

# Sustainability design

CHRISTOPH BECKER

FACULTY OF INFORMATION, UNIVERSITY OF TORONTO

VIENNA UNIVERSITY OF TECHNOLOGY

DAGSTUHL 16252



# Sustainability design

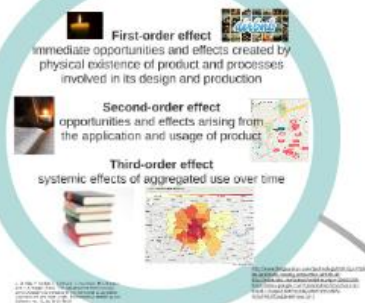
- ▶ Software increasingly central to the fabric of societies and industries
- ▶ Opportunities and goodwill, but few good outcomes
- ▶ Initiative started at Requirements Engineering for Sustainable Systems workshop, RE4SuSy 2014, following a suggestion in a position paper
- ▶ Aim to provide a common ground for thinking about **sustainability in systems design** across disciplines related to software

The screenshot shows the 'Who We Are' page of the Sustainability Design website. The page lists 14 team members, each with a small profile picture, their name, and a brief description of their role and research interests. The members listed are:

- Stéphane Bédard**: PhD researcher at the University of Toronto, focuses on requirements engineering and software systems.
- Christoph Becker**: Assistant Professor at the University of Toronto, leads the Digital Canada Institute, focuses on the intersection of technology and society.
- Stefano Bello**: postdoctoral fellow at the Karlsruhe Institute of Technology, Germany, focuses on sustainability in software systems.
- Conal Carter**: Professor at the University of Cambridge, focuses on requirements engineering and software systems.
- Alastair Chalmers**: researcher at the Department of Computer Science, University of Liverpool, UK, focuses on software systems engineering and sustainability.
- Laura Clarke**: lecturer at the Open University of the UK, focuses on sustainability and usability of software systems.
- Stuart Edwards**: postdoc at the University of Toronto, focuses on the application of computer science and software engineering to the modeling of complex systems.
- Mark Estabrook**: PhD researcher at the University of Heriot Watt, focuses on usability and user-centered design.
- Doug Finamore**: assistant professor at the University of California, focuses on requirements engineering and quality assurance.
- Clayton Fogarty**: senior lecturer at the University of York, focuses on the safety and security aspects of complex embedded systems.
- Carole Gallet**: PhD researcher at the University of Lille, focuses on requirements engineering and software systems.
- Michael Hall**: senior lecturer at the University of York, focuses on requirements engineering and software systems.
- Chris J. Healey**: senior lecturer in Software Systems Engineering at the University of Southampton, UK, focuses on sustainability in software systems.
- John Morgan**: PhD student at the University of York, focuses on requirements engineering and software systems.
- Chris O. Martin**: senior lecturer in Software Systems Engineering at the University of Southampton, UK, focuses on sustainability in software systems.

At the bottom of the page, there are social media links for Twitter, LinkedIn, Facebook, and GitHub, along with a footer containing the page number (14) and the website URL.

What is the role and impact of software systems?



**Sustainability Design principles**

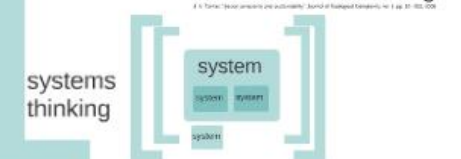
- Sustainability is **systemic**.
- Sustainability has **multiple dimensions**.
- Sustainability transcends **multiple disciplines**.
- Sustainability is a **concern** independent of the purpose of the system.
- Sustainability applies to both a system and its wider contexts.
- Sustainability requires action on multiple levels.
- System **visibility** is a necessary precondition and enabler for sustainability design.
- It is possible to meet the needs of future generations without sacrificing the prosperity of the current generation.
- Sustainability requires **long-term thinking**.

The Karlskrona Manifesto: [www.sustainabilitydesign.org](http://www.sustainabilitydesign.org)  
 KARLSKRONA MANIFESTO FOR SUSTAINABILITY DESIGN

# Sustainability in systems design

sustainability: the "capacity to endure"

sustain what? for whom? for how long?



