



Designation: E3012 – 22

# Standard Guide for Characterizing Environmental Aspects of Manufacturing Processes<sup>1</sup>

This standard is issued under the fixed designation E3012; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This guide provides an approach to characterize any category of manufacturing process and to systematically capture and describe relevant environmental information.

1.2 This guide defines the conceptual model of a unit manufacturing process (UMP) from which a formal representation can be specified.

1.3 This guide defines the graphical representation of a UMP model that supports the systematic structuring and visualizing of manufacturing information.

1.4 This guide defines a process characterization methodology to construct UMP models that characterize the environmental aspects of the manufacturing processes under study.

1.5 This guide provides the necessary structure and formality for identifying and capturing key information needed to assess manufacturing performance, yet provides no details about an actual assessment of the process performance.

1.6 This guide provides the conceptual definition for a system composed of multiple UMPs to represent a production system.

1.7 This guide may be used to complement other standards that address sustainability and the product life cycle. This guide most closely relates to the inventory component as discussed in the ISO 14040 series (ISO 14044) standards, and resource management as discussed in the ISO 55000 series (ISO 55001) standards.

1.8 *This guide does not purport to address all of the security issues and the risks associated with manufacturing information. It is the responsibility of the user of this standard to follow practices and establish appropriate information technology related security measures.*

1.9 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

*responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.10 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

[E2114 Terminology for Sustainability Relative to the Performance of Buildings](#)

[E2986 Guide for Evaluation of Environmental Aspects of Sustainability of Manufacturing Processes](#)

[E2987/E2987M Terminology for Sustainable Manufacturing](#)

[E3096 Guide for Definition, Selection, and Organization of Key Performance Indicators for Environmental Aspects of Manufacturing Processes](#)

### 2.2 ISO Standards:<sup>3</sup>

[ISO 14040 Environmental management—Life cycle assessment—Principles and framework](#)

[ISO 14044 Environmental management—Life cycle assessment—Requirements and guidelines](#)

[ISO 55000:2014 Asset management—Overview, principles and terminology](#)

[ISO 55001:2014 Asset management—Management systems—Requirements](#)

### 2.3 UL Standard:<sup>4</sup>

[ULE 880 Sustainability for Manufacturing Organizations](#)

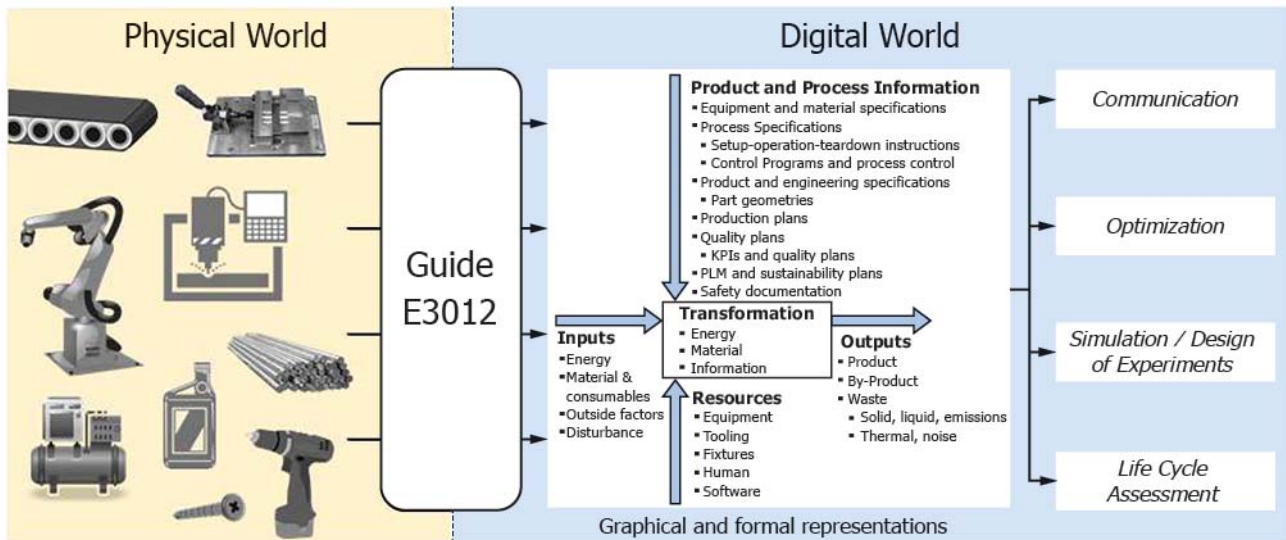
<sup>1</sup> This guide is under the jurisdiction of ASTM Committee [E60](#) on Sustainability and is the direct responsibility of Subcommittee [E60.13](#) on Sustainable Manufacturing.

