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**Automation systems and  
integration — Evaluating energy  
efficiency and other factors of  
manufacturing systems that influence  
the environment —**

Part 1:  
**Overview and general principles**

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*Systèmes d'automatisation et intégration — Évaluation de l'efficacité  
énergétique et autres facteurs de fabrication des systèmes qui  
influencent l'environnement —*

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*Partie 1: Aperçu et principes généraux*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. [www.iso.org/directives](http://www.iso.org/directives)

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. [www.iso.org/patents](http://www.iso.org/patents)

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is ISO/TC 184, *Automation systems and integration*, Subcommittee SC 5, *Interoperability, integration, and architectures for enterprise systems and automation applications*.

ISO 20140 consists of the following parts, under the general title *Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment*:

- *Part 1: Overview and general principles*

The following parts are under preparation:

- *Part 2: Environmental index evaluation process*
- *Part 3: Environmental influence aggregation process*
- *Part 4: Allocation/charge process of indirect influence/construction, reconfiguration and retirement (CRR) influence*
- *Part 5: Environmental influence evaluation data*

## Introduction

This part of ISO 20140 establishes an overview and general principles of a method for the assessment of environmental influence of manufacturing systems.

ISO 20140 specifies a method for evaluating the energy efficiency of a manufacturing system and other factors, e.g. energy consumption, waste and release, etc., that influence the environment. The evaluation method provides guidelines to analyse the usage of energy by the manufacturing system and the effects of the manufacturing system on the environment. ISO 20140 systematically evaluates the environmental influence through analysing the manufacturing activities and the manufacturing system.

ISO 20140 is intended for discrete products/parts manufacturing systems, such as those used in forming, machining, painting, assembling, testing and other manufacturing processes in the production of aircraft, automobile, electric appliances, machine tools and their components, and other similar products.

The focused application domain of ISO 20140 is a manufacturing system that consists of the hierarchical structure built from individual manufacturing equipment, i.e. a work unit, a work centre, an area, and a factory. ISO 20140 provides evaluation methods for the influence on the environment, resulting from different manufacturing system configurations and from improvements of production management and individual manufacturing equipment operations.

The evaluation method and underlying concept of ISO 20140 can also be used as the foundation for the environmental influence evaluation for continuous processes and/or batch processes.

ISO 20140 can be used for:

- benchmarking of environmental influence with a generic manufacturing system or between different manufacturing systems for producing the same product,
- alternative studies of environmental influence for improving a current manufacturing process, reconfiguring a current manufacturing system/equipment, and designing a new manufacturing system,
- setting the top level target of environmental improvement and the breakdown to intermediate systems, work units and individual manufacturing equipment, and
- improving the shop floor operations by visualizing the actual status of environmental influence.

Expected users of ISO 20140 are:

- a) managers for environmental conditions in a factory, site and enterprise;
- b) engineers for process planning of products;
- c) planners and designers for manufacturing systems; and
- d) engineers and foremen that produce products by operating a manufacturing system.

The structure of ISO 20140 and the relationships between parts are outlined in [Annex F](#).

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# Automation systems and integration — Evaluating energy efficiency and other factors of manufacturing systems that influence the environment —

## Part 1: Overview and general principles

### 1 Scope

This part of ISO 20140 establishes an overview and general principles of a method for the assessment of environmental influence of manufacturing systems.

ISO 20140 specifies for the discrete products/parts manufacturing sectors a common foundation and methodology for energy efficiency and other factors of environmental influence evaluation, which enables sector specific methods to be applied in characteristic situations.

ISO 20140 enables an assessment to be made of the environmental influence of manufacturing processes, which can be used either to seek an overall reduction in negative influence or an increase in positive results.

The evaluation method of ISO 20140 is applicable to the environmental influence of a manufacturing system which consists of individual manufacturing equipment, and which is configured as a work unit, a work centre, an area or a factory.

ISO 20140 specifies the requirements for the environmental influence data to be captured from the individual manufacturing equipment, as the most granular data for aggregating along the manufacturing system hierarchy.

**NOTE** The evaluation method and underlying concept of ISO 20140 can be used as the foundation for the environmental influence evaluation for a continuous process and/or a batch process, in common with a discrete products/parts manufacturing process.

