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Managing Variations in Meaning: Guidance for Using "Complexity" and Related Terms

Joshua Sutherland[1] | Dean Beale[2] | Francesco Dazzi[3] | Janet Singer[2] | Gary Smith[4] | Rudolph Oosthuizen[5] | Alfonso Lanza[1] | Ken Cureton[4] | Dorothy McKinney[6]

[1]SSEE - Sutherland Systems Engineering Enterprise Ltd, London, UK | [2]Independent Researcher, UK | [3]INAF - Istituto Nazionale di Astrofisica, Rome, Italy | [4]International Society for the Systems Sciences (ISSS), UK | [5]Department of Engineering and Technology Management, University of Pretoria, Hatfield, South Africa | [6]Lockheed Martin (retired), USA

Correspondence: Joshua Sutherland (joshua@joshuasutherland.com) | Dean Beale (Dean.Beale@incose.net) | Francesco Dazzi (francesco.dazzi.13@gmail.com)

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ABSTRACT

The term "Complexity" is widely used across disciplines, where it often represents distinct but related concepts such as complicatedness, emergence, difficulty, uncertainty, and chaos. This variability in usage can create miscommunication and misunderstanding, even within structured organizations like the International Council on Systems Engineering (INCOSE). This paper addresses this challenge by offering guidance tailored to three primary audiences—General/Casual, Practitioner, and Research—on using and interpreting "Complexity" effectively across trans-disciplinary contexts. Unlike efforts that prescribe a single definition, the approach here respects the variety of interpretations while providing techniques and ontologies to clarify usage. To illustrate, the paper compares different "Complexity" definitions, fostering awareness of both the similarities and distinctions. By promoting a common understanding, rather than a definition, this paper lays essential groundwork for future initiatives aimed at developing a unified scientific basis for "Complexity", enabling clearer, more consistent communication, and application.

1 | Background and Challenges

1.1 | The Importance of the Term "Complexity"

Many organizations consider complexity a key aspect of their business. For instance, INCOSE places high importance on "Complexity" embedding it in the definition of systems engineering as «*an integrative approach to help teams collaborate to understand and manage systems and their complexity*» [1]. Systems and complexity are fundamental concepts for systems engineers and central to INCOSE's mission. For INCOSE to meet its strategic objective to «*Advance systems engineering as the World's trusted authority*» [2], INCOSE must provide leadership on the meaning of the term "Complexity". Further, Suh [3] notes the role of complexity reduction in system robustness, while Krakauer [4] critiques the tendency to oversimplify an inherently complex and interconnected World.

1.2 | Challenges in Defining "Complexity" Across Contexts

Despite the importance, "Complexity" and related terms like "Complicated", "Emergent", "Difficult", "Uncertain", and

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"Chaotic" often carry varied meanings in virtually all areas and situations they are used, be it within or across domains and disciplines. Gershenson [5] highlighted this variety, surveying 24 leading figures in the field of complexity were asked « *How would you define complexity?*» a wide variety of meanings were provided. Edmonds [6] describes the widespread "overloading of the term" across a wide range of fields and disciplines including the following:

- **Biology**—complexity emerges from self-organizing, nonlinear interactions among simple agents in intricate structures that lead to unpredictable, emergent system-level behaviors [7];
- **Mathematics**—complexity is defined as the length of the shortest program on a fixed universal Turing machine that produces a given finite object [8];
- **Physics**—complexity is the phenomenon where simple deterministic nonlinear systems yield unpredictable, non-periodic flows characterized by extreme sensitivity to initial conditions and intricate, non-repeating behavior [9];
- **Computation**—complexity is the mathematical measure of the computational resources—typically time or space—required to solve problems as a function of the input size [10];
- **Logic**—logical complexity concerns the difficulty of proving a theorem or formal reasoning within a system [11];
- **Economics**—complexity is the diversity and sophistication of a country's non-tradable, tacit productive knowledge, reflected in its export products' variety and uniqueness [12];
- **Software design**—complexity in software design is defined as the number of linearly independent paths through a program's control flow graph, quantified by the formula $v(G) = E - N + 2$ [13];
- **Philosophy**—philosophical complexity deals with epistemological challenges and the nature of complex systems, including wicked problems [14];
- **General systems theory**—complexity is the emergent, qualitative property arising from the dynamic, interconnected interactions among a system's parts, producing behaviors that cannot be deduced from the individual components alone [15];
- **Management science**—complexity is the intricate interplay of heterogeneous components whose dynamic interdependencies and feedback loops give rise to emergent, non-linear behaviors that cannot be deduced from the parts alone [16];
- **Psychology**—complexity is the number of information elements that must be processed simultaneously and the extent of their interaction, which together determine the cognitive load during problem-solving [17];
- **Linguistics**—complexity is the cumulative amount of formal intricacy required to describe a language's system, reflecting both the growth of its distinctive elements and the maintenance of its systematic interrelations [18];
- **Medicine**—complexity in multimorbidity is defined by the dynamic, non-additive interactions among coexisting chronic conditions that collectively challenge conventional diagnosis, treatment, and health system design [19].

