

Glossary

Manufacturing

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No widely accepted and unambiguous definition of this term currently exists. Various definitions from encyclopaedia and international standards of reference feature rather blurry boundaries of the activities which manufacturing encompasses, along with an unclear overlap with the term *industry*. This goes hand in hand with an overall difficulty in finding consistent macroeconomic data on the manufacturing sector (such as energy consumption and greenhouse gas emissions). There are generally two ways of defining manufacturing: as an economic sector, i.e. by reference of the type of output it generates and input it requires, or as an organisation of value creation, i.e. by identifying the specific characteristics of manufacturing activities. The next subsections present these two views of the term in detail and suggest a definition for the purpose of consistency within this book.

Manufacturing as an Industrial Sector

The Encyclopaedia Britannica considers the term manufacturing in a broad sense as a synonym for “secondary industry”¹, i.e. the range of activities leading from raw materials to finished products, without distinction between continuous

¹From the Encyclopaedia Britannica (accessed 16.02.2016): “Alternative title: secondary industry. Manufacturing, any industry that makes products from raw materials by the use of manual labour or machinery and that is usually carried out systematically with a division of labour. (See industry.) In a more limited sense, manufacturing denotes the fabrication or assembly of components into finished products on a fairly large scale. Among the most important manufacturing industries are those that produce aircraft, automobiles, chemicals, clothing, computers, consumer electronics, electrical equipment, furniture, heavy machinery, refined petroleum products, ships, steel, and tools and dies. [...]”

(e.g. “chemicals” and “refined petroleum products”) and discrete products (e.g. “automobiles” and “heavy machinery”). The free encyclopaedia Wikipedia delivers a similar definition² focusing on the production of finished products, wherein components being integrated into other products are also considered to be finished products and thus likewise as input materials of manufacturing activities. These definitions however conflate the horizontal (range of products) and vertical (to what degree products are “finished”) boundaries of the activities embraced. Recognizing the difficulty in delivering a positive definition of the sector, the International Standard Industrial Classification of All Economic Activities (revision 4) of the United Nations Statistics Division delivers an ad hoc and negative definition of manufacturing, i.e. it avoids defining what is the common denominator of these activities, but instead gives a list of what products are considered to be the product of manufacturing and what products do *not* fall into this category. This definition leaves out naming the full scope of manufacturing activities such as mining or energy and water supply, while however including mention of the production of a large and heterogeneous range of continuous and discrete finished products such as food beverages, textiles, petroleum products or furniture. A similar definition is also available for the European area (Statistical classification of economic activities in the European Community, abbreviated as NACE).

Manufacturing as an Organisation of Value Creation

According to the Encyclopaedia Britannica, manufacturing is characterised by the “fabrication or assembly of components into finished products on a fairly large scale.” The free encyclopaedia Wikipedia also considers the scale of production as a determining factor and adds that manufacturing is performed through the “use or sale using labour and machine, tools, chemical and biological processing.” It however puts the concept of large scale into perspective by indicating that manufacturing activities may range from handicrafts to high tech enterprise. The Columbia Encyclopaedia indicates on this point that manufacturing is not to be juxtaposed against handcraft activities, since manufacturing indeed forms the basis of craftsmanship. However, apart from the question of scale, the concentration of production factors and the departure from handiwork, the defining characteristics of

²From the free encyclopedia Wikipedia (accessed 16.02.2016): “Manufacturing is the production of merchandise for use or sale using labour and machines, tools, chemical and biological processing, or formulation. The term may refer to a range of human activity, from handcraft to high tech, but is most commonly applied to industrial production, in which raw materials are transformed into finished goods on a large scale. Such finished goods may be used for manufacturing other, more complex products, such as aircraft, household appliances or automobiles, or sold to wholesalers, who in turn sell them to retailers, who then sell them to end users – the “consumers”. [...] Modern manufacturing includes all intermediate processes required for the production and integration of a product’s components. Some industries, such as semiconductor and steel manufacturers use the term fabrication instead. [...]”

manufacturing in this encyclopaedia are identified as the capitalistic organisation and the division of labour.

Definition in the Context of This Book

In pursuit of a narrowing down of the scope of the term to activities that are in the focus of the competencies of the authors, in the context of this book, we have decided to define manufacturing as the range of activities contributing to the fabrication or assembly of raw materials and components into discrete finished products through systematic division of labour. This term covers all necessary activities allowing the execution of manufacturing operations, i.e. design and operation of physical processes (e.g. machining), corresponding overhead processes (such as compressed air generation) and surrounding organisational processes such as product development, factory planning and supply chain management.

This definition covers both manner of considering manufacturing: as a subset of the industrial sector and as an organisation of value creation. It excludes the production of continuous products from the process industry by the reference to *discrete products*, defined by Duflou et al. (2012) as outputs that “can be identified and [are] measurable in distinct units rather than by weight or volume as in process industry.” These authors underline that process industries have been under focus for many years, as they represent the largest share of energy consumption among all industries. Aluminium production, for instance, released in 2009 around 1% of the global annual anthropic greenhouses gases (Liu et al. 2013). The definition adopted also excludes activities from craftsmanship by mentioning the systematic division of labour.

