Sustainability/Sustainment Definition

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This white paper was originally developed in Fall 2010 as part of a report to the Dean of Engineering at the University of Maryland from a committee assessing opportunities in Global Sustainability. Since then, many students have approached me about defining sustainment. Most come with the preconceived notion that "sustainment" and "sustainability" only refer to environmental sustainability, which is unfortunate. Sustainment and sustainability are concepts that are much older and broader than just the environmental context that the popular media relates them to. The objective of this white paper is to articulate a common definition of sustainability and/or sustainment that can be used as a basis for orienting, defining and integrating various diverse efforts ranging from business to technology and environment.

There is a difference between the implied meanings of the words sustainability and sustainment, but first, let's consider the root. The root for both words is "sustain". "Sustain" comes from the Latin *sustenare* meaning "to hold up" or to support, which has evolved to mean keeping something going or extending its duration [1]. The most common non-specialized synonym for sustain is "maintain". Although maintain and sustain are sometimes used interchangeably, maintenance usually refers to activities targeted at correcting problems or fixing defects, and sustainment is a more general term referring to the management of system evolution [2]. Sustainability can also mean static equilibrium (the absence of change) or dynamic equilibrium (constant, predictable or manageable change) [3].

Today, sustainability (or more accurately sustainable development) is most widely identified with environmental sustainability - the ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time [4]. Alternatively, "sustainment" has come to be associated with the process of assessing and improving a system's ability to preserve its function and value under continued operation, maintenance and unexpected change [1] The concept of sustainability appears throughout nearly all disciplines, most notably in the contexts of business, technology and environment.

The most widely circulated definition of sustainability is attributed to the Brundtland Report [5], which is often paraphrased as "development that meets the needs of present generations without compromising the ability of future generations to meet their own needs." This definition was created in the context of environmental sustainability, however, it is useful and applicable for defining all types of sustainability.[2]

Unfortunately, the definition of sustainability has been customized by many organizations to serve as a means to an end, and in some cases it has been abused to serve special interests and marketing,[3] and defining sustainability has become a cottage industry for people who are seeking grants [7].

Proposed Sustainability/Sustainment Definition

Environmental sustainability definitions abound. We desire a more general definition that can apply to environmental sustainability, but is also applicable to sustainment in the business and technology sense. While it is easy to agree on a definition of "unsustainability" (not able to continue), the definition of sustainability is more elusive. Here are three proposed definitions:

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[1] Interestingly, even though sustainability and sustainment are very closely related in a semantic sense, they are rarely interchanged in environmental sustainability practice, e.g., environmental sustainability organizations never refer to what they are doing as sustainment or sustainment engineering, however organizations that maintain systems (sustainment organizations) will often also use the word sustainability to describe what they do.

[2] For example, for technology sustainment, "present and future generations" in the Brundtland definition can be interpreted as the users and maintainers of a system.

[3] Wild Planet Sardines are apparently "sustainability caught" off the coast of California and then shipped to a cannery in Vietnam and finally returned to grocery store shelves in California [6].

1) The capacity of a system to endure.

   "system" – this could refer to an actual physical item, e.g., a product, which could be a laptop computer, an airplane or infrastructure (the electronic power grid). The system could also refer to a service or an institution, e.g., the U.S. Social Security Administration or the University of Maryland. It could refer to a system that a product (or group of products, or users of the products) resides in, e.g., an eco-system. Lastly, it could be a process, e.g., a manufacturing process.

   "endure" – this is a relative term that really means to endure from the viewpoint of the system's stakeholders. If the system is an eco-system, then the stakeholders are the population of people who reside in or otherwise care about the eco-system. If the system is a specific product, than the stakeholders are the customers and the organization that has to support the product.

2) Development, production, operation and management of systems that maximize the availability of goods and services while minimizing their footprint.

   "availability" – this represents the fraction of time (or some other measure of life) that a good or service is in the right state, supported by the right resources, and in the right place when the customer requires it (the "customer" could be an individual, a company, a city, a geographic region, etc.).

   "footprint" – this represents any kind of impact one is interested in (or is relevant to the specific stakeholders), e.g., environmental, cost (economics), human health, energy required, and/or other resource consumption (water, materials, labor, expertise, etc.).

3) Development, production and management of systems that provides the best outcome for all stakeholders now and for as long as required into the future.

   "stakeholders" – anyone who cares about the system or is impacted either directly or indirectly by the development, production and/or management of the system.

   "as long as required" would be replaced by "indefinitely" by the pure environmental sustainability community.

Sustainment-Dominated Systems

One spin-off from the definitions above is a focus on "sustainment-dominated" systems, [8]. A sustainment dominated system could be defined as a system for which the lifetime footprint significantly exceeds the footprint associated with making it. Where (as defined above), footprint refers to any kind of impact one is interested in (or is relevant to the specific stakeholders), e.g., environmental, cost (economics), human health, energy required, and/or other resource consumption (water, materials, labor, expertise, etc.).

Defining sustainment-dominated systems provides the opportunity to make a distinction between high-volume, low cost consumer products and larger, higher-cost systems such as airplanes, infrastructure, and institutions.

Related Concepts of Performability and Viability

Two related areas have recently appeared that are worth mentioning in the context of sustainability.

The first is "performability engineering". The term performability was introduced in 1980 by John Meyer [9] in the context of evaluation of highly reliable aircraft control computers for use by NASA to collect attributes like reliability, maintainability and availability. Performability engineering widens the definition of performability to also include sustainability in order to reflect a holistic view of designing, producing, and using systems or services that will satisfy the performance requirements of a customer [10].

Viability has been defined as a monetary and non-monetary quantification of application-specific risks and benefits in a design/support environment that is highly uncertain, [11]. Traditional "value" metrics go part of the way toward defining viability by providing a coupled view of performance, reliability and acquisition cost, but they are generally ignorant of how product sustainment is impacted. The concept of viability was developed in the context of technology insertion (redesigning systems or products) and attempts to couple sustainment with more conventional value metrics. Viability assessments usually include hardware, software, information and intellectual property aspects of the product or system and goes beyond just an assessment of the immediate or near-term impacts of a design, in that it evaluates the candidate design (or candidate architecture) over its entire lifetime.

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