Christoph Becker  
 christoph.becker@utoronto.ca

UNIVERSITY OF TORONTO  
 FACULTY OF INFORMATION  
 Digital Canadian Institute



#KarlskronaManifesto  
 #SustainabilityDesign  
[www.sustainabilitydesign.org](http://www.sustainabilitydesign.org)

# Selected (mis)perceptions & practices 4

## Individuals

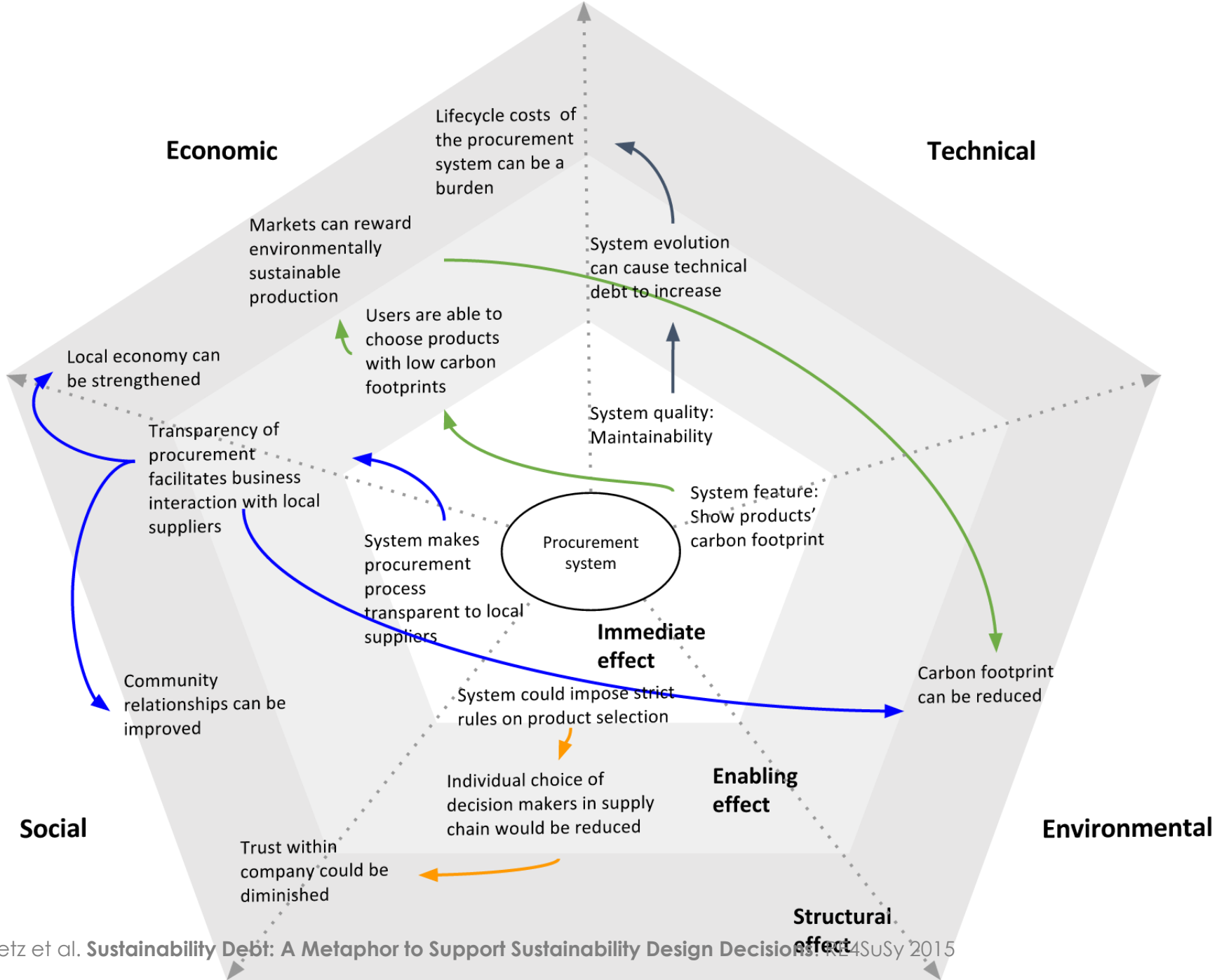
- Sustainability as environmental or financial
- Sustainability as separate from software engineering
- Sustainability as a nice-to-have quality

