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IEEE Standard Model Process for Addressing Ethical Concerns during System Design

Developed by the

Systems and Software Engineering Standards Committee
of the
IEEE Computer Society

Approved 16 June 2021

IEEE SA Standards Board

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

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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.

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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.

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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

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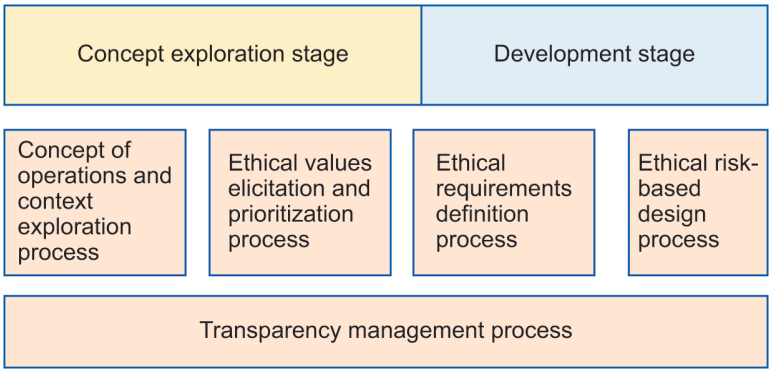


Figure 1—Relationship of processes and stages in IEEE Std 7000

(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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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