With "Complexity" used so frequently, «*it seems only to tag a work as inhabiting an intellectually desirable area*». In addition, sometimes, these inconsistencies are large, but most often differences are subtle and obscure making them difficult to detect.

Mitchell [20] observes that while many sciences of complexity exist, there is yet no unified science, with definitions remaining diverse in formality. The term is often referred to as being difficult to define [21, 22] with at least some in the project management community taking the approach "that you will know it when you see it" [23]. Meanwhile, others stick to the dictionary definition [24] treating it as a synonym of complicated, difficulty, or intricateness, which, for many, is the antithesis of complex.

The heat associated with defining the term might suggest why a review of key contributors to the discussion on how to handle complex problems appear to suggest that many avoid defining the term specifically. Little [25] uses, cow, bull, and horse as categories, Ackoff uses Messes, a term that has been adopted by the Open University [26] and other authors. Messes being defined as «*being very complex and crucial, with many interlocking aspects and uncertainty*» [26]. In addition, the other end of the Messy scale is "Difficulties", which include simple and complicated tasks that can be solved [26]. Others have use "Wicked", often in combination with Messes [27, 28], while Eddy Obeng from the project management community uses foggy, quest, and movie [29] as types of uncertainty and an early pioneer with a similar four box model used air, water, and fire [30].

Other experts on the topic of complexity do not specifically define the term (as far as we can determine), but instead infer the definition from the category descriptions that are associated with the term and neighboring terms. [31–34] sometimes overlaid on other frameworks. For example Snowden, in the Cynefin framework, uses "Simple", "Complicated", "Complex," and "Chaotic" which are related to knowledge management, known, knowable, somewhat knowable, and unknowable categories respectively. While the Stacey Matrix uses the same know how and know what axis as do many of the above, but on which the domains of simple, complicated, complex and chaos are mapped.

Attempts to define the term include seeking to find the least controversial definition [35] to using a range of examples and summarizing the key features observed [22]. It has been observed, individually, these terms and approaches are useful in the local context to which they are applied, but when many of them are being used in an organization seeking to handle complexity effectively they create a cacophony of confusion that prevents the adoption and coherent development of the new techniques required to survive [35].

1.3 | Implications of Unmanaged Variability of "Complexity" Definitions

Misunderstanding and confusion are the result of inappropriately handled definition variability. This impacts mainly practice and research. Additionally, due to the subtle and obscure nature of many differences often this misunderstanding and confusion can be undetected. Edmonds [6] discusses many of the issues of such handling of definition variability, particular the vagueness that is often present which prevents «*meaningful comparison between different formulations of complexity across different fields of study*». Such vagueness hinders progress in the study across multiple fields through the lens of complexity including evolution where «*vagueness of the term can frustrate progress is in the study of evolution where the issues of whether complexity increases with evolution and how this may happen are debated with cross purposes*».

1.4 | Precision vs. Ambiguity

Definitions vary along a precision-to-ambiguity spectrum. Research often demands precision. Williams et al. [36] advise that «*when your argument hinges on the meaning of a term, define it*», and Adami [37] highlights how the lack of a clear unambiguous definition weakens discussions on complexity trends. Practitioners echo this need, with the INCOSE Systems Engineering Handbook [1] advising «*One of the SE practitioners' first and most important responsibilities on a project is to establish nomenclature and terminology that support clear, unambiguous communication*». Dickerson et al. [38] take this precision further, with the "principle of definition" that a technical term's prose definition should accompanied by a mathematical interpretation to add clarity and rigor.

However, ambiguity has its benefits. As Sowa [39] explains, philosophers like Peirce and Wittgenstein argue that vagueness enables flexibility, allowing words to shift contextually. Wittgenstein's concept of language games shows how words acquire different nuances, supporting the adaptability of language in complex discussions. Given the variety of fields where the "Complexity" term is used, there must be recognition of the value of such adaptability to enable nuanced communication when required.

Navigating these definitional perspectives needs considered thought to ensure successful communication.

1.5 | Objectives

There are two approaches to address the confusion generated by the variability of "Complexity" definitions:

1. create a definition that is universally accepted,
2. create guidance on how to use the term effectively.

For the time being, the former remains a visionary objective, while the latter seems more doable for an immediate implementation.