The following are outside the scope of ISO 20140:

- the environmental influence evaluation methodology of systems outside the manufacturing system boundaries (e.g. other systems of the same site or other systems of the entire enterprise);
- the environmental influence evaluation methodology to handle the complete product life cycle;
- the method and data for environmental evaluation which are specific to a particular industry sector, manufacturer, or machinery.

### 2 Normative references

The following referenced documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14040:2006, *Environmental management — Life cycle assessment — Principles and framework*

### 3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

### 3.1 Terms and definitions

#### 3.1.1

##### **actual production time**

##### **APT**

time during a *work unit* (3.1.46) production, which includes only the value adding functions

Note 1 to entry: Actual production time is described in ISO 22400-2:—<sup>1)</sup>, 5.1.3.6.

#### 3.1.2

##### **area**

physical, geographical or logical grouping of *resource* (3.1.39) determined by the *site* (3.1.41)

EXAMPLE It can contain process cells, production units, production lines, and storage zones.

[SOURCE: IEC 62264-1:—<sup>2)</sup>, 3.1.1]

#### 3.1.3

##### **construction, reconfiguration and retirement influence**

##### **CRR influence**

*environmental influence* (3.1.14) of a manufacturing system at its life history steps of construction/reconfiguration and retirement

#### 3.1.4

##### **direct influence**

*environmental influence* (3.1.14) resulting from actual product production by *direct operation* (3.1.5) of *manufacturing equipment* (3.1.29)

#### 3.1.5

##### **direct operation**

mode of *manufacturing equipment* (3.1.29) which performs value adding functions in actual product production

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#### 3.1.6

##### **energy**

electricity, fuels, steam, heat, compressed air, and other like media

[SOURCE: ISO 50001:2011, 3.5, modified — Notes have been deleted.]

#### 3.1.7

##### **energy efficiency**

ratio or other quantitative relationship between an output of performance, service, goods or *energy* (3.1.6), and an input of energy

EXAMPLE Conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

[SOURCE: ISO 50001:2011, 3.8, modified — Note has been deleted.]

#### 3.1.8

##### **enterprise**

one or more organizations sharing a definite mission, goals, and objectives to offer an output such as a product or service

[SOURCE: ISO 15704:2000, 3.6]

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1) To be published.

2) To be published. (Revision of IEC 62264-1:2003)



**3.1.9****environment**

surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation

[SOURCE: ISO 14001:2004, 3.5, modified — Note has been deleted.]

**3.1.10****environmental aspect**

element of an organization's activities or products or services that can interrelate with the *environment* (3.1.9)

[SOURCE: ISO 14001:2004, 3.6, modified — Note has been deleted.]

**3.1.11****environmental characteristics data****ECD**

characteristics and/or performance specifications related to *environmental aspect* (3.1.10), both acquired by measurement and declared by the equipment suppliers

**3.1.12****environmental impact**

any change to the *environment* (3.1.9), whether adverse or beneficial, wholly or partially resulting from an organization's *environmental aspects* (3.1.10)

[SOURCE: ISO 14001:2004, 3.7]

**3.1.13****environmental index**

value that represents environmental efficiency and/or environmental influence related performance or characteristics

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**3.1.14****environmental influence**

changes to the *environment* (3.1.9), whether adverse or beneficial, wholly or partially resulting from a manufacturing system's *environmental aspects* (3.1.10)

[SOURCE: ISO 14001:2004, 3.7, modified — “Environmental impact”, “any change” and “organization” have been replaced by “environmental influence”, “changes” and “manufacturing system”.]

**3.1.15****environmental influence footprint**

sum of *environmental influence* (3.1.14) of a manufacturing system component as a *product* (3.1.35), used in the construction and reconfiguration step of a manufacturing system, based on a *life cycle assessment* (3.1.22)

**3.1.16****factory**

identified physical, geographical and/or logical component within a *site* (3.1.41), which is an organization with *resource* (3.1.39) for manufacturing products or providing services, and which is controlled by and reports to a business unit of a manufacturing *enterprise* (3.1.8)

Note 1 to entry: At least one factory is located within a site.

Note 2 to entry: A factory is the highest entity of a manufacturing system within a site.

