GreenICTComp

ICT ja ilmasto, 4/4

OPETUSHALLITUS RAHOITTAA HANKETTA

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GreenICTComp

Kestävyysajattelu

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ICT ja ilmasto

JALANJÄLKI

ICT-alan tärkeimmät ilmastonmuutosta kiihdyttävät seikat ja niiden ymmärtäminen osana tietoyhteiskuntakehitystä. Mikä on ilmastonmuutos? Mitä on ICT? Mikä on jalanjälki?

JALANJÄLKIVAIKUTUSTEN LINKITTYMINEN

ICT-alan jalanjälkivaikututusten aikaskaala, linkittyminen muihin yhteiskunnan toimintoihin sekä vastuu vaikutuksista.

KÄDENJÄLKI JA MUUT KESTÄVYYDEN DIMENSIOT

ICT-alan kädenjälkivaikutukset eri aloilla, kuten liikkuminen, logistiikka, maatalous, teollisuus ja älyteknologiat. ICT-alan merkitys ilmasto- ja ympäristötyössä. Edellisten pohjalta alan suurimmat tunnistetut haasteet ja niiden rajaaminen kestävyysongelmiksi.

SUSTAINABILITY MINDSET JA YHTEENVETO

Edellisiin kertoihin pohjaten mitä voisi tehdä toisin? Yhteenveto ja koulutuksen aikana tehtyjen tehtävien esittely.

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4/4 - Sustainbity mindset

30.10.2024 16-19 (Jari Suomessa)

- Kotitehtävän purkaminen
- 2-3-5 (käytiin läpi jo edellisellä kerralla)
- Karlskrona manifesto
- Sustainability mindset / kestävyysajattelu (näkökulman muuttaminen kestäväksi)
- Tiedot, taidot ja kompetenssit
    - GreenComp - European sustainability competence framework
    - Ashokin työ - SE4GD framework
    - Wiek
- Sustainability by design
    - Lauran MIT paperin ajatukset
- Esimerkkejä
    - Astianpesu
    - ICT-laitteiden vaihtaminen
- Oppimistavoite
    - Opiskelija ymmärtää kuinka ajatusmallin muutoksella saadaan aikaan kestävyysmuutoksia
- Tehtävä:
    - Tee omasta ICT-aiheesta materiaali, jolla voit muuttaa toisten ajatusmallia/toimintatapoja kestävämmälle pohjalle

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Luennon agenda

- Kotitehtävän purku

- Kestävyysajattelu
- Teollisuuden (yhteiskunnan) tarpeet kestävyyteen liittyville tiedoille ja taidoille
- Kestävyyteen liittyvät tiedot ja taidot
  - Opintorakenteissa ja -sisällöissä
  - Sustainability mindset frameworkit
- Karlskrona manifesto
- Kestävyyden huomioiva malli yrityksille

- Kotitehtävä

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Tavoiteltavat oppimistulokset

- Tämän luentokerran jälkeen opiskelija:
  - ymmärtää kestävään kehitykseen liittyvän ajatusmallin
  - tiedostaa yritysten ja yhteiskunnan tarpeet tietojen ja taitojen kehittämiselle
  - tuntee uusimmat kestävän kehityksen tietoihin ja taitoihin liittyvät kehykset
  - tiedostaa, että eri aloilla voi olla erilaisia työkaluja ja/tai prosesseja kestävyyden integroimiseksi osaksi toimintaa

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Kotitehtävän
purku

Kotitehtävä

Jatka työskentelyä valitsemasi ICT-palvelun parissa. **Mieti millaisia kädenjälkivaikutuksia palvelullasi on** aiemmin pohdittujen jalanjälkivaikutusten lisäksi. **Millainen on jalanjälkivaikutusten ja kädenjälkivaikutusten suhde?**

Pohdi lisäksi myös **millä tavoilla ympäristövaikutukset linkittyvät kestävyyden muihin dimensioihin (kokonaiskestävyys). Millä mittareilla eri dimensioiden vaikutuksia voitaisiin mitata?** Palauta tehtäväsi ennen seuraavaa kertaa. Varaudu jälleen esittelemään vastauksesi seuraavalla kerralla hyvin lyhyesti.

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Kestävyys-
ajattelu

Kestävä kehitys lähtökohtana

VAI

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Kestävyysajattelu

- Kestävä kehitys ei ole tavoitetila, se on ajattelutapa
- Kestävyys on skaalautuva ominaisuus
- Kestävyys on tasapaino, negatiiviset ja positiiviset vaikutukset
- Kestävyys on systeemistä, vaikutukset suoria, epäsuoria ja rakenteellisia
- Kysymys: Miten voin tehdä tämän asian kestävämmin?

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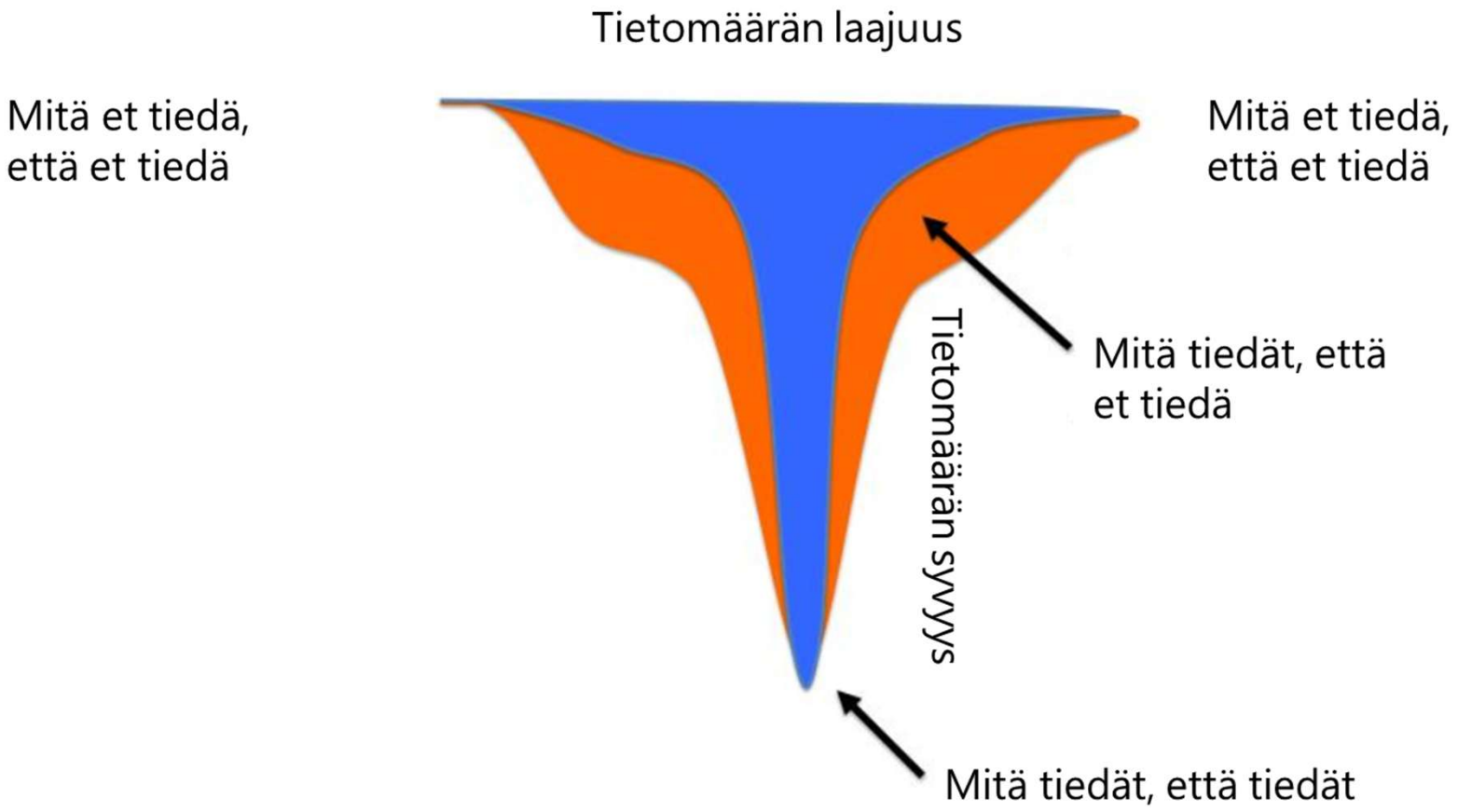
Laajuus ja syvyys