The paper objective is to indicate how the "Complex" term should be handled, explicitly without seeking to develop or assert a preferred definition. It aims to bridge communication gaps surrounding "Complexity" across multiple communities and in different situations by

1. providing actionable guidance for effective communication tailored for general audiences, practitioners, and researchers without endorsing specific definition;
2. demonstrating similarities and differences across definitions;
3. presenting techniques for comparing definitions;
4. proposing steps toward common terminology;
5. provide insights to help readers successful navigate the use of the "Complexity" term;
6. establishing a foundation for future scientific work.

1.6 | Guidance Without Advocacy

This paper provides practical guidance for engaging with "Complexity"—within the reality of today—an important term but with multiple meanings in use. The guidance aims to support immediate communication needs and foster a broader, long-term goal of collective understanding. This paper does not prescribe or advocate any particular meaning of "Complexity" but examples are provided to illustrate variation and are not endorsements of any specific interpretation.

2 | Literature Review

2.1 | Existing Guidance for Managing Multiple Definitions of "Complexity" and Similarly Overloaded Terms

Looking across the systems engineering literature and into other fields, no references were found providing guidance on using the term "Complexity" where the meaning of the term is contested.

However, there are similar examples in other fields where key terms have multiple interpretations across disciplines, and researchers have offered guidance without prescribing a fixed definition. These references provide a model for how guidance on term usage can be structured without enforcing a single definition, focusing instead on how the term can be applied contextually. A sample is hereinafter provided.

Resilience: Folke [40] discusses resilience in socioecological systems, emphasizing its broad application across disciplines such as ecology, sociology, and engineering. Rather than prescribing one fixed definition, Folke presents a framework for understanding resilience in different contexts, allowing for flexibility in its interpretation while promoting a shared understanding across fields.

Sustainability: Robert et al. [41] address sustainability, a term often used in environmental science, economics, and public policy with different connotations in each. Instead of offering a singular definition, this work provides guidance and framework on how sustainability can be operationalized across different sectors, allowing for diverse interpretations depending on the context of application.

TABLE 1 | Example definitions of "Complexity".

ID	Complexity definition	Source	Audience	References
1	The state of having many parts and being difficult to understand or find an answer to.	Cambridge University Press - Cambridge Dictionary	General	[44]
2	Complexity is the state of having many different parts connected or related to each other in a complicated way.	Collins English Dictionary	General	[45]
3	Complexity characterizes the behavior of a system or model whose components interact in multiple ways and follow local rules, leading to non-linearity, randomness, collective dynamics, hierarchy, and emergence.	Wikipedia article citing [46] and [47]	General	[48]

Innovation: Fagerberg [42] describes the challenges of defining the concepts of innovation and invention. Including when these are transferred between different contexts. One suggested approach is to clarify phenomena by identifying what they are not, which can sometimes provide a clearer perspective than direct definitions.

2.2 | Approaches to Definitional Analysis for "Complexity"

[6] articulates the need for «*A common explanatory framework would make clear the similarities and differences that exist between such formulations across subject boundaries*». Such that various definitions can be compared.

A common approach for comparison is to identify various dimensions to characterize complexity. A non-exhaustive list provided by Lloyd [43] lists 40 measures of complexity grouped into three different dimensions of "Difficulty of Description", "Difficulty of Creation", and "Degree of Organization". Mitchell [20] explores nine different measures of complexity including but not limited to "Complexity as Size" and "Complexity as Entropy" and for each illustrates how a more complex system (the human genome) compares to a less complex system (the yeast genome).

Beale et al. [35] build a table to compare six alternative natural language definitions of complexity, by noting if any particular element of complexity is included or not included in the definition. This approach makes the differences of the definitions significantly less obscure than having the reader parse each definition individually.

3 | An illustration of "Complexity" Definition Variability

3.1 | A Sample of Variability of "Complexity" and Related Terms

A variety of example definitions of "Complexity" are presented in Table 1 and "Complex System" in Table 2, each of which has been classified as to being focused on any of the following audiences primarily: General/Casual, Practitioner, and Research. A variety of definitions were chosen to represent the variety of definitions in existence, but all definitions were required to be explicit in literature. Despite listing all these definitions clearly, it is challenging for a reader to comprehend the differences between them.

Additionally, implicit definitions are common in the literature, leading to potential misunderstandings when readers assume a familiar definition that may not align with the author's intended meaning. Beale et al. [35] illustrate this issue by identifying implicit emergent definitions that are uncovered by analysis of a range of key community documents.

