE—ISO/IEC TR 29119-11[B38] provides detailed guidance on testing of AI-based systems.

e) The organization should communicate the limitations of the AI algorithms (for example, stating the probability with which its result seems to be true)

Control over an AI's logic evolution can be met if the above criteria of data quality control and algorithm design are applied. In addition, the organization should have the possibility to integrate a mechanism to reverse or to adapt learning based on data set exclusion.

For the long-term controllability of a machine-learning process within an AI, the AI organization should establish BATs to provide sufficient transparency of the development of the AI's intelligence or reasoning. Such BATs can include mechanisms like running the algorithm in reverse, hence refiguring its learning path, and accessing a number of central neurons to see what inputs activated them most or to extract snippets of text, keywords, or images that are representative for the patterns discovered by the AI.

Annex G

(informative)

Typical ethical values

This standard encourages the elicitation of individually held values, virtues, personal maxims, and principles as motivation for applying values to the SOI and its effect on the users. To avoid inadvertent gaps in ethical values elicitation and prioritization, values elicited in this way should be compared with lists of common ethical values that may be relevant to a system in its context. This annex provides typical examples of values, related values, and opposing values applicable to system design.

Table G.1 lists ethical values commonly applied to system design. These values should be considered during the processes described in Clause 8 through Clause 10. This is not an exhaustive list and other values, both positive and negative, may be identified. The core values are shown with related values and opposing values. Some of the opposing values are not direct opposites but merely contrasting values or lesser embodiments of the absolute value. For example, control and trust are opposite ethical values regarding the relationship of a human and a system, and transparency and privacy are opposite ethical values. Competence is not the complete opposite of perfection, but a task done competently is not necessarily perfect.

NOTE—Human rights are not a value, but rather a characterization of a set of values that are deemed the inherent property of each human.

Table G.1—Typical ethical values for systems design

Ethical value applicable to system design	Related value	Opposing value
Autonomy	Moral agency, dignity, independence, freedom, liberty, mobility, self-direction, power, self-actualization, ownership	Accountability, responsibility, responsiveness, reciprocity, paternalism, slavery
Care	Accountability to shareholders, investors, suppliers, and other stakeholders; understanding; compassion; love; empathy; protection of the vulnerable; affection; support; friendliness; beneficence; benevolence; generosity; gentleness; helpfulness; kindness; comfort; quality of life; paternalism	Torture, maleficence, persecution, machine capability, logic, objectivity
Control	Human responsibility, governance, usability, portability, logic, sense of accomplishment, moderation	Trust, accountability to stakeholders; imagination, reminding, obedience
Fairness	Responsible position on conflicts of interest, tolerance, justice, balance, equality (legal, gender, minority)	Bias, suspicion, discrimination, arbitrariness
Inclusiveness	Participation, partnership, solidarity, interdependence, compatibility, accessibility, diversity	Control, bias, detachment
Innovation	Modifiability, adventure, novelty, excitement, playfulness, diversity, development, learning, curiosity, creativity	Tradition, distraction
Perfection	Integrity, truth, honesty, achievement, transcendence, universalism, wisdom	Competence, feasibility, over-capacity,
Privacy	Respect for confidentiality, intimacy, anonymity	Transparency, inclusiveness, alerting
Respect	Politeness, courtesy, respect for environment and natural habitat, respect for information and confidentiality, respect for norms, reputation	Self-esteem, maleficence

Table continues

Table G.1—Typical ethical values for systems design *(continued)*

Ethical value applicable to system design	Related value	Opposing value
Sustainability	Respect for environment and natural habitat, efficiency, maintainability, operability, supportability, reliability, durability, resilience, forgiveness, robustness, redundancy, reusability, re-configurability, simplicity, economy, renewability	Cost (extravagance), wastefulness, poverty, consumption
Transparency	Openness, cleanliness, explicability, explainabililty, access to data. auditability	Privacy, bribery, corruption
Trust	Predictability, dependability, veracity	Control
NOTE—Opposing values can be positive or negative.		

The following is a set of values with observations on how they may be perceived or realized in systems design. The values are presented in alphabetical order and not prioritized.

— *Autonomy:* The ability of persons to govern themselves including formation of intentions, goals, motivations, plans of action, and execution of those plans, with or without the assistance of other persons or systems. A person perceives autonomy vis-a-vis a machine if that machine leaves ample room for a user to act according to his or her proper reasons and motives. The perception of autonomy vis-a-vis a machine is created by machines leaving users ample choices and allowing users access to adjust the logic.