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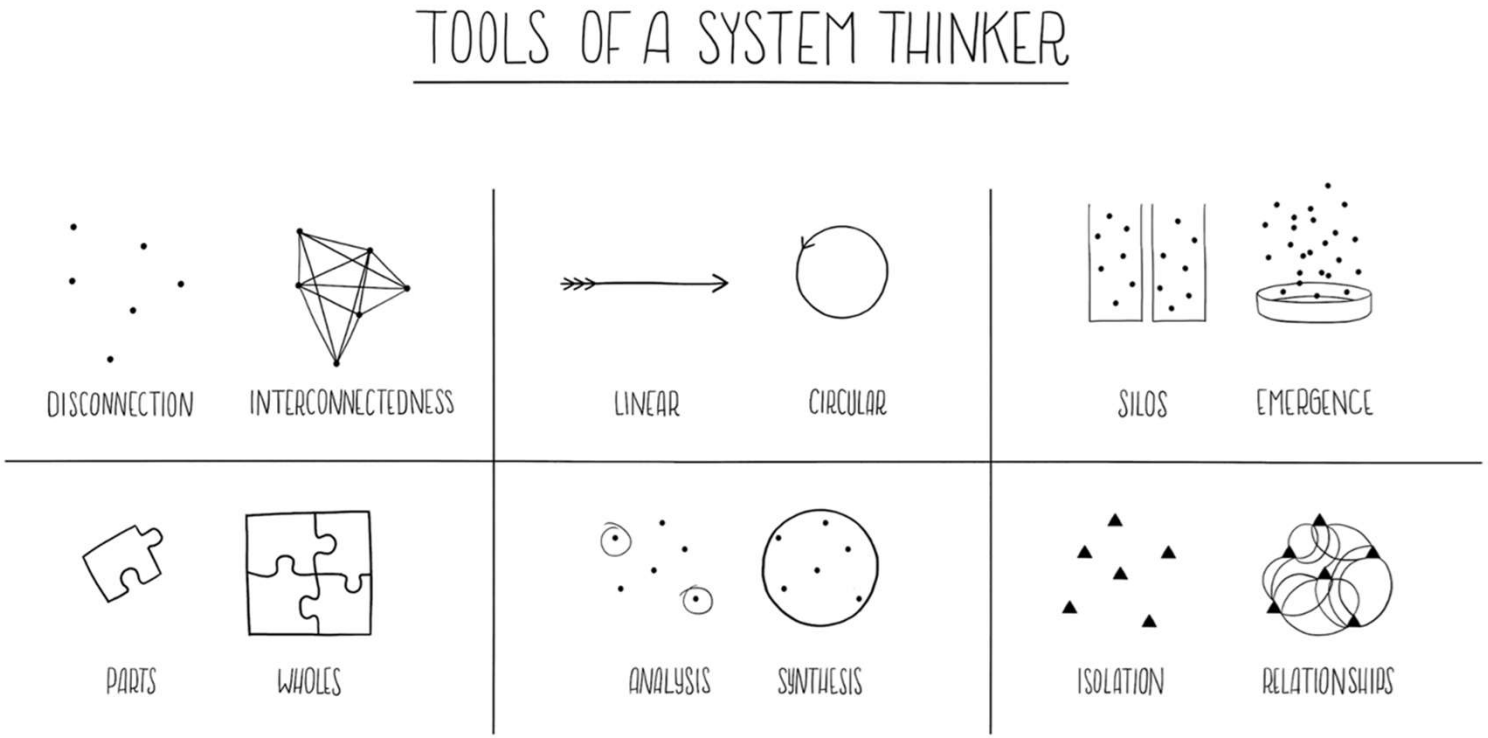
Kestävyysajattelu on systeemistä



Kuva: Leyla Acaroglu
https://medium.com/disruptive-design/tools-for-systems-thinkers-the-6-fundamental-concepts-of-systems-thinking-379cdac3dc6a

DISRUPT DESIGN

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Elinkaariajattelu

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Kestävyysajattelun aikaperspektiivit

“Those who fail to learn from history are doomed to repeat it”
- Winston Churchill

“The best way to predict the future is to invent it.”
- Alan Kay

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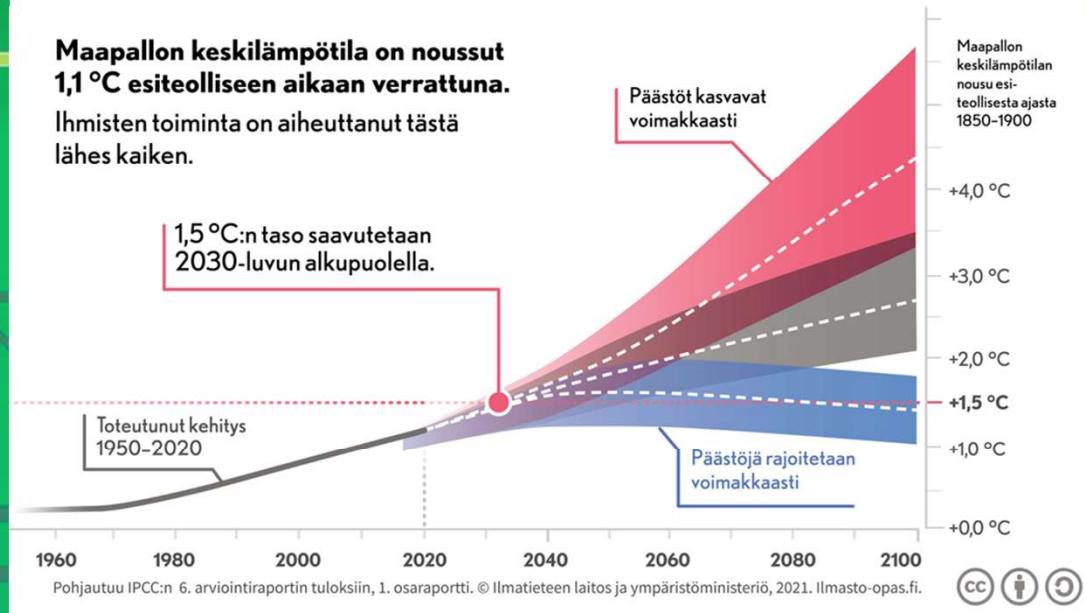
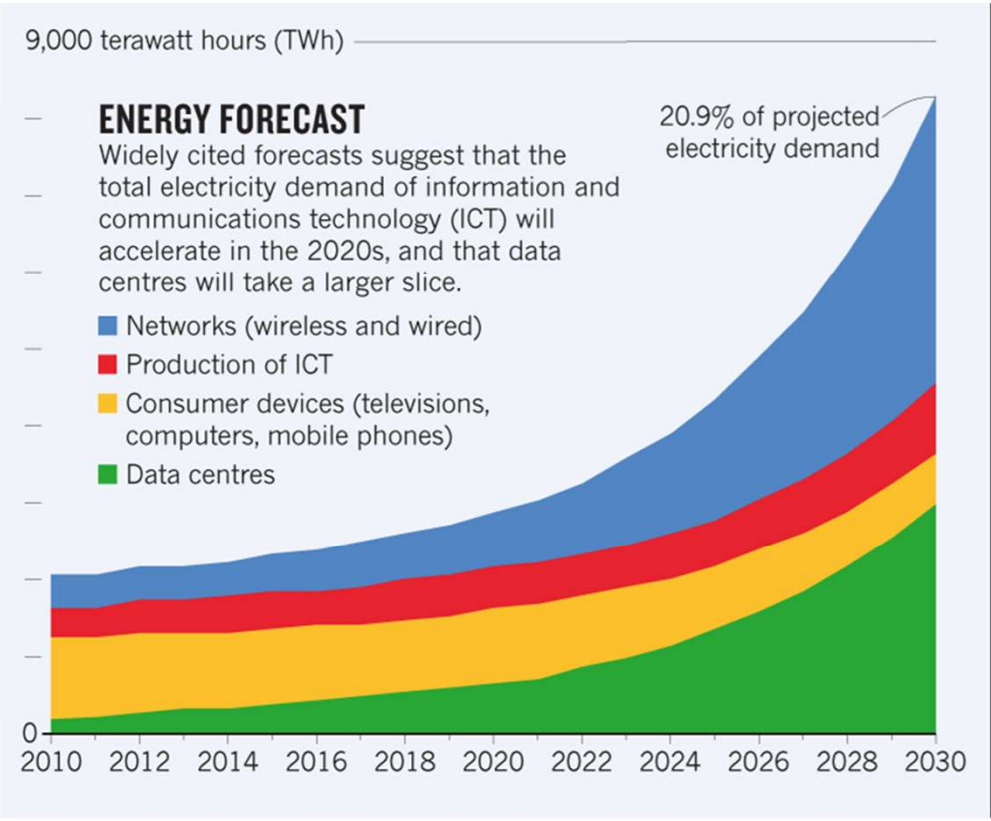
Tulevaisuusajattelu