3.2 | Comparative Analysis of "Complexity" and Related Terms

To better illustrate the "Complexity" definition variability, the definitions listed in Table 1 and Table 2 are analyzed by using the complexity-definition breakdown technique described in Beale et al. [35]. The analysis outcome is shown in Figure 1

Using such a reductionist technique, the following is identified:

1. none of the definitions have the same breakdown of complexity elements and thus are not the same definition;
2. radical differences can be identified easily (e.g., for the definition of "Complex System" US DoD CCRP [49] is completely based on behavior and no mention of difficulty, while MIT ESD v17 [50] emphasizes «*difficult to describe, understand, predict, manage, design, or change*»;
3. subtle differences can be identified easily (e.g., unfamiliarity is included in Complexity Primer [52], but not in the earlier INCOSE definitions [51] that the Primer sought to replace.

Additionally, many definitions are presented with multiple terms to demarcate between major distinctions. For example, taking two examples of "Complex System" from Table 2:

- INCOSE Complex Systems Working Group (CSWG)—Complexity Primer [52] provides (among others) definitions to "Complex System", "Complicated System", and "Simple System", as shown in Table 3;

TABLE 2 | Example definitions of “Complex System”.

ID	Complex system definition	Source	Audience	References
1	The phenomenological definition of a complex system is that it exhibits non-linear, emergent, adaptive behavior.	US DoD Command and Control Research Program (CCRP)	Practitioner and Research	[49]
2	A system with components and interconnections, interactions, or interdependencies that are difficult to describe, understand, predict, manage, design, or change. (This implies non-random and non-simple structure).	MIT - Engineering Systems Division (ESD) - v17 Terms and Definitions	Practitioner and Research	[50]
3	A complex system is a system in which there are non-trivial relationships between cause and effect: each effect may be due to multiple causes; each cause may contribute to multiple effects; causes and effects may be related as feedback loops, both positive and negative; and cause-effect chains are cyclic and highly entangled rather than linear and separable.	INCOSE - Systems Engineering and System Definitions	Practitioner	[51]
4	Complex systems must include self-organization, autonomy, many parts, non-linearity, emergence, the whole being greater than the sum of the parts, and often a range of other characteristics.	Complexity Theory Proxy Definition	Research	[35]
5	A complex system has elements, the relationship between the states of which are weaved together so that they are not fully comprehended, leading to insufficient certainty between cause and effect.	INCOSE Complex Systems Working Group (CSWG) - Complexity Primer	Practitioner	[1, 35, 52]

TABLE 3 | Example of accompanying definitions related to “Complex System”.

ID	Definition	Source	Audience	References
1	**Behaviorally Complex System**: “A system is behaviorally complex if its behavior is difficult to predict, analyze, describe, or manage.”	MIT - Engineering Systems Division (ESD) - v17 Terms and Definitions	Practitioner and Research	[50]
2	**Structurally Complex System**: “A system is structurally complex if the number of parts is large and the interconnections between its parts is intricate or hard to describe briefly.”	MIT - Engineering Systems Division (ESD) - v17 Terms and Definitions	Practitioner and Research	[50]
3	**Complicated System**: “A complicated system has elements, the relationship between the states of which can be unfolded and comprehended, leading to sufficient certainty between cause and effect.”	INCOSE Complex Systems Working Group (CSWG) - Complexity Primer	Practitioner	[52]
4	**Simple System**: “A simple system has elements, the relationship between the states of which, once observed, are readily comprehended.”	INCOSE Complex Systems Working Group (CSWG) - Complexity Primer	Practitioner	[52]

Types of Definitional Constituents	Definition:	Cambridge Dictionary	Collins Dictionary	Wikipedia - Complexity (English)	US DoD CCRP (Moffatt 2003)	MIT ESD v17 (de Weck 2011)	INCOSE Definitions (Sillitto 2019)	Complexity Primer (CSWG 2021)	Complexity Theory Proxy (Beale 2024)
		Complexity			Complex System				
Perspective	Subjective (observer-based)	✓	▫	▫	▫	✓	▫	✓	▫
	Objective (observer-independent)	▫	▫	✓	▫	▫	▫	▫	✓
Comprehension	Unfamiliarity	▫	▫	▫	▫	▫	▫	✓	▫
	Lack of understanding	▫	▫	▫	▫	▫	✓	✓	▫
Effort	Difficult	✓	▫	▫	▫	✓	▫	▫	▫
	Non-simple	▫	▫	▫	▫	✓	▫	▫	▫
Structural Characteristics	Many parts	✓	✓	▫	▫	▫	▫	▫	✓
	Many different parts	▫	✓	▫	▫	▫	▫	▫	▫
	Many connections	▫	✓	▫	▫	▫	▫	▫	▫
	Entangled connections	▫	▫	✓	▫	▫	▫	✓	▫
	Hierarchical	▫	▫	✓	▫	▫	▫	▫	▫
	Non reductionist	▫	▫	×	▫	▫	✓	▫	✓
Behavioral Characteristics	Non-linear	▫	▫	✓	✓	▫	✓	▫	✓
	Emergent	▫	▫	✓	✓	▫	▫	▫	✓
	Random (assumed aletory)	▫	▫	✓	▫	×	▫	▫	▫
	Causality-deficient	▫	▫	▫	▫	▫	✓	✓	▫
	Collective dynamic	▫	▫	✓	▫	▫	▫	▫	▫
	Evolving and self-organized	▫	▫	▫	▫	▫	▫	▫	✓
	Following local rules	▫	▫	✓	▫	▫	▫	▫	▫
	Adaptive	▫	▫	▫	✓	▫	▫	▫	✓