**3.1.17****indirect influence**

*environmental influence* (3.1.14) resulting from activities that support actual product production by *direct operation* (3.1.5) of *manufacturing equipment* (3.1.29), in *indirect mode* (3.1.18) of manufacturing equipment and operation and maintenance of the *manufacturing support system* (3.1.30)

**3.1.18**

**indirect mode**

mode of *manufacturing equipment* (3.1.29) to support its *direct operation* (3.1.5)

EXAMPLE Idle/standby mode and maintenance.

**3.1.19**

**input**

material or energy flow that enters a *unit process* (3.1.42)

[SOURCE: ISO 14040:2006, 3.21, modified — “Product” has been removed from definition, and Note has been deleted.]

**3.1.20**

**life cycle**

<manufacturing system> finite set of generic phases and steps a system may go through over its entire *life history* (3.1.28)

[SOURCE: ISO 15704:2000, 3.11, modified — Concept domain has been added.]

**3.1.21**

**life cycle**

<product> consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal

[SOURCE: ISO 14040:2006, 3.1, modified — Concept domain has been added.]

**3.1.22**

**life cycle assessment**

**LCA**

<manufacturing system> compilation and evaluation of the inputs, outputs and the potential *environmental influence* (3.1.14) of a manufacturing system throughout its *life cycle* (3.1.20)

[SOURCE: ISO 14040:2006, 3.2, modified — “Environmental impact” and “product system” have been replaced by “environmental influence” and “manufacturing system”, and concept domain has been added.]

**3.1.23**

**life cycle assessment**

**LCA**

<product> compilation and evaluation of the inputs, outputs and the potential *environmental impacts* (3.1.12) of a product system throughout its *life cycle* (3.1.21)

[SOURCE: ISO 14040:2006, 3.2, modified — Concept domain has been added.]

**3.1.24**

**life cycle impact assessment**

**LCIA**

phase of *life cycle assessment* (3.1.23) aimed at understanding and evaluating the magnitude and significance of the potential *environmental impacts* (3.1.12) for a product system throughout the *life cycle* (3.1.21) of the product

[SOURCE: ISO 14040:2006, 3.4]

**3.1.25**

**life cycle influence assessment**

phase of *life cycle assessment* (3.1.22) aimed at understanding and evaluating the magnitude and significance of the potential *environmental influence* (3.1.14) for a manufacturing system throughout the *life cycle* (3.1.20) of the manufacturing system

[SOURCE: ISO 14040:2006, 3.4, modified — “Impact” and “product system” and “product” have been replaced by “influence” and “manufacturing system”.]

**3.1.26****life cycle inventory analysis**

<manufacturing system> phase of *life cycle assessment* (3.1.22) involving the compilation and quantification of inputs and outputs for a manufacturing system throughout its *life cycle* (3.1.20)

[SOURCE: ISO 14040:2006, 3.3, modified — “Product” has been replaced by “manufacturing system”, and concept domain has been added.]

**3.1.27****life cycle inventory analysis**

<product> phase of *life cycle assessment* (3.1.23) involving the compilation and quantification of inputs and outputs for a product throughout its *life cycle* (3.1.21)

[SOURCE: ISO 14040:2006, 3.3, modified — Concept domain has been added.]

**3.1.28****life history**

actual sequence of steps a system has gone through during its lifetime

[SOURCE: ISO 15704:2000, 3.12]

**3.1.29****manufacturing equipment**

equipment which is operated for directly producing a product, in a manufacturing process

**3.1.30****manufacturing support system**

system which is used for providing the necessary *other resource* (3.1.32) to a manufacturing system

**3.1.31****material**

primary or secondary material, or intermediate product, that is used to produce a product

Note 1 to entry: Secondary material includes recycled material.

[SOURCE: ISO 14040:2006, definition 3.15, modified — “Raw material” has been replaced by “material” as the term, and “intermediate product” has been added to the definition.]

**3.1.32****other resource**

*input* (3.1.19) other than the *material* (3.1.31)

EXAMPLE *Energy* (3.1.6); coolant and lubricant; air conditioning and lighting.

Note 1 to entry: The term “other resource” is used in order to distinguish it from such *resources* (3.1.39) of a manufacturing system as *manufacturing equipment* (3.1.29) and *manufacturing support system* (3.1.30).

**3.1.33****output**

*product* (3.1.35), material or energy flow that leaves a *unit process* (3.1.42)

Note 1 to entry: Products and materials include raw materials, intermediate products, co-products and releases.