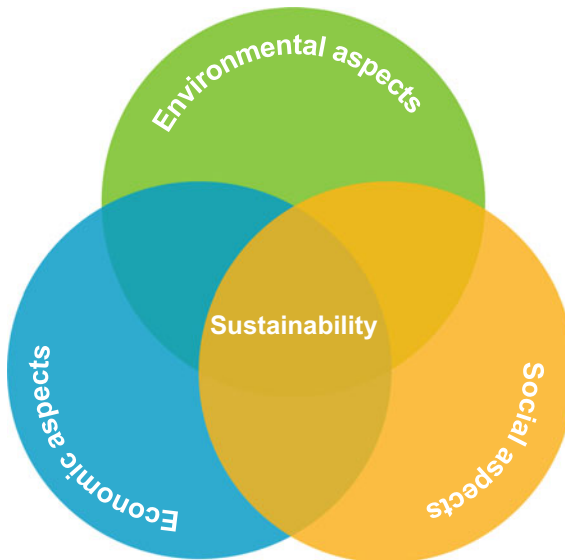
Sustainability

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The term “sustainability” is a concept that emphasizes the balanced continuity of nature and human society (Vehkamäki 2005). It has raised public awareness and become a high-profile topic increasingly preoccupying government entities and industries.

Sustainability as a term has been used since the late Middle Ages and was originally coined in connection with sustainable forest management, where it surfaced in the Saxon Forest Regulation in 1560 (Augusti 1839). It was further mentioned by Carl von Carlowitz in the book published in 1713 in the context of his proposal that continuous, permanent and sustainable utilisation become the rule for forestry (von Carlowitz 1713). The report “Limits of growth” of the Club of Rome in 1972 (Meadows et al. 1972) reintroduced the word in connection with human development and considers the limits of available resources, damages to the natural environment, and poverty of human societies. In 1987, the report known as “Our Common Future” by the Brundtland commission referred to sustainable development, as a development that “meets the needs of the present generation without compromising the ability of future generations to meet their own needs” (Brundtland et al. 1987). In other words, “sustainable development would create and maintain the conditions under which humans and nature can exist in productive harmony that permits fulfilling the social, economic and other requirements of present and future generations”³.

Following these definitions, sustainability is considered within this book consisting of three dimensions: environment, society, and economy, as displayed by the following figure.



³US-EPA: <http://www.epa.gov/sustainability/basicinfo.htm#sustainability> (access June 2013).

Sustainable Manufacturing

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Authors from the field seem only to agree on the fact that no widely accepted definition of the term sustainable manufacturing currently exists (Jayal et al. 2010; see for example Haapala et al. 2013). It therefore unfortunately inherits doubly confounded fuzziness from the definitions of both manufacturing and sustainability combined—both terms being defined by this glossary. The next subsections present a review of existing definitions of the literature and suggest a definition for the sake of consistency within this book.

Scope of Existing Definitions

Existing definitions collected from the literature show mostly divergences regarding the explicit inclusion of the social dimension of sustainability. While some papers provide definitions referring only to the environmental dimension of sustainability (implicitly including the economic dimension), some others refer to the three dimensions. This observation corroborates the statement of Haapala et al. (2013) who notes that “sustainable manufacturing is sometimes used carelessly to describe the actions related to characterizing and reducing the environmental impacts of manufacturing.” However, as noted by Mihelcic et al. (2003), solutions focusing only on the environmental solutions are insufficient since “even systems with efficient material and energy use can overwhelm the carrying capacity of a region or lead to other socially unacceptable outcomes.”

Among the definitions addressing all three dimensions of sustainability, the one used the most is that of the United States Department of Commerce (DOC) and the Environmental Protection Agency (EPA). It defines sustainable manufacturing as “the creation of manufactured products through economically-sound processes that minimize negative environmental impacts while conserving energy and natural resources. Sustainable manufacturing also protects employee, community, and consumer safety.” Another often cited definition from Mihelcic et al. (2003) defines sustainable manufacturing as the “design of human and industrial systems to ensure that humankind’s use of natural resources and cycles do not lead to diminished quality of life due either to losses in future economic opportunities or to adverse impacts on social conditions, human health, and the environment.” Both definitions implicitly consider all three dimensions of sustainability.

Definition in the Context of This Book

Following the choice of considering all dimensions of sustainability, we have adopted a definition close to that of the EPA/DOC, but which reinforces the integration of the three dimensions while however leaving the concretization of sustainability dimensions open. Sustainable manufacturing is defined here as *the creation of discrete manufactured products that, in fulfilling their functionality over their entire life cycle, cause a manageable amount of impacts on the environment (nature and society) whilst delivering economic and societal value.*

Note that environmental engineering, i.e. a range of engineering and managerial techniques concerned with the protection of the environmental quality of a given area, is not included in the scope of this definition. Approaches such as solid waste management, water supply, wastewater treatment, air pollution management or even geoen지니어ing are therefore not addressed in this contribution.

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