✓	In definition
▫	No mention
×	Explicitly not in definition

FIGURE 1 | Comparative analysis of some "Complexity" definitions and related terms.

- MIT—Engineering Systems Division (ESD)—v17 Terms and Definitions [50] provides (among others) definitions to: "Complex System", "Behaviorally Complex System", and "Structurally Complex System", as shown in Table 3.

The application of a comparative analysis of terms, such as that shown in Figure 1, can enable detection of an underlying concept defined by using different terms. In general, such a technique simplify the handling complexity-definition variability in a repeatable and systematic manner.

4 | Guidance on Using the Term "Complexity"

4.1 | Principles

The guidance is based on the following general principles.

1. Avoid using "Complexity" if something distinctly different is meant. As Edmonds [6] notes, "Complexity" often «*seems only to tag a work as inhabiting an intellectually desirable area*». Do not contribute to this.
2. Recognize the diversity of definitions and meanings of "Complexity" used across and within disciplines. Tables 1–3, and Figure 1 illustrate this variability.
3. It is each communicator's responsibility to clarify "Complexity" in their work to avoid misunderstandings and foster productive discourse.
4. Given this diversity of definitions and meanings, assume that the meaning you assign to "Complexity" may not align with others' interpretations. This advice applies equally to information creators and consumers.

Specific guidance is divided into the three audience types (i.e., General / Casual, Practitioner, and Research) listed in Table 4 and explored in detail in the next sections.

4.2 | Guidance for General/Casual Usage of the Term "Complexity"

In everyday English conversation, "Complexity" and related terms—including "Complicated," "Emergent," "Difficult,"

TABLE 4 | Summary of advice targeted for different audiences.

Audience	Audience's focus	Advice for information creators	Advice for information consumers
General/Casual	Grasping the broad idea of "Complexity" and related terms as a unique class of problems and opportunities.	**Goal**: Ensure concepts are accessible to a general audience. **Guidance**: Concentrate only on what is useful and understandable.	**Goal**: Understand enough to grasp the basic concept. **Guidance**: Don't assume the word has a specific meaning, instead seek to understand the concept they are trying to convey.
Practitioner Community	Building systems and dealing with the effects of "Complexity".	**Goal**: Foster accurate understanding and application of terms in practical, real-world scenarios. **Guidance**: State clearly and up front the definition being used.	**Goal**: Understand how the definition impacts the system in question. **Guidance**: Appreciate the diversity of definitions. Do not make assumptions as to what definition is being used.
Research Community	Understanding complexity's underlying nature and causes.	**Goal**: Provide a precise definition of the research under consideration. **Guidance**: Cite clearly and up front the definition being used.	**Goal**: Understand precise definition of the research under consideration. **Guidance**: Check the definition being used.

"Uncertain," and "Chaotic"—are often used interchangeably to convey broadly related ideas. However, each term can carry distinct nuances that may get lost in casual usage.

4.2.1 | Advice for Information Creators Communicating to General and Casual Audiences

When communicating with a general audience, it is essential to understand the audience's level of familiarity with these concepts. Tailor your language to focus on clarity and accessibility. Definitions like those from de Weck et al. and CSWG [50, 52] and Moffat [49] provide a useful foundation but should be adapted to emphasize aspects that are both relevant and easy to understand, avoiding excessive detail that could detract from accessibility.

4.2.2 | Advice on Consuming Information from General and Casual Sources Using the Term "Complexity"

As a consumer of information in general settings, avoid being overly literal or corrective. Rather than assuming the word has a specific technical meaning, focus on understanding the broader concept being conveyed. This flexible approach allows for clearer communication and productive discussion without rigid definitions, which is especially important in casual contexts.

4.3 | Practitioner Community Usage of the Term "Complexity"

The practitioner community, given its likely familiarity with a particular definition of "Complexity," faces the greatest risk of miscommunication due to limited exposure to the diversity of definitions. Practitioners may operate under specific, context-driven interpretations that could differ significantly from definitions in other disciplines or communities. This highlights the importance of ensuring clarity when discussing "Complexity" in professional settings.