Kestävyysajattelu, rajalliset ja rajattoman pelit

“An infinite mindset embraces abundance whereas a finite mindset operates with a scarcity mentality. In the Infinite Game we accept that “being the best” is a fool’s errand and that multiple players can do well at the same time.”

- Simon Sinek

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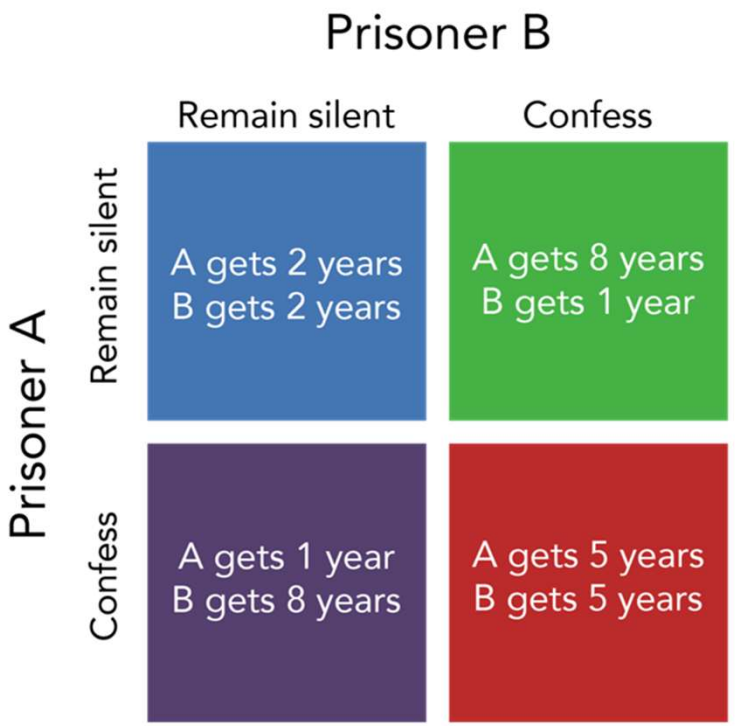
Kestävyysajattelu, rajalliset ja rajattoman pelit

Peliteorian klassikko: vangin dilemma

- Rajallinen peli, ts. pelataan kerran
- Rajaton peli, ts. pelataan jatkuvana
- Rajallisissa peleissä eri strategia kuin rajattomissa peleissä, eli
  - Mukava - Yhteistyö oletuksena
  - Rankaiseva - Välitön palaute petokseen
  - Anteeksiantava - Paluu yhteistyöhön
  - Epäkade - Antaa toisen voittaa yksittäisen erän ja saada enemmän pisteitä
- Elämä on rajaton peli



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Teollisuuden
tarpeet
kestävyyteen
liittyville tiedoille
ja taidoille

Millaisia tietoja ja taitoja oikeasti tarvitaan

TIEKE
TIETOYHTEISKUNNAN KEHITTÄMISKESKUS RY

- Kestävyyttä voidaan tarkastella tieteellisesti, akateemisesti, jne., mutta mitä taitoja käytännön työelämässä oikeasti tarvitaan?
- Tutkimus 9 eri maassa

Fig. 2. Themes with respect to research questions.

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Sustainability competencies and skills in software engineering: An industry perspective☆

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Keywords:
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Education
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Sustainable development goals
Skills

ABSTRACT

Context: Achieving the UN Sustainable Development Goals (SDGs) demands a shift by industry, governments, society, and individuals to reach adequate levels of awareness and actions to address sustainability challenges. Software systems will play an important role in moving towards these targets. Sustainability skills are necessary to support the development of software systems and to provide sustainable IT-supported services for citizens.
Gap: While there is a growing number of academic bodies including sustainability education in engineering and computer science curricula, there is not yet comprehensive research on the competencies and skills required by IT professionals to develop such systems.
Research goal: This study aims to identify the industrial sustainability needs for education and training from software engineers' perspective. For this, we answer the following questions: (1) what are the interests of organisations with an IT division with respect to sustainability? (2) what do organisations want to achieve with respect to sustainability, and how? and (3) what are the sustainability-related competencies and skills that organisations need to achieve their sustainability goals?
Methodology: We conducted a qualitative study with interviews and focus groups with experts from twenty-eight organisations with an IT division from nine countries to understand their interests, goals, and achievements related to sustainability, and the skills and competencies needed to achieve their goals.
Results: Our findings show that organisations are interested in sustainability, both idealistically and increasingly for core business reasons. They seek to improve the sustainability of software processes and products but encounter difficulties, like the trade-off between short-term financial profitability and long-term sustainability goals or an unclear understanding of sustainability concepts from a software engineering perspective. To fill these gaps, they have promoted in-house training courses, collaborated with universities, and sent employees to external training. The acquired competencies should support translating environmental and social benefits into economic ones and make sustainability an integral part of software development.

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Yritysten kiinnostus

- Yritysten kiinnostus jaettiin kohteen mukaan
  - Yritykselle itselleen
  - Asiakkaille
  - Omistajille
  - Sidosryhmille
- Kaikessa korostuu ajatus hyötyä kestävyyden huomioimisesta

RQ1 summary

Interests with respect to business:
The interviewees highlighted that the economic benefit brought by sustainability was the main driving force for the organisations' interest. However, only a small number of organisations specifically stated that implementing sustainable practices brought them economic gains. The advantages explicitly mentioned are to be found in the area of business opportunities and competitiveness. Concerns about environmental impacts were also very present.

Interests with respect to customers:
Interviewed organisations felt that their customers had moral concerns that they had to respond to. The most mentioned moral concerns driving customers, according to our interviewees, are environmental ones, specifically reducing carbon emissions and energy use as well as social matters. With regard to social concerns here, COVID-19 had a strong impact on the customer's demands. Despite these demands, several organisations mentioned that they had difficulties to win customers due to a lack of interest in sustainability.