[SOURCE: ISO 14040:2006, 3.25]

**3.1.34****process**

set of interrelated or interacting activities that transforms *inputs* (3.1.19) to *outputs* (3.1.33)

[SOURCE: ISO 14040:2006, 3.11]

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### 3.1.35

#### **product**

any goods or service

[SOURCE: ISO 14040:2006, 3.9, modified — Notes have been deleted.]

### 3.1.36

#### **production line**

collection of equipment dedicated to the manufacture of a specific number of products or product families

Note 1 to entry: A production line is a type of work centre.

[SOURCE: IEC 62264-1:—, 3.1.32]

### 3.1.37

#### **release**

emissions to air and discharges to water and soil

[SOURCE: ISO 14040:2006, 3.30]

### 3.1.38

#### **residual CRR influence**

*CRR influence* (3.1.3) of a manufacturing system and its components, which is still residual after offset through the specific term of CRR influence charge/offset process and/or at the time of retirement

### 3.1.39

#### **resource**

enterprise entity that provides some or all of the capabilities required by the execution of an *enterprise* (3.1.8) activity and/or business process

[SOURCE: ISO 15704:2000, 3.18]

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### 3.1.40

#### **reusable material**

*material* (3.1.31) remaining after a manufacturing process which can be reused or recycled

EXAMPLE Chips as removed materials after machining; removed material after die casting.

### 3.1.41

#### **site**

identified physical, geographical, and/or logical component grouping of a manufacturing *enterprise* (3.1.8)

[SOURCE: IEC 62264-1:—, 3.1.39]

### 3.1.42

#### **unit process**

most detailed activity element of a *process* (3.1.34) considered in the *environmental influence* (3.1.14) evaluation for which input and output data are quantified

[SOURCE: ISO 14040:2006, 3.34, modified — “Smallest element” and “life cycle inventory analysis” have been replaced by “most detailed activity element of a process” and “environmental influence evaluation”.]

### 3.1.43

#### **waste**

substances or objects which the holder intends or is required to dispose of

[SOURCE: ISO 14040:2006, 3.35, modified — Note has been deleted.]

**3.1.44****work cell**

equipment grouped together to produce a family of parts having similar manufacturing requirements within a production line

Note 1 to entry: A work cell is a type of work unit.

[SOURCE: IEC 62264-1:—, 3.1.43]

**3.1.45****work centre**

equipment element under an *area* (3.1.2) in a role-based equipment hierarchy that performs production, storage, material movement, or any other Level 3 or Level 4 scheduled activity

[SOURCE: IEC 62264-1:—, 3.1.44]

**3.1.46****work unit**

equipment element under a *work centre* (3.1.45) in a role-based equipment hierarchy that performs production, storage, material movement, or any other Level 3 or Level 4 scheduled activity

Note 1 to entry: A work unit is the most detailed collection of manufacturing equipment of a manufacturing system considered in the *environmental influence* (3.1.14) evaluation for which input and output data are quantified.

[SOURCE: IEC 62264-1:—, 3.1.45, modified — “Note 1 to entry” has been added.]