— *Care:* Ethical risk-based design inherently includes some unquantifiable implicit requirements, which are difficult to include in formal specifications. Engineers therefore need to take day-to-day design decisions with potential ethical impact. In order to do so, engineers should embrace an attitude of care and consider their own reaction, or that of someone close to them, to the product's behavior.

— *Control:* Having control of a machine means having a) cognitive control in terms of being informed about what is going on in the computing environment, b) having decisional control in terms of having choices over what is going on in one's networked environment, and c) behavioral control in terms of receiving feedback on one's actions/choices taken. As this standard results in ethically aligned system designs, it is applicable for organizations that have sufficient control over the system for which they assume responsibility.

The behavior and other properties of a system are considered as ultimately under human control, even if some properties emerge in the course of system usage and cannot be predicted beforehand. See Annex F for further discussion.

— *Fairness:* Fairness has the attributes of systematic discrimination with an absence of bias in reaching reasonable judgments and allowing opportunities. On the other hand, a computer system is biased when it systematically and unfairly discriminates against certain individuals or groups of individuals in favor of others. The three attributes of a) systematic, b) unfair and c) discriminating are all present for bias to materialize. Unfairness means that decisions taken by a machine or algorithm are b) 1) inappropriate or b) 2) unreasonable. Discrimination is created if there is a c) 1) denial of opportunity and/or c) 2) assignment of an undesirable outcome for the user.

— *Inclusiveness:* Inclusiveness in a system means that it is accessible to differently abled users, unbiased in its decisions, and fair to the broadest range of characteristics (especially human characteristics) it may encounter. On a project, inclusiveness involves respect and consideration for the judgment of internal stakeholders and other participants who provide information and participate in decision-making. Inclusiveness encompasses suggested improvements to the design and product and alerts regarding risks and harms arising during the product lifecycle.

— *Openness:* Openness is related to transparency as a value. Ethical value project culture should be marked by openness in voicing concerns, communicating system constraints and limitations, and sharing understanding of how the system works. Openness should be more highly valued than fear of disclosure within the organization. Participants in ethical value efforts should feel comfortable if their actions became public at any time.

— *Perfection:* It is unlikely that there can be a perfect system design even when a "zero-defects" approach is taken. Engineers should however try to meet or exceed value requirements, both stated and implicit, wherever possible. Extra costs incurred through a striving for value-based product perfection should be identified and highlighted in cost/benefit analyses for the product.

— *Politeness:* Computer communication with human users is less likely to be successful if the computer is perceived as rude or insulting. Politeness in computer interaction with humans implies the use of all of the following aspects: a) polite communication and b) the granting and respecting of user choices. Polite communication means respecting a) 1) cultural norms of polite language and a) 2) polite interaction (i.e., gestures). Granting and respecting user choices implies that the machine needs to b) 1) offer useful choices (i.e., choices desired by users, choices that are easily understandable, and choices that are transparent in its implications), b) 2) respect user choices (avoiding potentially undesired preemptive actions, not initiating actions without user consent, signaling respect for choices made), and remember past choices (have an interaction memory). Machine identity revelation implies that c) 1) the user knows by whom the machine is operated, c) 2) what parties are involved in the interaction, and c) 3) what the contact details of the involved parties are (including humans reachable at the machine operator for further advice).

— *Privacy:* Privacy means that a) the collection, b) processing, and c) dissemination of personal information is done in such a way as to maintain the information self-determination of a data subject. In addition, any form of d) invasion is avoided. Privacy in terms of information collection is given when a) 1) situations of unsolicited surveillance and a) 2) interrogation are avoided; personal information is best obtained by asking data subjects for their explicit, informed, and uncoerced consent to data collection. Privacy in terms of information processing is given when b) 1) situations of unexpected and unsolicited personal data aggregation or b) 2) secondary use are avoided, when the data subject's b) 3) data security it maintained, and when (b4) the data subject is not excluded from any service based purely on his/her data or on the automated decisions based upon that data. Privacy in terms of information dissemination is given when c) 1) there is no breach of confidentiality vis-à-vis the data subject and when there is c) 2) no exposure, c) 3) disclosure, c) 4) blackmail, c) 5) appropriation, or c) 6) distortion happening based on personal data. Increased accessibility of a data subject (due to further use or visibility of his/her data; i.e., through social media) can be a privacy issue, reduced by asking data subjects for their explicit and informed consent to information dissemination. Privacy breach in terms of invasion is given when a machine d) 1) intrudes or interferes with a person's natural flow of action and d) 2) against his/her will. It is also given when d) 3) a machine interferes with a user's free flow of decision making.