Interests with respect to shareholders:
Economic benefits, especially business opportunities, were what the organisations saw as most important for their shareholders. Aside from that, some organisations did mention social concerns as an important aspect for shareholders.

Interests with respect to stakeholders:
External drivers such as the media and the development of international frameworks highly influenced the interest of stakeholders in the sustainability of the organisations. Another main driver was employees' personal interest.

Yritysten tavoitteet

- Yritysten tavoitteet jaettiin kolmeen osaan
  - Asetetut tavoitteet
  - Suunnitelmat tavoitteeseen pääsemiseksi
  - Havaitut vaikeudet
- Prosessien muutos nähtiin tärkeänä keinona
  - johtotason ja toteuttavan tason välillä kuitenkin kuilu (Visiiri-hanke)
- Kestävyyttä ei nähdä yhtä tärkeänä kuin taloudellista menestystä

RQ2 summary

Established sustainability goals:
The interviewed organisations highlighted the need for improving their design processes and products to support sustainability and stressed the importance of a change in culture to positively contribute to society and help their customers make the right decisions.

Execution plan and experience to achieve the goals:
To achieve the established sustainability goals, the organisations focused on seeking collaboration with their business partners and other external entities, transforming their internal working processes, and developing tools to support interconnectivity, interdependence, and adaptability. The experiences reported included knowing how to collaborate with external stakeholders effectively, reducing carbon emissions, and applying automation when possible.

Encountered difficulties:
The difficulties reported were caused by internal and external factors. The major internal factors were related to the trade-off between short-term financial profitability and long-term sustainability goals, an unclear understanding of sustainability concepts and goals, and the culture of the employees, which was often oriented towards KPIs in conflict with sustainability goals. With regard to external factors, economic barriers and inadequate policies were the two most frequently mentioned.

Tarvittavat tiedot ja taidot

- Tietoja ja taitoja kartoitettiin kolmessa kategoriassa
  - Yrityksessä jo olevat tiedot ja taidot
  - Yrityksen havaitsemat puuttuvat tiedot ja taidot
  - Lähestymistapa puuttuvien tietojen ja taitojen hankkimiseksi
- Tiedoissa ja taidoissa korostuu vahvasti kestävyysajattelun ja teknisen osaamisen erottaminen toisistaan

RQ3 summary

Skills and competencies available in-house:
To reduce the expectation level for the staff, many organisations separated IT departments from sustainability experts, so a sustainability background was not normally required for IT-skilled employees. However, specific soft skills (e.g., problem-solving, collaboration) and technical competencies (e.g., architecture, data management) were expected and available within the IT workforce to achieve the target sustainability goals.

Skills and competencies missing in-house:
Despite separating IT departments from sustainability experts to reduce the need for sustainability knowledge, many organisations still wanted to fill that gap for their IT staff. Improving communication efficiency and defining sustainability measurement metrics were often mentioned as missing soft and technical skills within the organisations' workforces.

Solutions to acquire the missing skills and competencies:
The organisations took both internal and external approaches to fill sustainability knowledge gaps for their IT staff. Popular solutions were organising in-house training courses, collaborating with universities, sending employees to externally organised courses, and hiring sustainability consultants

Visiirin työpajassa opittua

- Visiiri - Vihreän siirtymän kansallinen ekosysteemi hankkeen työpajassa opittiin:
  - Johtotaso: Isoilla yrityksillä kestävyys osana arvoja sekä nimetty vastuuhenkilö
  - Johtotaso: Pienemmillä yrityksillä ei yhtä hyvin määritelty
  - Tuotetaso: Yleiset tavoitteet kestävyydelle
  - Tuotetaso: Yleisiä ohjeita, mutta ei muuten prosesseissa
  - Tuotetaso: Vastuu sekavasti

  - HUOM! Vaikka johtotasolla kestävyys olisi hyvinkin määritelty, ei tuotetasolle siirry kestävyysvaatimuksia!

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Kysely

Kysely

Käy vastaamassa kyselyyn.

Aikaa käytettävissä noin 5 minuuttia.

https://forms.gle/wLdTpM3LjVYW4gs88

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Tiedot ja
taidot

Kestävyyteen ja vastuullisuuteen liittyvät tiedot ja taidot

- Teollisuuden tarpeita kartoittanut kysely osoitti, että yritykset eivät osanneet varsinaisesti nimetä erityisiä kestävyyteen liittyviä tietoja ja taitoja, vaan tyypillisesti ne nähdään “pehmeinä” taitoina verrattuna tekniseen osaamiseen
- Tämä on odotettua, sillä kestävyysajattelu ei tyypillisesti ole tyypillisesti ollut osana koulutusta tai koulutukseen liittyviä rakenteita
  - ACM/IEEE Curricula guidelines
    - SE2014 mainitsee kerran termin sustainability
    - CC2020 osana projektiosaamista sekä eettisessä tarkastelussa
    - CS2023 osana AI:ta, Accountability and responsibility in design, Society, Ethics and professionalism
  - SWEBOOK v.4 (2025) mainitsee kahdessa kohdin

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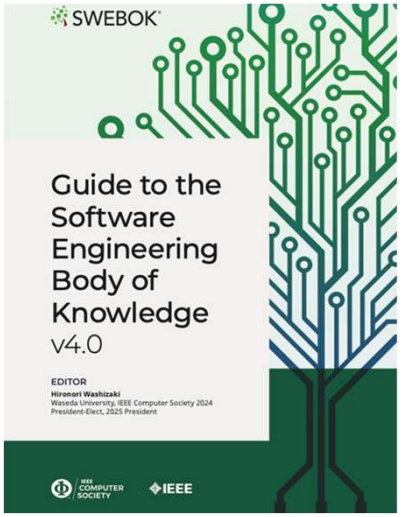


Esimerkkejä

Knowledge Unit 2: Accountability and Responsibility in Design: Sustainability, security, privacy, trust, and ethics

- CS Core Topics
  - **Design impact**: sustainability, inclusivity, safety, security, privacy, harm, and disparate impact.
  - **Ethics:** in design methods and solutions; the role of artificial intelligence; responsibilities for considering stakeholder impact and human factors, role of design to meet user needs.

SEP/Sustainability

Sustainability is defined by the United Nations as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Alternatively it is the "balance between the environment, equity and economy." (UCLA Sustainability). As computing extends into more and more aspects of human existence, we are already seeing estimates that 10% of global electricity usage is spent on computing, and that percentage seems prone to continue growing. Further, electronics contribute individually to demand for rare earth elements, mineral extraction, and countless e-waste concerns. Students should be prepared to engage with computing with a background that recognizes these global and environmental costs, and their potential long term effects on the environment and local communities.