## Professional environment

- Lack of methodological support
- Roles & responsibilities of customers, engineer & managers
- Management support
- Assumed costs and perception of trade-off

## Norms in engineering practice

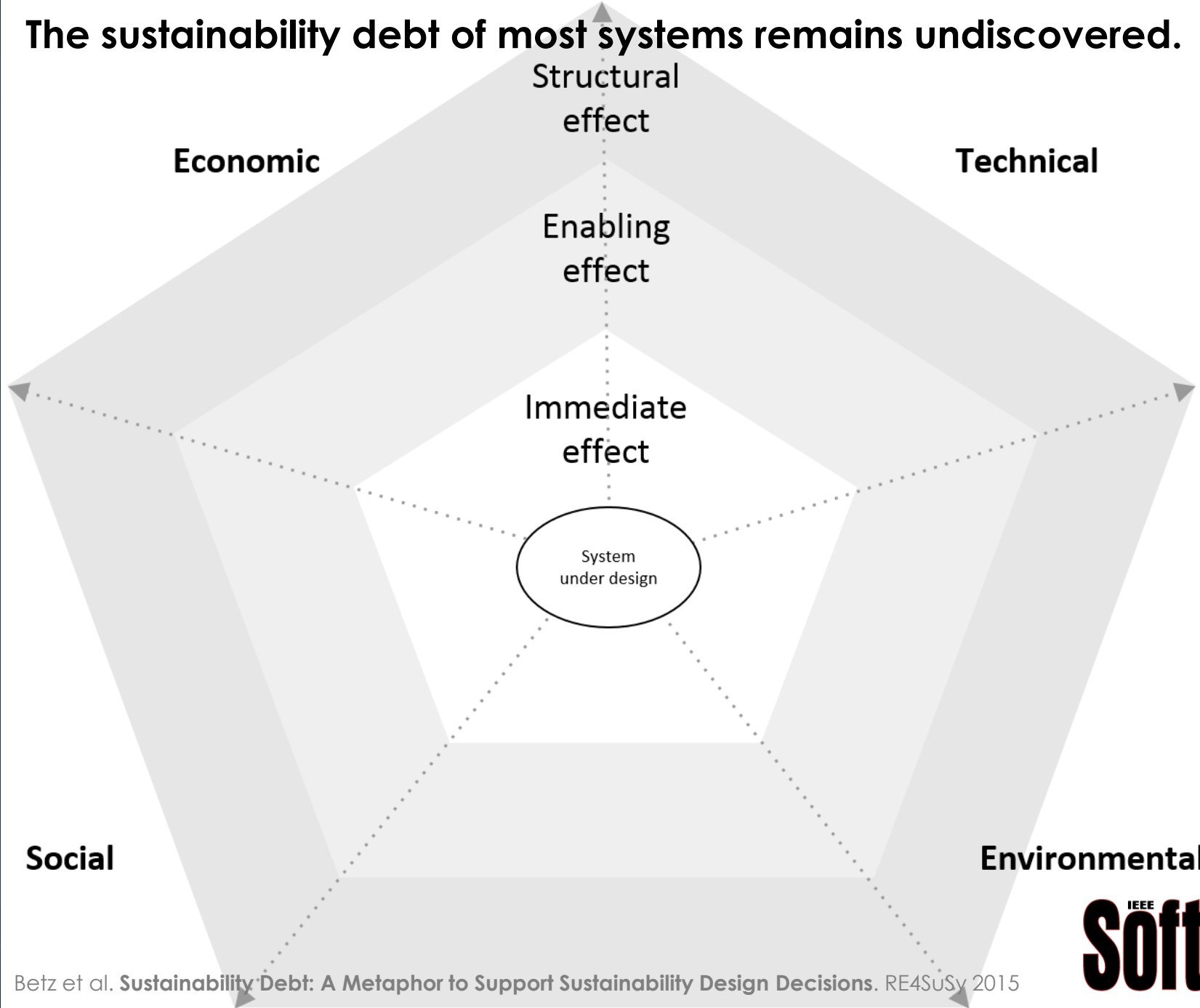
- Project success assessed at delivery only
- Poor communication of sustainability values
- Regulations are drivers for sustainability



Betz et al. **Sustainability Debt: A Metaphor to Support Sustainability Design Decisions**. In: RE4SuSy 2015