— *Respect:* Respect in human-machine interaction implies that a machine is perceived as a) attentive and b) responsive. Attentiveness implies that the machine is perceived as a) 1) replying in a reasonable amount of time and a) 2) respecting user privacy. Responsiveness implies that the machine is perceived as b) 1) applying appropriate criteria in its decisions b) 2) made explicit to the user (see "transparency") and that it is perceived as acting b) 3) fairly and b) 4) politely (acknowledging inconvenience the user may have encountered) (see *Politeness*).

— *Transparency:* Transparency means that information provided about a system is a) meaningful, b) useful, c) accessible, d) comprehensive, and e) truthful. "Meaningful" means that information about a system or its functioning should not necessarily contain everything one can possibly publish about a system's functioning (i.e., plain log files). Instead, it should contain the information a) 1) relevant for users' concern or a) 2) user control. "Usefulness" of information implies that consumers can b) 1) act upon it and b) 2) make choices easily, acting upon the information provided to them. "Accessible" means that it is possible to c) 1) easily obtain and retrieve the relevant information in a machinereadable or c) 2) other way whether through state-of-the-art electronic channels or via constrained devices or constrained networks. “Comprehensive” means that information about a system should be d) 1) easy to read and understand for ordinary people and d) 2) not require any expert knowledge. “Truthful” means that information about a system accurately reflects a system’s or system landscape’s activities, such as e) 1) data processing and e) 2) data sharing practices. The information should be e) 3) up to date and e) 4) written in plain language that is clear and direct. It should not e) 5) mislead users in any way, e) 6) hide information, or give e) 7) a “half-truth” about practices.

— *Trust:* Trust in a system can be granted as a result of a system’s demonstrated a) competence, b) benevolence, c) honesty and d) predictable behavior. System competence is a matter of system dependability; that is system a) 1) security, a) 2) reliability, and a) 3) safety. Dependability can be signaled to users through some evidence or frame, such as quality seals or certification, publicly stated guarantees, and warranties. System benevolence is embedded in human-computer interaction, which can be of b) 1) emotional, b) 2) responsive, and b) 3) respectful manner (see *Respect*). System honesty can be signaled by a system through c) 1) its way of being transparent (see *Transparency*). System predictability is fostered by d) 1) embedding standardized forms of interaction (signaling situation normality) and d) 2) making a system sustainable and d) 3) easy-to-use.

The following values are not treated in detail as ethical values in this standard. More specialized standards are already available regarding these special value domains.

— *Aesthetics (beauty, beatitude, harmony):* is typically not regarded as a core value in systems engineering but is realized through other demonstrators of “good” design, such as simplicity, usability, efficiency, or quality. Aesthetic properties such as color and form are in scope when they affect cultural values.

— *Health:* Health is the state of physical and mental well-being, not just the absence of disease or infirmity.

— *Safety:* A system is safe when it does not, under defined conditions, lead to a state in which human life, health, property, or the environment is endangered.

— *Security:* A system is secure when the environment is not able to affect it in an undesirable way. Undesirable effects are minimized through the information qualities:

- Confidentiality [data is a) 1) encrypted and a) 2) accessible only to authorized parties]
- Integrity [b) 1) data is whole, b) 2) complete, and b) 3) uncorrupted]
- Availability [c) 1) data is accessible when needed], c) 2) authenticity (data is genuine, original, and stems from a trusted source)
- Accuracy (data is free of errors)

Annex H

(informative)

Organizational-level values

An organization thta espouses and supports the core values and principles outlined below in a matter of course in their daily operations is more likely to successfully design a system compliant with this standard. This annex distinguishes between the values of a system, which is the core analytic focus of this standard, and the values of the organization designing and integrating the system which is not assessed directly by this standard. This annex is offered to assist in aligning organizational and project values within this context. This standard works for applying values to system design based on organizational values. Organizational values can be generated using the Ethical Values Elicitation and Prioritization process, and organizational policy statements can be based on the values. Organizational policy statements are not an output of this standard but, can be developed based on its processes.