Topics:

[CS Core]

1. Being a sustainable practitioner by taking into consideration environmental, social, and cultural impacts of implementation decisions (e.g. algorithmic bias/outcomes, , economic viability, and resource consumption)
2. Explore local/regional/global social and environmental impacts of computing systems use and disposal (e-waste)
3. Discuss the tradeoffs involved in proof-of-work and proof-of-stake algorithms

Curricula 2023

Version Beta

March 2023

The Joint Task Force on Computing Curricula

Association for Computing Machinery

(ACM)

IEEE-Computer Society

(IEEE-CS)

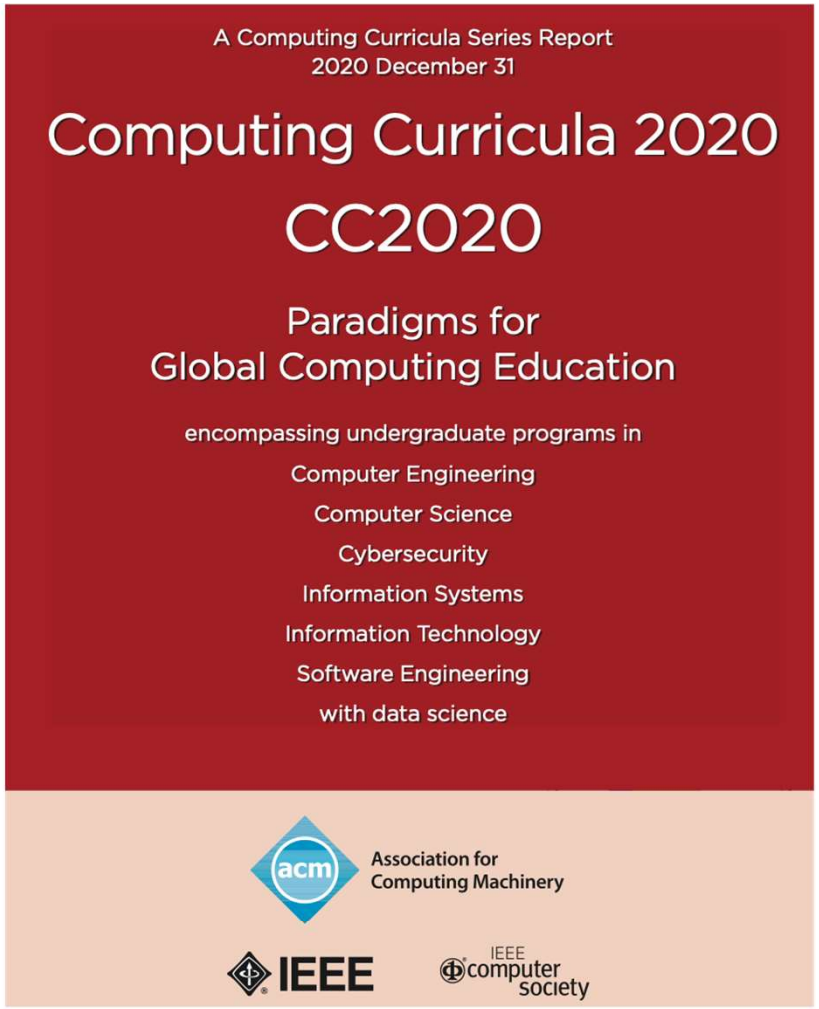
Association for Advancement of Artificial Intelligence

(AAAI)

Esimerkkejä

CE-SPE — Systems and Project Engineering

1. Manage a project that requires the analysis of a system (hardware and software), including system requirements, both technical (including functional and performance requirements) and in terms of suitability, usability and inclusiveness, taking a holistic perspective to craft specifications and evaluating reliability. [*Project management principles; User experience; Risk, dependability, safety & fault tolerance; Requirements analysis and elicitation; Hardware and software processes; System specifications; System architecture design and evaluation; Concurrent hardware and software design; System integration, testing, and validation; Maintainability, sustainability, manufacturability*]



Ethics, Impacts, and Sustainability [ETIS]

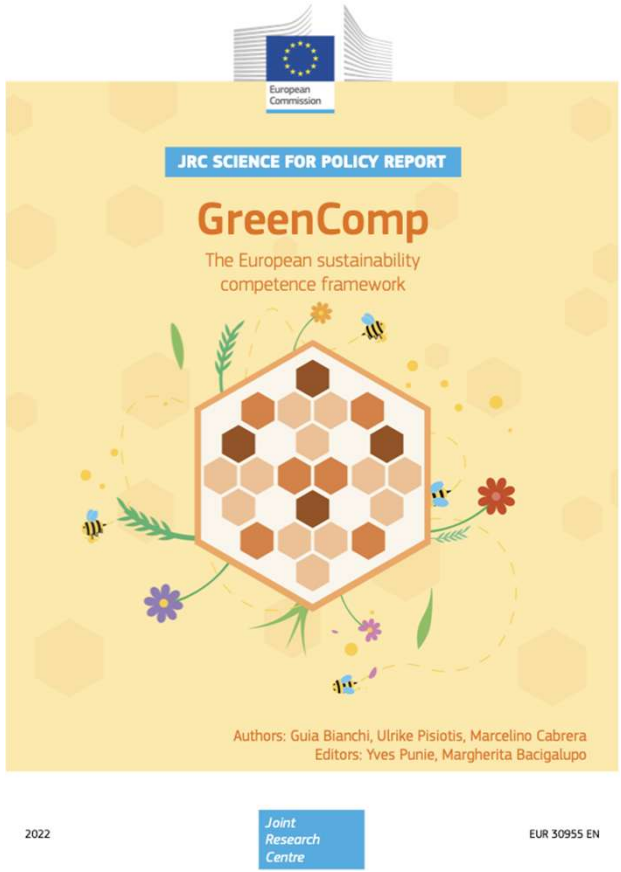
H. Apply sustainable system approaches by incorporating multiple IT practices for a corporate environment in a manner that ensures personnel privacy and integrity.

I. Develop a policy concerning contracts usable within an enterprise or government that ensures safety and health standards in compliance with regulatory statutes and requirements for mutual benefit irrespective of cultural and personal characteristics.

GreenComp – European Sustainability Competence Framework

"The aim of GreenComp is to foster a sustainability mindset by helping users develop the knowledge, skills and attitudes to think, plan and act with empathy, responsibility, and care for our planet."

- Jaettu neljään aihepiiriin
  - Embodying sustainability **values**
  - Embracing **complexity** in sustainability
  - Envisioning sustainable **futures**
  - **Acting** for sustainability



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Embodying sustainability values

AREA	COMPETENCE	DESCRIPTOR
1. *Embodying sustainability values*	1.1 **Valuing sustainability**	To reflect on personal values; identify and explain how values vary among people and over time, while critically evaluating how they align with sustainability values.
	1.2 **Supporting fairness**	To support equity and justice for current and future generations and learn from previous generations for sustainability.
	1.3 **Promoting nature**	To acknowledge that humans are part of nature; and to respect the needs and rights of other species and of nature itself in order to restore and regenerate healthy and resilient ecosystems.

Maapallo / luonto sidosryhmänä?

K: *knows that ethical concepts and justice for current and future generations are related to protecting nature;*

S: *can articulate and negotiate sustainability values, principles and objectives while recognising different viewpoints;*

A: *cares about a harmonious relationship existing between nature and humans.*

Embracing complexity in sustainability

AREA	COMPETENCE	DESCRIPTOR
2. *Embracing complexity in sustainability*	2.1 **Systems thinking**	To approach a sustainability problem from all sides; to consider time, space and context in order to understand how elements interact within and between systems.
	2.2 **Critical thinking**	To assess information and arguments, identify assumptions, challenge the status quo, and reflect on how personal, social and cultural backgrounds influence thinking and conclusions.
	2.3 **Problem framing**	To formulate current or potential challenges as a sustainability problem in terms of difficulty, people involved, time and geographical scope, in order to identify suitable approaches to anticipating and preventing problems, and to mitigating and adapting to already existing problems.

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Problem framing

Envisioning sustainable futures

AREA	COMPETENCE	DESCRIPTOR
3. *Envisioning sustainable futures*	3.1 **Futures literacy**	To envision alternative sustainable futures by imagining and developing alternative scenarios and identifying the steps needed to achieve a preferred sustainable future.
	3.2 **Adaptability**	To manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity and risk.
	3.3 **Exploratory thinking**	To adopt a relational way of thinking by exploring and linking different disciplines, using creativity and experimentation with novel ideas or methods.