4.3.1 | Advice for Information Creators Communicating to the Practitioner Community

When communicating "Complexity" concepts to practitioners, it is essential to clearly state the definition upfront and remain consistent with it throughout. Creators should illustrate definitions with practical examples to contextualize the term's meaning within real-world applications. If any critical concept—such as uncertainty or emergence—requires further elaboration, it should be explicitly clarified to avoid ambiguity. Additionally, creators should be vigilant in aligning their content with the stated definition. Inconsistencies between the definition and content can lead to significant misunderstandings, as observed in various publications where the definition does not match the implied usage.

4.3.2 | Advice on Consuming Information From the Practitioner Community Sources Using the Term "Complexity"

Practitioners should remain aware of the specific context in which "Complexity" is used, as definitions may vary across different projects or organizations. Recognizing this diversity helps reduce misinterpretation and ensures accurate application. Practitioners are encouraged to request examples to see how "Complexity" manifests within that particular context. When a definition or suitable example is lacking, asking for clarification can help bridge understanding, facilitating more effective implementation and minimizing the risks associated with miscommunication.

4.4 | Research Community Usage of the Term "Complexity"

The research community requires a more formalized and precise approach to defining "Complexity," often characterized by mathematical, technical, or empirical methods to illustrate key aspects. Researchers aim to explore complexity's underlying nature, causes, and effects, often adopting technical definitions that can be quantified or modeled. Definitions of "Complexity" in this field are typically neutral, emphasizing the role of system interactions and stakeholder perspectives without implying that complexity is inherently positive or negative.

4.4.1 | Advice for Information Creators Communicating to the Research Community

For effective communication within the research community, information creators should adopt technical definitions with formal, often quantitative examples. For instance, structural complexity might be quantified with matrix mathematical formulas, as illustrated by Sinha and de Weck [53]. Similarly, as Dickerson et al. [38] emphasize in the "principle of definition," a prose definition should be complemented with a mathematical or technical interpretation to enhance precision and clarity.

Clear citations are essential in research communications to enable readers to trace the origin and application of a specific definition. Furthermore, aligning theoretical definitions with real-world cases or stakeholder interactions can provide a more holistic understanding of complexity. Information creators should ensure that these definitions are consistently applied throughout their work to prevent misinterpretation.

4.4.2 | Advice on Consuming Information From the Research Community Sources Using the Term "Complexity"

Information consumers in research contexts should prioritize identifying and understanding the specific technical definition of "Complexity" employed in each source, paying attention to the context and implications of this definition for the study's findings. Consumers should be prepared to inquire about unclear definitions or methods, particularly in cases where the definition's alignment with the study's analysis is not transparent.

5 | Process to Communicate Complexity Successfully

5.1 | Process for Using the Term complexity

Based on the above principles the following framework is recommended to manage the term complexity.

1. **Avoid**—Check to ensure that the use of the term is appropriate and necessary. Check that it is not being used to communicate information rather than build ego. Check that alternative term could not be used more effectively.
2. **Consider and recognize community usage**—Before proceeding defining the term, consider how the term is used in the community. Consider how to use the term and where there maybe definition challenges. Consider examples or stories that help communicate what you mean and why this specific definition is important. Consider what type of community you have and tailor your advice as indicated in Table 4.
3. **Clarify the definition requirements**—according to Table 4. Use a range of definitional constituents, as shown in Figure 1, to structure what you mean by the "Complexity" term (see example in Section 5.2). Or use mathematical constructs as suitable.
4. **Communicate and standardize your definition**—Once the definition has been clarified, recognizing that others will have different unaligned definitions, it can be necessary to explain the reason of the chosen definition. Such attitude remove defensive barriers and foster feedback on the chosen definition. Eventually, this might enable an iterative refinement of the used definition. However, it is important that the authors follow their defined definition throughout the entire communication process.

5.2 | Clarifying Your Definition Using the Generic Communication Model

Most communication models are based on the concept that someone creates an information, encodes it in the form of a message and sends it to an information consumer through a transmission channel. Then, the information consumer (i.e., receiver) decodes the message to comprehend the initial thought/idea and provides a feedback. The same occurs when the receiver becomes the sender and vice versa. In both transmissions, noise may interfere and distort the message. A good example is the Berlo's model. [54].

Figure 2 shows how the guidance described in Section 4 contributes to a generic communication model. Both principles and techniques facilitate the encoding and decoding activities, minimizing the risk of miscommunication.