In addition to the general values and principles, certain principles of work and cooperation can facilitate projects so that the organizational environment encourages the delivery of EVR, e.g., to prioritize humanity over profit and time, to embrace an attitude of care, inclusiveness, and openness.

Organizations that do not explicitly define their ethical values are more likely to encounter ethical issues, such as placing economic gain or privileges of a few above human rights; suppressing human autonomy through systematic control; disguising the responsibilities of human operators for system outputs; concealing system limitations in accounting for ethical values; or misleadingly representing systems with anthropomorphic characteristics.

Embedding the principles may be included in the formal targets in product development and internal improvement projects.

NOTE 1—ISO TR 38504 provides guidance on alignment of principles to organizational governance.

To work toward the goal of ethical system design, organizations should consider the following core values and principles that can be applied at a strategic organizational level as well as for a specific system or project.

The following ethical principles should be reflected in the core values in the organization to support the Ethical Risk-Based Design process. Consistent values should also be included in the Value Register for the SOI.

a) Human rights are to be protected.
b) Human autonomy and moral agency are to be protected.
c) Algorithms should be reviewed for fairness in application to the target population of human users or human subjects.
d) The responsibilities of human beings (in designing, commissioning, owning, operating etc. those systems) are to be made clear throughout the SOI lifecycle.
e) Anthropomorphic representation of the system, including in linguistic and extra-linguistic cues, is to be regarded as a risk.

NOTE 2—IEEE P7003 (in preparation) covers these topics in more detail.

Annex I

(informative)

Case for Ethics

This standard provides advisory and normative requirements for ethically aligned design activities. It is highly desirable, however, that the effort, resources and time spent, as well as evidence and outcomes attained in the course of implementing the requirements and the spirit of this standard, are recorded, consolidated, structured and presented in an adequate, consistent, and coherent narrative: a Case for Ethics. The Case for Ethics is a project memory and an auditable repository. Similar to a safety case, the Case for Ethics is intended to provide a structured account of the ethical and technical activities undertaken in the course of pursuing an ethically aligned design for the SOI. The Case for Ethics is a key contribution toward the organizational memory and maturity in ethically aligned design and a foundational information product for assessments.

The structure, contents, and arguments pertinent to a final claim for an ethically aligned design should be developed in an evolutionary manner throughout the life of a system. The Case for Ethics encourages the process outputs, evidence, and outcomes to be recorded at each stage of the ethically aligned design to provide a process or project repository and memory as well as a structured argument for the ethicality of the product, service or system. It constitutes indispensable inputs into any subsequent ethics assessment for the SOI and the organization.

The following content is recommended for the Case for Ethics for a given SOI. It serves as a checklist that can be satisfied by the organization's content mapping, templates and information models. This outline is not intended to address all possible contents, or to mandate the title of the information item, nor the order or titles of the sections in documents presenting some or all of the contents of the Case for Ethics.

a) Introduction
    1) Societal context
    2) Key drivers
b) System of interest, scope, and boundaries
    1) Purpose
    2) Context: scope, boundary, and interfaces
        i) Direct and indirect stakeholders
        ii) Data flows
        iii) Processes
    3) Initial concept of operation
    4) Other supporting or dependent systems (SoS)
c) Setting the ethical context outcomes
    1) Realistic scenario description
        i) Envisaged market share assumption (as outlined in the business plan)
        ii) Assumed place(s) of service usage
        iii) Assumed geographic location(s) of service offering
        iv) Assumed primary user interface(s)

2) Preliminary harms and benefits
3) Key stakeholders involved in consultation
4) Consultation
5) Value Register
   i) Value list
   ii) Value clusters identified as positive and negative field potentials per stakeholder and/or stakeholder relationship
   iii) Value narrative (e.g., scenario or use case illustrating the effect of the value)

d) Enterprise ethical value-based strategy
   1) Enterprise ethical policy statement
   2) Enterprise ethically aligned design processes
   3) System level EVRs (Ethical values impacted by the SOI)

e) Ethical value risk assessment and management outcomes
   1) Ethical values at risk: evaluation and tolerability criteria
   2) Ethical values sustained or promoted
   3) Risk mitigation and control options for ethical values at risk
   4) Derivation of ethically driven functional and non-functional requirements

f) Functional and non-functional requirements traced in the system design

g) Ethical claims for the SOI and conclusions

h) Principal resources and references

Annex J

(informative)

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