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Acting for sustainability

AREA	COMPETENCE	DESCRIPTOR
4. *Acting for sustainability*	4.1 **Political agency**	To navigate the political system, identify political responsibility and accountability for unsustainable behaviour, and demand effective policies for sustainability.
	4.2 **Collective action**	To act for change in collaboration with others.
	4.3 **Individual initiative**	To identify own potential for sustainability and to actively contribute to improving prospects for the community and the planet.

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SE4GD Framework for sustainability mindset

SE4GD competencies / Elements of the SE4GD competence	Sustainable mindset							
	Eco-literate (knowledge)	Sustainable lifestyle (competence)			Sustainability literate (knowledge and skills)			Global orientation (knowledge)
	Understanding the environmental limitations	Long-term vision	Desire to change	Courage to act	Ability to identify needs and opportunities	Innovation and knowledge management competencies	Skills and competencies for right decisions	Understanding of the cultural differences
UNESCO skills for sustainable development	Life and lifestyle	Life and lifestyle & citizenship	Life and lifestyle	Problem solving and innovations	Problem solving and innovations	Problem solving and innovations	Life and lifestyle	Citizenship
21st century skill categorization	Content knowledge: environmental literacy	Content knowledge: Global awareness	Life and career skills: Initiative and self direction	Life and career skills: Initiative and self direction & Leadership and responsibility	Learning and innovation skills: critical thinking and problem solving	Learning and innovation: creativity and innovation	Life and career skills: Initiative and self direction & Leadership and responsibility	Content knowledge: Global awareness
Reflex study	Innovation and knowledge management & international orientation	Innovation and knowledge management	Being flexible & innovation and knowledge management	Being flexible & innovation and knowledge management	Being flexible & innovation and knowledge management	Innovation and knowledge management	Being flexible	International orientation

SE4GD competencies / Elements of the SE4GD competence	Software engineering methods and tools for sustainability (ACM/IEEE SWE curricula guidelines)				
	Hard (knowledge, skills and competencies)		Soft (knowledge, skills and competencies)		
	Professional knowledge	Technical knowledge	Teamwork	End-user awareness	Design solutions in context
UNESCO skills for sustainable development	Work and employment	Work and employment	Problem solving and innovations & Citizenship	Citizenship	Work and employment
21st century skill categorization	Content knowledge & Information, Media and Technology skills: ICT literacy	Content knowledge & Life and career skills: Leadership and responsibility	Life and career skills: Flexibility and adaptivity & Social and cultural skills	Life and career skills: Social and cultural skills	Content knowledge & Life and career skills: Flexibility and adaptability
Reflex study	Professional work	Professional work	Being flexible & mobilizing human resources	Being flexible & mobilizing human resources	Professional work & innovation and knowledge management

SE4GD Framework for sustainability mindset v2

	Sustainability Mindset			Realizing Mindset
SUSTAINABILITY AREA	Awareness (Eco-literacy)	Awakening (Sustainability literacy)	Transition (Sustainability toolset)	Action (Agents of change)

COMPETENCIES	• Sustainability
	  ◦ Planetary boundaries
	  ◦ Finite resources
	  ◦ SDGs
	  ◦ Challenges
	• Context Awareness
	  ◦ Socio-ecological
	  ◦ Econo-economical
		• Learning from collective
		• Vision for the future
		• Desire to change
		• Adapting
		• Values and ethics
		• Responsibility and fairness
			• Systems thinking
			• Critical thinking
			• Problem framing
			• Design thinking
			• Knowledge management
			• Innovation & entrepreneurial thinking
			• Value creation
			• Sustainable MVP
			• Scalable design
				• Courage to take lead
				• Growth mindset
				• Collective action
				• Political agency
				• Impact assessment

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Awareness “Eco-literacy”

Aim: Understanding sustainability, and realizing the challenges of sustainability

Outcome: Students can identify and describe sustainability related issues

- Sustainability
  - Learners grasp and imbibe sustainability values, understand the planet's complex interdependencies, and are empowered to act towards realising a viable ecosystem on the planet.
- Context awareness
  - Learners develop an appreciation of and consequently an ability to assess the unique cultural, social, economic, geographic, and ecological factors of an environmental situation, enabling them to tailor solutions to specific circumstances and conditions.

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Awakening “Sustainability literacy”

Aim: Accepting the sustainability crisis, and envisioning a sustainable future

Outcome: Students can identify their own role and impact on tackling some of the sustainability challenges

- Learning from the collective
  - Learners start to appreciate the extensive knowledge from both nature and humanity's historical experiences. They develop the ability to find sustainability solutions via biomimicry (in nature) and by drawing on the diverse solution set of the collective human wisdom, especially the indigenous communities.
- Desire to change / Motivation(s)
  - Learners are capable of introspection in context of sustainability, develop attitude for the change, and a motivation to change behavior (starting from their individual selves and gradually extending beyond into social/professional spaces) for a more sustainable future.

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Transition “Sustainability toolset”

Aim: Evolving into a software practitioner with a sustainability mindset [SOFT] and taking practical steps/decisions to incorporate sustainability aspects in (software engineering) work/tasks [HARD]

Outcome: Students are equipped with tools for the change

- Problem framing [and/or] Needs identification
  - Learners develop ability to to identify present and future sustainability challenges that arise due to existing standard practices. They learn to describe these challenges by considering their effects, difficulty, technological limits, local and global context, and other relevant important factors. Additionally, they are able to pinpoint what resources are needed to address these sustainability issues, whether the goal is to lessen, adapt to, or completely solve the issue.
- Sustainable MVP / Profitable transition
  - Learners understand concepts of equity and justice, promote equity and justice among present and future generations. Extend the notion of fairness by taking into account interests and capabilities of other species and ecosystems, as well as imbibe the idea of preserving nature for future generations.

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Action “Agents of change”

Aim: Engaging for sustainability within the (SE) organization and the greater (SE) ecosystem

Outcome: Students have the courage and abilities to act for the change

- Political agency [engaging with regulatory bodies to establish, enforce & evolve sustainability regulations [in context]
  - Learners become effective beyond the boundaries of their specific universities/ workplaces. They are able to identify and collaborate with like minded individuals across organizations, work with regulatory bodies, governments and such entities, to nurture and develop long term frameworks/policies/guidelines for sustainability.
- Impact assessment
  - Learners develop ability to recognize, measure and showcase the impact of their solutions (MVP as well as full scale versions). They become effective in initiating a virtuous cycle of change within and across organizations, and continuing it into society at large.

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Karlskrona
manifesto

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Sustainability Design and Software: The Karlskrona Manifesto

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***Abstract*—Sustainability has emerged as a broad concern for society. Many engineering disciplines have been grappling with challenges in how we sustain technical, social and ecological systems. In the software engineering community, for example, maintainability has been a concern for a long time. But too often, these issues are treated in isolation from one another. Misperceptions among practitioners and research communities persist, rooted in a lack of coherent understanding of sustainability, and how it relates to software systems research and practice. This article presents a cross-disciplinary initiative to create a common ground and a point of reference for the global community of research and practice in software and sustainability, to be used for effectively communicating key issues, goals, values and principles of sustainability design for software-intensive systems. The centrepiece of this effort is the *Karlskrona Manifesto for Sustainability Design*, a vehicle for a much needed conversation about sustainability within and beyond the software community, and an articulation of the fundamental principles underpinning design choices that affect sustainability. We describe the motivation for developing this manifesto, including some considerations of the genre of the manifesto as well as the dynamics of its creation. We illustrate the collaborative reflective writing process and present the current edition of the manifesto itself. We assess immediate implications and applications of the articulated principles, compare these to current practice, and suggest future steps.**

I. Introduction

It is clear that society is facing major sustainability challenges that require long-term, joined-up thinking. How do we sustain our technical infrastructures, given how much we rely on them for everything from communication and navigation through to storing health records, identifying security threats, and keeping the lights on? How do we sustain prosperity in society, given the erosion of trust in our political institutions and a growing inequality in ownership of resources? And, above all, how do we sustain the planetary systems that support life on earth, in the face of accumulation of pollutants, species loss, and accelerating climate change?

