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# Mind the Gap: Bridging the Sustainable Software Systems Research Divide

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**Abstract**

Sustainability is a major concern to humanity as a result of the consequences of the rapid consumption of the planets finite natural resources, combined with exponential economic and population growth. Principally associated with the field of ecology, sustainability has emerged as an important area of research in a number of sub-fields within the domain of computing including human-computer interaction. While these communities have attempted to address the challenges of sustainability from their different perspectives, there is a severe lack of common understanding of the fundamental concepts of sustainability and how they relate to software systems. As a result, there is a need for a common ground and consistent terminology to reduce the replication of effort. This paper presents the Karlskrona Manifesto for Sustainability Design as a mechanism for initiating a conversation between the different communities in addressing the challenges of developing sustainable software systems.

**Author Keywords**

Sustainability, sustainability design, human-computer interaction, Karlskrona Manifesto, requirements engineering, software engineering, technical sustainability, usability engineering

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## ACM Classification Keywords

D.2 [Software Engineering]; D.2.1 [Requirements Specifications]; H.5 [Information Interfaces and Presentation]; K.4 [Computers and Society].

## Introduction

*"World society is still trying to comprehend the concept of sustainability, a term that remains ambiguous and widely abused even sixteen years after the Brundtland Commission coined it". [6]*

Addressing the sustainability of the planet is fundamental to the survival of our societies and the human species. However, it is suggested the current state of our world is unsustainable as a result of "humanities ecological footprint on the carrying capacity of planet Earth" [6]. The topic of sustainability has emerged as an important area of research in a number of fields within the subject area of computing including software engineering, requirements engineering, and human-computer interaction. These disciplines have a major role to play in addressing sustainability as a result of the pervasiveness of software systems, which can enable or undermine sustainability. This has resulted in a rise in the number of events, which have sustainability as a primary focus<sup>1 2 3 4 5 6 7 8 9 10</sup>. While these communities have attempted to

address the challenges of sustainability from their different perspectives [11] [14], research effort in addressing common issues is fragmented resulting in replicating effort on common issues and themes. For example, attempts to define the term and construe meaning for different contexts has proved challenging [13]. The importance of sustainability and software as a growth research area has been further underlined by long-term funding initiatives from the NSF (USA) [7] and the EPSRC (UK) [5]. However, even though the importance of sustainability is increasingly recognized, many software systems are unsustainable, and the broader impacts of most software systems on sustainability are unknown. The concept of sustainability is inherently multi-disciplinary, as it concerns a complex system viewed across multiple dimensions. As a result, any effort to address sustainability involves integrating concepts, principles, and methods from a range of disciplines [4]. To help bridge the sustainability research gap, this paper presents the Karlskrona Manifesto for Sustainability Design [3] as a mechanism to foster a conversation between the different communities in order to help identify core principles and practices to address the significant challenges in achieving sustainable software systems.

## Towards a Manifesto for Sustainability Design

The manifesto was initiated in preparation of the Third International Workshop on Requirements Engineering for Sustainable Systems (RE4SuSy) [10], held at RE'14 [9], Karlskrona, Sweden. The specific form for this action was jointly agreed upon based on a paper submitted to the workshop [1], which suggested that the time was ripe for a sustainable design manifesto to provide a focal point. The central result of our work was the Karlskrona manifesto [2], which we propose as a vehicle to be used

<sup>1</sup>AAAI CS, <http://www.aaai.org/Conferences/AAAI/>

<sup>2</sup>CSESSP, <https://www.nitr.gov/csessp/>

<sup>3</sup>GREENS, <http://greens.cs.vu.nl>

<sup>4</sup>GInSEng, <http://alarcos.esi.uclm>

<sup>5</sup>ICT4S, <http://ict4s.org>

<sup>6</sup>RE4SuSy, <http://web.csulb.edu/bpenzens/re4susy/>

<sup>7</sup>S-HCI, <http://www.sigchi.org/communities/hci-sustainability>

<sup>8</sup>SHPC, <https://sites.google.com/a/temple.edu/shpc2015/>

<sup>9</sup>SSSE, <http://http://sustainabilitydesign.org/ssse15>

<sup>10</sup>WSSSPE, <http://wssspe.researchcomputing.org.uk/>

for effectively communicating key issues, goals, values and principles of sustainability design; a process of understanding the world and articulating an alternative conception on how it should be shaped, according to the designers intentions. The following section outlines the principles and commitments proposed in the manifesto.

### **The Karlskrona Manifesto: Principles and Commitments**

The manifesto proposes the following set of principles and commitments:

- **Sustainability is systemic.** Sustainability is never an isolated property. Systems thinking has to be the starting point for the trans-disciplinary common ground of sustainability.
- **Sustainability has multiple dimensions.** We have to include those dimensions into our analysis if we are to understand the nature of sustainability in any given situation.
- **Sustainability transcends multiple disciplines.** Working in sustainability means working with people from across many disciplines, addressing the challenges from multiple perspectives.
- **Sustainability is a concern independent of the purpose of the system.** Sustainability has to be considered even if the primary focus of the system under design is not sustainability.
- **Sustainability applies to both a system and its wider contexts.** There are at least two spheres to consider in system design: the sustainability of the system itself and how it affects the sustainability of the wider system of which it will be part of.
- **System visibility is a necessary precondition and enabler for sustainability design.** Strive to make the status of the system and its context visible at

different levels of abstraction and perspectives to enable participation and informed responsible choice.

- **Sustainability requires action on multiple levels.** Seek interventions that have the most leverage on a system and consider the opportunity costs: Whenever you are taking action towards sustainability, consider whether this is the most effective way of intervening in comparison to alternative actions (leverage points).
- **It is possible to meet the needs of future generations without sacrificing the prosperity of the current generation.** Innovation in sustainability can play out as decoupling present and future needs. By moving away from the language of conflict and the trade-off mindset, we can identify and enact choices that benefit both present and future.
- **Sustainability requires long-term thinking.** Consider multiple timescales, including longer-term indicators in assessment and decisions.
- **Sustainability design** in the context of software systems is the process of designing systems with sustainability as a primary concern, based on a commitment to these principles.

### **Beyond the Karlskrona Manifesto for Sustainability Design**

A number of communities have considered the development of a manifesto to communicate core ideas and principles for sustainability, which have remained either undeveloped [8] or ignored by their communities at large [12]. The principles and commitments for sustainability design outlined in the manifesto is to encourage the treatment of sustainability as a systemic concept that transcends multiple disciplines,

independently of the purpose of the system. The aim of this paper is to introduce the Karlskrona Manifesto for Sustainability Design to the HCI community in order to initiate a discussion on how these principles apply to HCI and if there are additional and/or alternative principles that HCI community should put forward to the Software Design and Development community at large. The manifesto is a living document that we hope will evolve by incorporating the expertise and viewpoints of different communities. Further information on our work can be found at: <http://sustainabilitydesign.org>

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