Current edition approved May 1, 2022. Published May 2022. Originally approved in 2016. Last previous edition approved in 2020 as E3012–20. DOI: 10.1520/E3012-22.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

<sup>4</sup> Available from Underwriters Laboratories (UL), 2600 N.W. Lake Rd., Camas, WA 98607-8542, <http://www.ul.com>.



UMPs store digital representations of physical manufacturing assets and systems to enable engineering analysis, for example, optimization, simulation, and life cycle assessments.

FIG. 1 Overview of Significance and Use of this Guide

#### 2.4 UNECE Document:<sup>5</sup>

**Recommendation No. 20** Codes for Units of Measure Used in International Trade

### 3. Terminology

3.1 For definitions of terms used in this guide, refer to Terminologies E2114 and E2987/E2987M.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *composite unit manufacturing process (UMP) model, n*—a structure representation of interactions between more than one UMP model.

3.2.1.1 *Discussion*—Similar to a UMP model, a composite UMP model is defined with distinct inputs, outputs, product and process information, transformations, and manufacturing resources.

3.2.2 *manufacturing resource, n*—an entity that enables a manufacturing process.

3.2.2.1 *Discussion*—Manufacturing resources include (but are not limited to) manufacturing assets, such as equipment, human operators, machinery, software, automation units, control devices, instrumentation, and tooling.

3.2.2.2 *Discussion*—Manufacturing resources do not include natural resources since natural resources such as iron ore do not directly facilitate the completion of a manufacturing process. For other uses of the term “resource,” refer to the common definition of the term.

3.2.3 *model composition, n*—the act of linking individual unit manufacturing process (UMP) models together to create a composite of UMP models that can characterize the metrics of interest of a production system or product.

3.2.4 *unit manufacturing process (UMP) model, n*—structured representation of the information associated with a UMP.

### 4. Significance and Use

4.1 This guide provides a systematic approach for characterizing the environmental aspects of manufacturing processes based on well-established formal languages.

NOTE 1—In computer science, a formal language is a language designed for use in situations in which natural language is unsuitable as, for example, in mathematics, logic, or computer programming. The symbols and formulas of such languages stand in precisely specified syntactic and semantic relations to one another. Formal representations are derived from formal languages.

NOTE 2—A UMP model is defined using formal languages, such as eXtensible Markup Language (XML) (1),<sup>6</sup> Unified Modeling Language (UML) (2), or Systems Modeling Language (SysML) to facilitate data exchange, computability, and communication with other manufacturing and analysis applications. These capabilities support manufacturers in evaluating, documenting, and improving performance. This guide specifically incorporates UML and XML but does not limit implementations to these languages.

4.2 This guide provides the structure and formalism to ensure consistency in characterizing manufacturing processes in a computer-interpretable way, thus enabling effective communication, computational analytics, and exchange of performance information.

4.3 Fig. 1 shows how this guide is used to transition manufacturing resources, such as industrial robots, machine tools, and auxiliary devices, from the physical world to the digital world through graphical and formal representations. In doing so, required information to perform engineering analysis,

<sup>5</sup> Available from United Nations Economic Commission for Europe (UNECE), Palais des Nations CH-1211 Geneva 10 Switzerland, <https://www.unece.org>.

<sup>6</sup> The boldface numbers in parentheses refer to a list of references at the end of this standard.