The discipline of Software Engineering (SE) has a major role to play in sustainability, because of the extent to which software systems mediate so many aspects of our lives. However, software practice has a tendency to focus only on the immediate effects and tangible benefits of software products and platforms. SE research has, for the most part, focused on increasing the reliability, efficiency and cost-benefit relation of software products for their owners, through a focus on processes, methods, models and techniques to create, verify and validate software systems and keep them operational.

The lack of long-term thinking in software engineering research and practice has been critiqued throughout the history of the discipline. For example, software maintenance and evolution were raised as concerns even at the very first software engineering conference [1]. Since then, efforts to increase the maintainability of software products and facilitate their evolution have often focused on improving architecture, decreasing lifecycle costs and managing technical debt [2]. Neumann has criticized the lack of long-term thinking over security considerations in SE [3]. For our digital information assets, some now speak of a 'digital dark age' [4], where, having discarded analog media in preference for digital, we now find that many of these assets become unreadable, due, in part, to the rapid lifecycles of software technology.

While progress has been made on design for maintainability of software *per se*, considerations that extend beyond immediate software product qualities and user benefits are generally treated as secondary concerns, optional qualities to be addressed only after the system under design has been shown to be a success in terms of technical and/or marketing criteria. The larger impact of software artefacts on society and the natural environment is not routinely analyzed. But by trading off longer-term sustainability questions for shorter-term success criteria, we accumulate threats to sustainability. We argue that this trade-off itself is unnecessary. As Neumann

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Karlskrona manifesto

Ymmärrämme, että on olemassa tietoisuus ja halu kestävämmästä maailmasta sekä paljon aitoa halua ja hyvää tahtoa, mutta tämä on yksinään tehotonta, ellemme ymmärrä seuraavaa:

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- **There is** a narrow perception of sustainability that frames it as protecting the environment or being able to maintain a business activity.

- **Whereas** as a systemic property, sustainability does not apply simply to the system we are designing, but most importantly to the environmental, economic, individual, technical and social contexts of that system, and the relationships between them.

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- **There is** a perception that sustainability is a distinct discipline of research and practice with a few defined connections to software.

- **Whereas** sustainability is a pervasive concern that translates into discipline- specific questions in each area it applies.

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- **There is** a perception that sustainability is a problem that can be solved, and that our aim is to find the ‘one thing‘ that will save the world.

- **Whereas** it is a ‘wicked problem‘ – a dilemma to respond to intelligently and learn in the process of doing so; a challenge to be addressed, not a problem to be solved.

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- **There is** a perception that there is a tradeoff to be made between present needs and future needs, reinforced by a common definition of sustainable development, and hence that sustainability requires sacrifices in the present for the sake of future generations.

- **Whereas** it is possible to prosper on this planet while simultaneously improving the prospects for prosperity of future generations.

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- **There is** a tendency to focus on the immediate impacts of any new technology, in terms of its functionality and how it is used.

- **Whereas** the following orders of effects have to be distinguished: Direct, first order effects are the immediate opportunities and effects created by the physical existence of software technology and the processes involved in its design and production. Indirect, second order effects are the opportunities and effects arising from the application and usage of software. Systemic, third order effects, finally, are the effects and opportunities that are caused by wide-scale use of software systems over time.

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- **There is** a tendency to overly discount the future. The far future is discounted so much that it is considered for free (or worthless). Discount rates mean that long-term impacts matter far less than current costs and benefits.

- **Whereas** the consequences of our actions play out over multiple timescales, and the cumulative impacts may be irreversible.

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- **There is** a tendency to think that taking small steps towards sustainability is sufficient, appropriate, and acceptable.

- **Whereas** incremental approaches can end up reinforcing existing behaviours and lure us into a false sense of security. However, current society is so far from sustainability that deeper transformative changes are needed.

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- **There is** a tendency to treat sustainability as a desirable quality of the system that should be considered once other priorities have been established.

- **Whereas** is not in competition with a specific set of quality attributes against which it has to be balanced – it is a fundamental precondition for the continued existence of the system and influences many of the goals to be considered in systems design.

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- **There is** a desire to identify a distinct completion point to a given project, so success can be measured at that point, with respect to pre-ordained criteria.

- **Whereas** measuring success at one point in time fails to capture the effects that play out over multiple timescales, and so tells us nothing about long-term success. Criteria for success change over time as we experience those impacts.

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- **There is** a narrow conception of the roles of system designers, developers, users, owners, and regulators and their responsibilities, and there is a lack of agency of these actors in how they can fulfill these responsibilities.

- **Whereas** sustainability imposes a distinct responsibility on each one of us, and that responsibility comes with a right to know the system design and its status, so that each participant is able to influence the outcome of the technology application in both design and use.

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- **There is** a tendency to interpret the codes of ethics for software professionals narrowly to refer to avoiding immediate harm to individuals and property.

- **Whereas** it is our responsibility to address the potential harm from the 2nd and 3rd-order effects of the systems we design as part of our design process, even if these are not readily quantifiable.

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Tämän seurauksena, vaikka kestävän kehityksen merkitys tunnustetaan yhä enemmän, monet ohjelmistojärjestelmät ovat kestämättömiä ja useimpien ohjelmistojärjestelmien laajempia vaikutuksia kestävään kehitykseen ei tunneta.

Siksi ehdotamme seuraavia alustavia periaatteita ja sitoumuksia:

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Karlskrona manifesto

- **Sustainability is systemic**. Sustainability is never an isolated property. Systems thinking has to be the starting point for the transdisciplinary 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.

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- **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.

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- **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 sustainability of the wider system of which it will be part.

- **Sustainability requires action on multiple levels**. Some interventions have more leverage on a system than others. Whenever we take action towards sustainability, we should consider opportunity costs: action at other levels may offer more effective forms of intervention.

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- **System visibility is a necessary precondition and enabler for sustainability design**. The status of the system and its context should be visible at different levels of abstraction and perspectives to enable participation and informed responsible choice.

- **Sustainability requires long-term thinking**. We should assess benefits and impacts on multiple timescales, and include longer-term indicators in assessment and decisions.

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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 design manifesto

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Becker at al.: Requirements: The key to sustainability, IEEE Software, 2016