The encoding plays a key role, because the clarity of the used definition is determined during that activity. The following actions are crucial for a suitable encoding activity:

1. indicate the exact term to be defined, e.g., "Complexity", "Complex System", "Complex Problem";
2. consider what perspective (e.g., objective absolute perspective, view of the team) matters and reflect it in the language used;
3. select what definitional constituents must be included into the definition and what must be excluded.

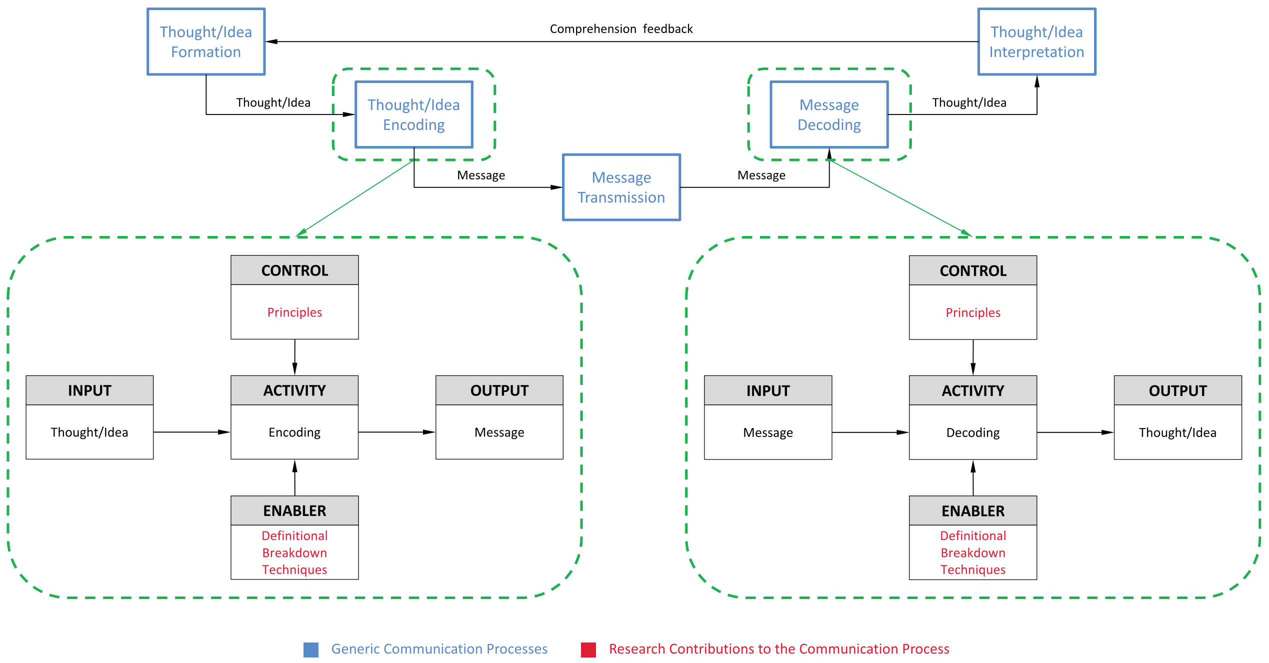

FIGURE 2 | Contribution of the research artifacts to the generic communication model.

TABLE 5 | Example of options selected for the definition development.

Definitional constituents	Chosen options
Perspective	Subjective
Comprehension	Lack of understanding
Effort	Difficult
Structural characteristics	Entangled connections
Behavioral characteristics	Emergent

Regarding the third action, hereinafter an example is presented. A definition of "Complex System" could be formed using the technique shown in Figure 1 and by selecting the options listed in Table 5.

The result is the following definition: "A complex system is a set of entangled connections that can not be understood leading to unexpected emergence that make its realization difficult." All definitional constituents do not need to be included, what is more important is to be as succinct and clear as possible in communicating the usage of the term. Whether or not there is agreement or disagreement is irrelevant, what matters is that the definition has been clearly communicated.

Once the definition has been communicated, recognizing that others will have different unaligned definitions, it can be necessary to explain the reason of the chosen definition. Such attitude remove defensive barriers and foster feedback on the chosen definition. Eventually, this might enable an iterative refinement of the used definition.

However, it is important that the authors follow their defined definition throughout the entire communication process.

6 | Future Routes for Converging on Common Terminology

This paper provides guidance for navigating the diverse definitions of "Complexity" that exist across fields and used in different situations. However, further work is essential to converge on a shared understanding, recognizing that this will be an ongoing journey for the community. As Mitchell [20] notes, «*If the sciences of complexity are to become a unified science of complexity, then people are going to have to figure out how these diverse notions — formal and informal — are related to one another, and how to most usefully refine the overly complex notion of complexity. This is work that largely remains to be done.*» This underscores the need for targeted efforts to build a more cohesive framework and avoid "Complexity" being a catch-all "intellectual tag" rather than a functional concept, as noted by Edmonds [6].