Becker et al. **Requirements: The Key to Sustainability**. In: ISE 2016 special issue: The Future of Software Engineering, January 2016

# The sustainability debt of most systems remains undiscovered.



**IEEE**  
**Software**

Betz et al. **Sustainability Debt: A Metaphor to Support Sustainability Design Decisions.** RE4SuSy 2015

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## KARLSKRONA MANIFESTO FOR SUSTAINABILITY DESIGN

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- ▶ Strive to advance not just technical and economic, but also social, individual and environmental goals simultaneously
- ▶ Need for new approaches:
  - ▶ Context
  - ▶ long-term interactions
  - ▶ socio-technical
- ▶ Need to counter pervasive misperceptions
  - ▶ 11 misperceptions and counterpoints

# 11 misperceptions and counterpoints such as...

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- ▶ **There is** a tendency to focus on the immediate effects of a new system in terms of its functionality and how it is used.
- ▶ **Whereas** the following orders of effects have to be distinguished:
  1. **Direct**, first order effects are the immediate opportunities and effects created by the physical existence of a system and the processes involved in its design and production.
  2. **Enabling**, second order effects are the opportunities and effects arising from its application and usage.
  3. **Structural**, third order effects, finally, are aggregate effects from wide-scale use of a system over time.



# Requirements: The Key to Sustainability

Christoph Becker, University of Toronto

Stefanie Betz, Karlsruhe Institute of Technology

societies that the resulting sociotechnical systems' boundaries and interactions are often hard to identify. For example, communication, travel booking, and procurement systems influence the socioeconomic and natural environment through far-reaching effects on how we form relationships, how we travel, and what we buy. The engineering process rarely makes these effects explicit. Their lack of visibility makes assessing a software system's long-term and cumulative impacts difficult.

- ▶ Requirements set the foundation for the impact of systems.
- ▶ Sustainability Design
  - ▶ Requires an appreciation of '**wicked problems**' in systems design
  - ▶ favors **integrated understanding** over a divide-and-conquer approach to systems analysis.

# Decision gates

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- ▶ Project purpose
- ▶ System boundary scoping
- ▶ Stakeholder identification
- ▶ Requirements elicitation
- ▶ Success criteria definition
- ▶ ....

# Challenges

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- ▶ Barriers on individual, business & disciplinary levels
- ▶ Discourse reveals
  - ▶ Reductionist perspective
  - ▶ Solutionist mindset
  - ▶ Techno-determinism
  - ▶ Misperceptions & blind spots
  - ▶ Assumptions about the engineering process

# Who can help?

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- ▶ Socio-technical systems
- ▶ Social informatics
- ▶ Values in design
- ▶ Behavioural economics
- ▶ ...
- ▶ ...
- ▶ ...
- ▶ Critical Systems Thinking
- ▶ Social Construction of Technology
- ▶ ...

# What can we do?

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- ▶ The conceptual toolset of SW engineering is inadequate for understanding what we normally call "software sustainability"
- ▶ We've barely begun to articulate, within the engineer community, some thoughts about sustainability design
- ▶ SD requires a paradigm shift, but the engineering community is unlikely to get that shift going.
- ▶ SSH research has commonly remained in a position of critique
- ▶ SSH needs to engage - **constructively**.
- ▶ Interesting threads exist, but most either on macro-level ("the bicycle") or micro-level (one person's experience).

# What do I plan to do?

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- ▶ I'm interested in empirical research that helps us understand what exactly is happening when people take trade-off decisions between current & future benefits in software projects
  1. Case studies of systems design projects
    - ▶ Understand path-dependent decision making
    - ▶ Question assumptions about trade-off decisions
    - ▶ Identify leverage points for intervention
  2. Tools to make sustainability debt visible
  3. Action Research with software teams
- ▶ use that insight to develop design methods and tools to support more responsible choices, and translate that into practice

- ▶ [www.sustainabilitydesign.org](http://www.sustainabilitydesign.org)
- ▶ [dci.ischool.utoronto.ca](http://dci.ischool.utoronto.ca)
- ▶ [christoph.becker@utoronto.ca](mailto:christoph.becker@utoronto.ca)
- ▶ @ChriBecker



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FOR SUSTAINABILITY DESIGN