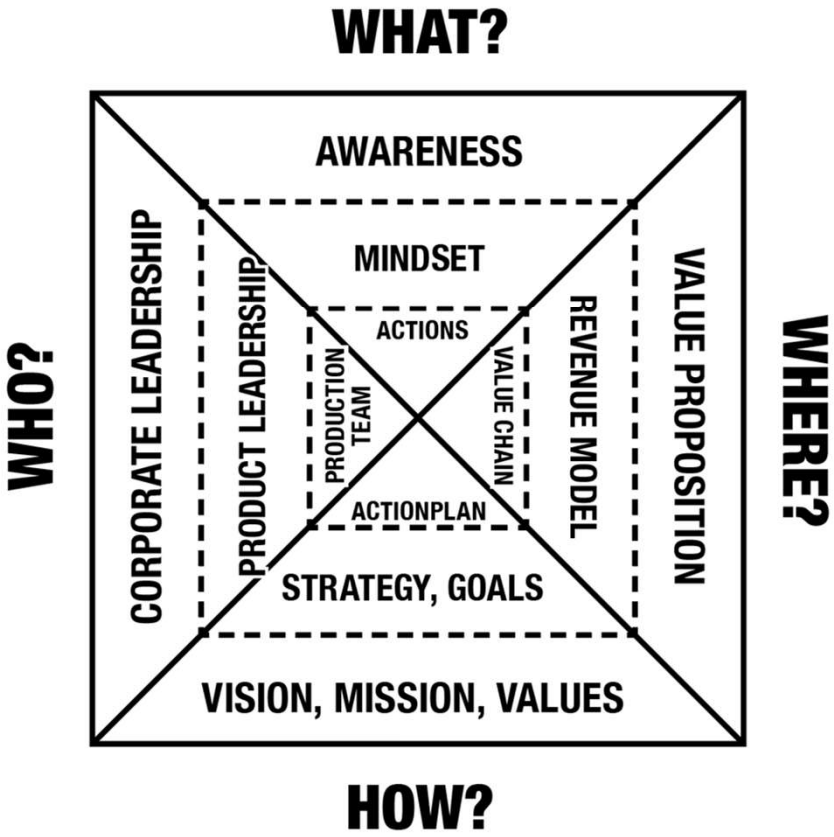
Task	Standard current practice	Focus of future practice
Mind-setting	The world is a puzzle, and we should solve the problem.	The world is complex, and we should first understand the dilemmas.
Determination of the project objective and the system purpose, boundary, and scope	Focus on the immediate business need and key system features. Don't question the project's or system's purpose.	Emphasize how the project can affect sustainability in all dimensions. Strive to advance sustainability in multiple dimensions simultaneously. Experiment with different system boundaries to understand the alternative impacts.
External constraint identification	See constraints as imposed by the direct environment of the system and its technical interfaces. Minimize the constraints considered, but include legal, safety, security, technical, and business resources.	See constraints in each dimension as opportunities. Look for constraints from additional sources, starting with company corporate-social-responsibility policies, legislation, and sustainability standards.
Stakeholder identification	Minimize the number of stakeholders involved, and focus on those who have influence. Focus on internal stakeholders, and exclude unreachable stakeholders.	Maximize stakeholder involvement in an inclusive perspective integrating external stakeholders, and involve those who are affected. Assign a dedicated role to be responsible for sustainability, and introduce surrogate stakeholders to represent outside interests.
Success criteria definition	Focus on the financial bottom line at project completion. Measure the business outcome and financial return on investment.	Focus on advancing multiple dimensions simultaneously, including financial aspects, and take into account that most effects occur after project completion.
Requirements elicitation	Focus on the features and immediate effects the stakeholders want.	Help the stakeholders understand the system's enabling effects. Use creativity techniques and long-term scenarios to forecast the potential structural impact.

Risk identification	Identify risks that threaten timely project completion within the budget.	Include the effects on the system's wider environment. Include enabling and structural effects and risks that can develop over time.
Tradeoff analysis	View tradeoff analysis as a prioritization and selection problem, and let the key stakeholders decide.	Strive to transform sustainability tradeoffs into mutually beneficial situations. Ensure that a wider range of stakeholders (or their surrogates) discuss sustainability tradeoffs.
Go/no-go decision	Base the decision on feasibility, financial costs and benefits, and risk exposure to project participants—that is, internal stakeholders.	This continues to be an internal business decision but is documented to show to external audiences that it took into account sustainability indicators and enabling effects. The decision is based on a consideration of positive and negative effects in all five dimensions.
Requirements validation	Let key stakeholders verify that their interests are captured.	Ensure broad community involvement focused on understanding effects.
Project completion	Verify whether success criteria are met on the completion date. After that, focus on maintenance and evolution.	Evaluate the effects in all five dimensions over a certain time frame after completion, aligned with the expected timescale of effects.
Requirements documentation	Current templates ignore long-term effects and sustainability considerations.	Templates require information about sustainability as a design concern and support analysts with checklists.


Paths to
Sustainability

Paths to Sustainability model

- Havaittiin, että yrityksillä on haasteita lähteä liikkeelle kestävyysaiheiden parissa sen moniulotteisuuden vuoksi.
- Mallin tarkoituksena on auttaa yrityksiä lähestymään kestävyyttä ja viemään se osaksi omia toimintoja.



Porras Jari, Abdullai Larry, Partanen Laura, Sipilä Antti (2025).Towards an Ecosystem Model in Enabling Sustainability Transition: The Case of Finnish Government Sustainability Strategy for the ICT Sector

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Mitä?

- Jotta yritykset voisivat toimia kestävästi, heidän tulee olla tietoisia kestävyydestä
- tieto ja ymmärrys kestävästä kehityksestä ja esimerkiksi kestävän kehityksen tavoitteista
- Kolmion taustalla on suunnitellun käyttäytymisen teoria, joka esittää yksilön käyttäytymispäätöksien määräytyvän ensisijaisesti aikomusten (intentio) perusteella, joihin puolestaan vaikuttavat asenteet ja subjektiiviset normit

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Miten?

- Miten-kolmiolla vastataan siihen, miten kestävyyttä voidaan lähestyä yrityksissä.
- Malli ehdottaa, että kestävyyden tulisi olla yrityksen kivijalkana sen arvoissa.
- Arvot ohjaavat strategiaa ja tavoitteita, joita yritys itselleen asettaa. Kestävyys tulisi näkyä myös täällä.
- Konkreettisen muodon kestävyys saa toimintasuunnitelman ja prosessien kautta.

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Kuka?

- Kenen sitten yrityksessä tulisi olla tietoinen kestävyydestä?
- Lyhyesti kaikkien yrityksessä työskentelevien tulisi olla tietoisia kestävyydestä
- Kestävyyden tulee olla läpileikkaavaa

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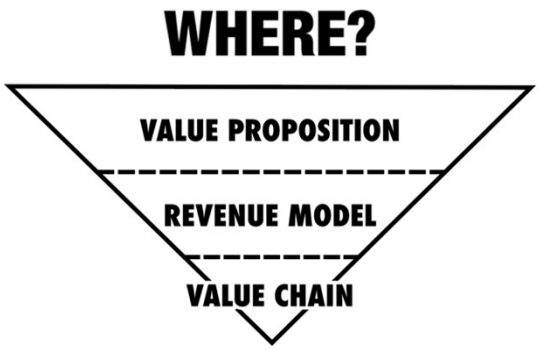
Porras Jari, Abdullai Larry, Partanen Laura, Sipilä Antti (2025).Towards an Ecosystem Model in Enabling Sustainability Transition: The Case of Finnish Government Sustainability Strategy for the ICT Sector

Missä?

- Neljäs kolmio antaa ehdotuksen siitä, missä kestävyyden tulisi näkyä yrityksen toiminnassa.
- Se tulisi näkyä yrityksen arvolupauksessa sekä ansaintamallissa.
- Kestävyys tulee huomioida myös arvoketjuissa, jotka erityisesti ICT-alalla ovat hyvin monimutkaisia.



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Loppusanat

Itsenäinen ajattelu

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VISIO sitouttaa ihmiset

”Gandhi didn’t free India because he had a goal to free India. He freed India because he had a vision of free India”

- Jordan Belfort

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MISSIO fokusoi suunnan

”If you don't set your goals based upon your Mission Statement, you may be climbing the ladder of success only to realize, when you get to the top, you're on the WRONG building.”

- Stephen Covey

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Ja muuttuu toiminnaksi strategiassa

”Vision without execution is hallucination”

- Thomas Edison

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Lopputehtävä

Kotitehtävä

Luo aiempien kotitehtäviesi pohjalta materiaali, **jolla voisit muuttaa toisten toimintatapoja tai ajatusmalleja kestävämmälle pohjalle.**

Palauta tehtäväsi 15.11.2024 mennessä.

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Kiitos!