The principles underlying Ashby's Law of Requisite Variety [55] offer valuable insights for managing complexity in a way that matches the diverse behaviors within complex systems. The law states that for a management system to effectively control a complex system, it must exhibit at least as much variety as the system it aims to manage. Applying this principle to the pursuit of a unified terminology for "Complexity" suggests that the approach should be adaptable and flexible enough to account for the varied interpretations and dimensions of complexity across fields. Without this adaptability, the approach risks becoming too simplistic to effectively capture the nuances of complex systems, leading to misinterpretation or even failure in practice.

Potential routes for achieving convergence include the following:

1. **Etymological studies**—Investigate the evolution and historical interpretations of "Complexity" to uncover the term's

core nuances, facilitating alignment across disciplines. The Latin roots of the term has been explored in Beale et al. [35], other language cultures could be explored.

2. **Identification of implicit definitions**—Develop methods for identifying instances where definitions of "Complexity" are implied rather than explicitly stated. This process would involve analyzing context clues, language patterns, and assumed knowledge within texts to clarify the intended meaning. Using a technique similar to Figure 1 can help nuance out the subtleties.
3. **Formalizing existing definitions**—Developing standardized descriptions of existing definitions to clarify the distinct components and commonalities, aiding professionals in selecting the most suitable definitions for their work.
4. **System modeling and comparative analysis**—Constructing representative models to apply and compare different definitions of "Complexity" in practice, helping to reveal where definitions overlap and diverge, helping the community assess the strengths and weaknesses of each.
5. **Natural language evolution**—Use of a technique like the one applied in Figure 1 to define the meaning of a term can enable increased communication and adoption of favored elements. Additionally, monitoring in the usage of a term can indicate how the term in evolving and by what communities. Overtime these techniques could increase the probability of ever larger communities coalescing around a single definition.
6. **Cross-conceptual distinction**—Distinguishing "Complexity" from related terms such as "Complicated," "Emergent," "Difficult," "Uncertain," "Chaotic," and "Simple" to minimize ambiguity.

For convergence efforts to succeed, collaboration among professionals with diverse perspectives is essential. Working together, the community can build techniques (e.g., Figure 1) that respect variability in definitions while advancing toward a shared understanding of complexity. This paper provides foundational guidance to facilitate this progress, emphasizing adaptability while fostering coherence.

It is clear from the references cited that a top-down approach to establishing a definition is unlikely to succeed, not least as so many people, including INCOSE, has sought to be authoritative and yet communities prefer to use their own local definitions. This is not considered a bad thing, and indeed variation in local usage is helpful for adapting to specific situations. Consequently, if a universal standard was to be developed the only likely approach is from local communities agreeing the definitions that are useful for them, and in collaboration with other communities definitions that are useful for that team of teams. The advantage of establishing a standard definition is that communities can develop or improve their local definitions (i.e., child definitions) in accordance with a shared, generic definition (i.e., parent definition). This might improve effectiveness and efficiency in cooperation between communities, organizations, and individuals. However, this can only be achieved if the communities are consciously aware of how they are using the "Complexity" term and communicating this definition.

This paper, if used, enables the bottom-up approach to a common definition to materialize, as it set out the conditions for clear communication. This significantly addresses a gap in what is needed for systems engineers and others to progress in handling complex problems effectively.

7 | Conclusion

This paper underscores the importance of actively managing the term "Complexity" across disciplines, fields, and different situations, fields, and different situations, highlighting the varied interpretations that exist. It is ultimately each communicator's responsibility to clarify "Complexity" in their work to avoid misunderstandings and foster productive discourse. The guidance in Section 4 provides specific strategies for distinct audiences, i.e.,:

- for general use, focus on conveying a broad understanding;
- among practitioners, agree upon a working definition to support collaboration;
- for researchers, emphasize rigor and evidence-based clarity.

Looking ahead, collaborative strategies such as system modeling, definitional formalization, and identifying implicit meanings can aid convergence on a unified understanding of complexity. Such efforts will foster a common technique, such as Figure 1, that respects diverse perspectives while advancing clearer, actionable definitions.

Top-down, prescriptive approaches to defining "Complexity" are unlikely to be effective and may restrict the adaptability needed within local communities. Instead, local practitioner communities are encouraged to establish clear, context-specific definitions utilizing natural definitional elements, as shown in Figure 1, and to expand these definitions through practice and consensus with increasingly larger communities.

By actively engaging in this responsibility, each each community can progress toward an interdisciplinary understanding of complexity that is both adaptable and precise.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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