**3.2 Abbreviated terms**

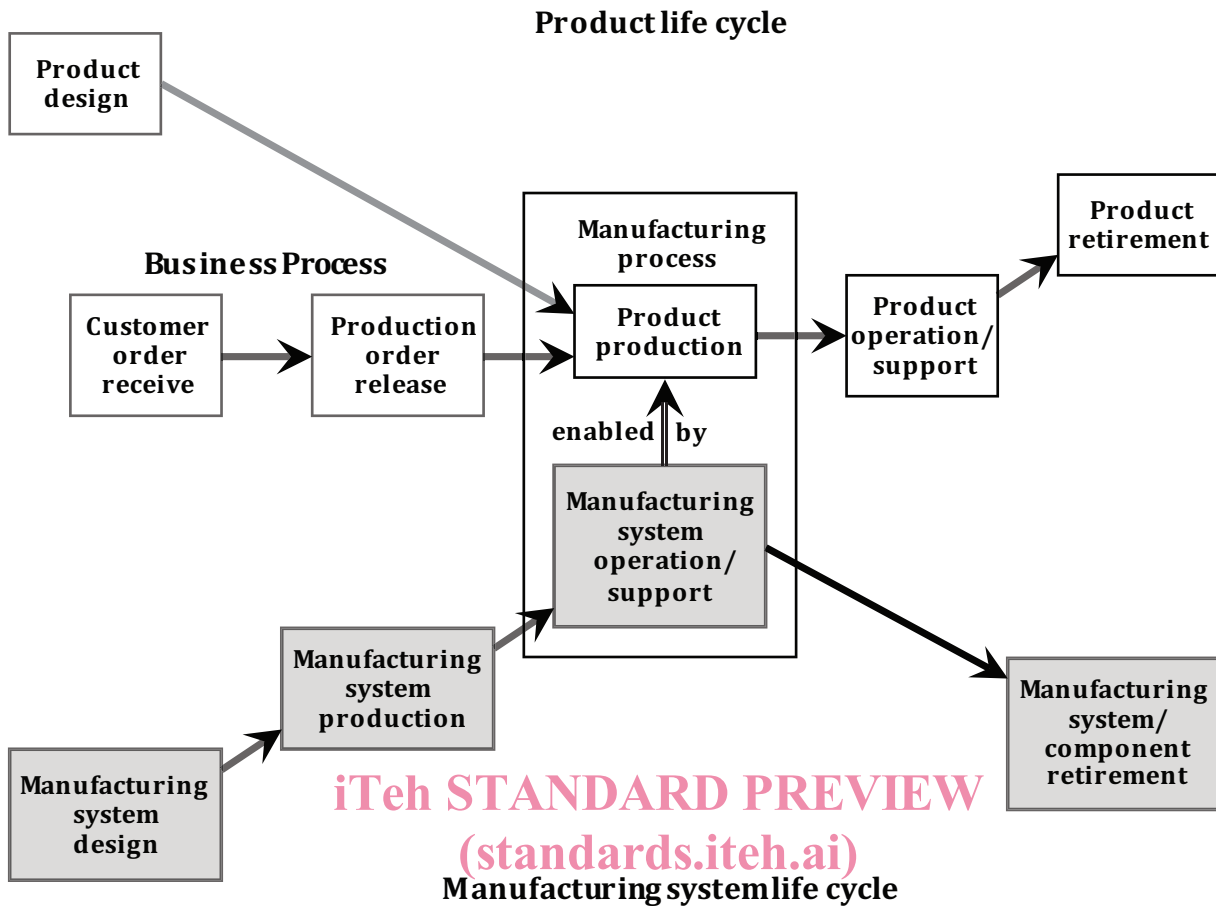
<b>APT</b>	Actual Production Time
<b>CRR</b>	Construction, Reconfiguration and Retirement (of a manufacturing system)
<b>ECD</b>	Environmental Characteristics Data
<b>LCA</b>	Life Cycle Assessment

**4 Manufacturing system and its environmental influence evaluation****4.1 Product life cycle and manufacturing system life history****4.1.1 Product life cycle and manufacturing system life cycle**

The manufacturing process for producing a product is positioned at the intersection of the product life cycle, the manufacturing system life cycle and the business process, as illustrated in [Figure 1](#). The product life cycle and the manufacturing system life cycle have common life cycle stages and phases, respectively, of design, production, operation and support, and retirement.

The product production at a factory may change depending on the change of product quantity and/or product mix corresponding to a customer order change, starting a new production of a newly designed or design changed product, and a manufacturing system configuration change.

The manufacturing system environmental influence at a factory may change depending on the product production changes, and changes in process plans for producing a product, and the manufacturing execution control, for improving the environmental influences.



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**Figure 1 — Product life cycle and manufacturing system life cycle**

**4.1.2 Manufacturing system life history for its environmental influence evaluation**

An environmental evaluation of a manufacturing system shall consider the whole life history steps of the system in addition to its operation step where actual production is executed, as illustrated in [Figure 2](#).

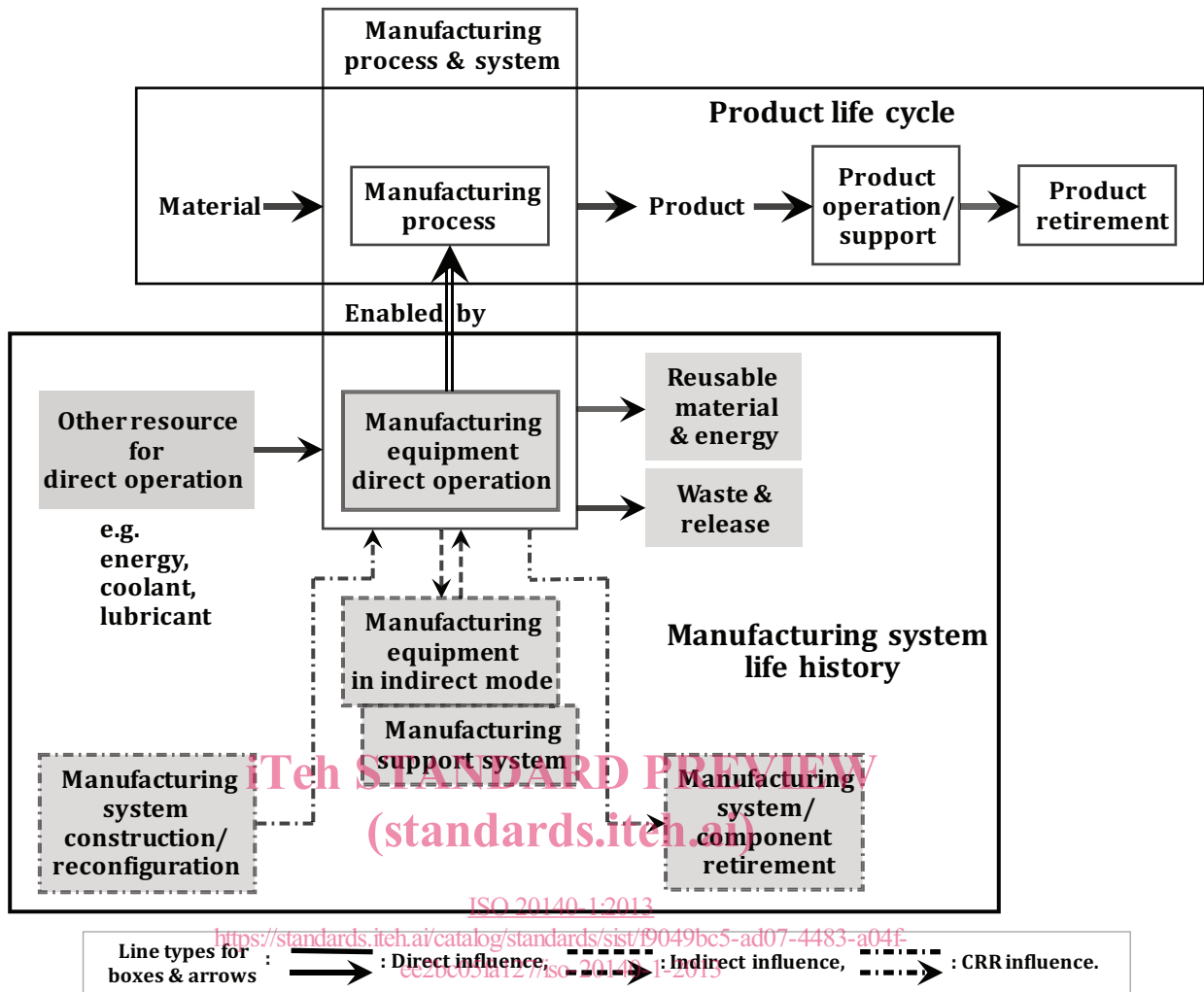


Figure 2 — Product life cycle and manufacturing system life history

Material and other resources, as the input to the manufacturing process that influences the environment, and product, reusable material and energy, and waste and release, as the output from the manufacturing process that influences the environment, are identified in [Figure 2](#).

NOTE 1 Neither the product design stages nor the manufacturing system design phases (identified in [Figure 1](#)) are identified in [Figure 2](#), because both product design and manufacturing system design are the given conditions for the environmental influence evaluation of a manufacturing system for actual product production for realizing the customer order under the business process.

NOTE 2 The life history concept is designed to identify the representation in time of activities, carried out through the life history with iterative nature, specified in ISO 15704:2000, 4.2.9 and explained in ISO 15704:2000, A.3.1.3.3, in relation to the life cycle specified in ISO 15704:2000, 4.2.8.

For environmental influence evaluation, every step of the life history of a manufacturing system shall be identified and its actual environmental influence data shall be acquired.

The life history steps of a manufacturing system for which significant environmental influences occur are:

- construction/reconfiguration,
- operation, and
- retirement.