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Permacomputing – Speculative Future

Why This Computer *Doesn't* Run Software

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Content

1. Introduction: Why Do We Crave for Healthier Computing?

IBM software for a greener world, hardware that does not need updates, energy reducing data formats, wetware computers. What if we, as a society could decide the future of forward-looking, human friendly computers? As Michal Green in his "Zen movie" (1986) video art, which took up a whole 20MB hard disk, cost over 100$ and was done on a toy computer like a Macintosh 512K[1], once said:"…there will be strange but not unforeseen consequences, which we must understand if we are to proceed along the path to computer Enlightenment"[2].(fig.1) Michael was the first artist to publish a book of drawings and graphics made exclusively on a Macintosh, which were originally printed on an ImageWriter dot matrix printer and revised when the first LaserWriter laser printer came out.[3] The artist was questioning if in an evolutionary countermove, has technology given us the silicon chip to help… get us out of this mess? Is the personal computer secretly a cultural antitoxin?[4] Can a computer make a significant contribution to a conscious life-style?[5]
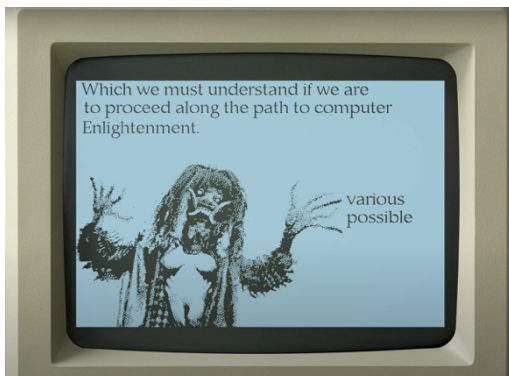

Figure 1
Michael Green, ZEN movie, 1986, video still

"Since 2020 the term perma-computing resonated with a lot of people", explains Marloes de Valk a software artist and researcher, "it captures something that is very much wished for, a counternarrative to the rapid "upgrade-or-die" cycle promoted by the tech industry."[6] Permacomputing is linked to an environmentally lightweight practice like permaculture and currently it is collaboratively developed on the permacomputing wiki.[7] The term permacomputing hints at us wanting to do better without being naive about the paradox of the unethical and

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[1] Green, *ZEN movie.*
[2] Ibid.
[3] Ibid.
[4] Green, *Zen & Art of the Macintosh: discoveries on path to computer Enlightenment*, 74.
[5] Green, *ZEN movie.*
[6] De Valk, Heikkilä, *Permacomputing.*
[7] Permacomputing wiki, 2022.

damaging practices of the computing supply chain: from mining to manufacturing, argues de Valk.[8]

The theorist of the term "permaculture", Bill Morrison believed that "a sustainable system is any system, that in its lifetime can produce more energy than it takes to establish and maintain it", and "permaculture design is the first system of conscious function design in the world", he adds: "…and functional design is sustainable"[9]. Permaculture was first formulated in 1978, and stands in opposition against industrial agriculture. It is an approach to land management and settlement design that adopts arrangements observed in flourishing natural ecosystems. The term permacomputing is inspired by permaculture, and as an idea is based on applying permaculture's concepts to computing and "high" technology. Permacomputing is defined as a concept and a practice-oriented community, that is trying to solve the issues of resilience and regenerativity in computer and network technology.[10]

In my paper, which is about 26K characters/ 4439 words long, and approximately 32.1 minutes reading time, I will try to understand the concept of permacomputing as the practice of a speculative future within the frameworks of modern technological scalability, Siliconization and its disruptive nature. I will begin by delving deeper into the etymology and history of the term 'permaculture', while explaining its affiliation to permacomputing. Then I will follow with the principles of permacomputing and cover often related concepts, such as supercomputing, feminist computing and other N-computing(s). Additionally, I will address the problems that permacomputing is trying to solve, including the decentralization of technology, the diversification of computer cultures, 'dematerialization', and the reduction of resource use.

After an inspirational reading of "Permacomputing Aesthetic" by A. Mansoux at Annika Haas's class "Whose Technology?", and fuelled by a constant frustration in the fast-paced design studio where I work, my interest piqued when I discovered this topic. I am often feeling conflicted at work, where I assist in the creation of once-in-a-lifetime event installations, which

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[8] De Valk, Heikkilä, *Permacomputing*.
[9] Mollison, *Permaculture: A Designer's Manual*.
[10] Permacomputing wiki, 2022.

take hundreds of render hours to produce and ever new hardware to run on. I felt a need to deepen my understanding of the relation between ecology and technology, and what modern computing really is and where it's going. For me permacomputing as a concept raises some questions: How will our technologically-oriented future look? What kinds of justices can we seek from it? Why do we crave healthier computing? Are we capable of cultivating a new practice of computation by working together on (re)using digital technology? Can it be done within the boundaries of our planet and the reality of our climate?

2. Permanence in Permaculture and Permacomputing.

Over the last hundred years of development of human civilization energy consumption has increased, which is often equated with "progress", according to Ville-Matias Heikkilä, the programmer, writer and oldschool *demoscene* coder-artist who first described the term permacomputing in 2020 on his website. Ville is keenly interested in cultural and ecological permanence. His ideas in the existing discussions and activities are shaped around how to "give computers a meaningful and sustainable place in a human civilization that has a meaningful and sustainable place in the planetary biosphere". In his essay on Permacomputing, he wrote: "The existence of computers in a human civilization can be justified by their ability to augment the potential"[11]. Heikkilä is interested in how the term's meaning will develop now that people are adopting it.[12]

The term *permaculture*, is derived from a combination of two Latin words *Permanens* – meaning to endure and *culture* – the practices that support human occupation. The ideas of permaculture for its founders, Bill Mollison and David Holmgren, were based on the simple question related to the design of agriculture – if nature is dominated by perennial trees and plants, why is our agriculture dominated by annual crops? Why does not it follow the design rule of nature?[13] When something is permanent, it is stable and enduring. Systems and structures that are designed to last, have the ability to sustain.[14]

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[11] Heikkilä, „Permacomputing", 2020.

[12] De Valk, Heikkilä, *Permacomputing*.

[13] Mollison, Holmgren, "What is Permaculture?"

[14] Mollison, *Permaculture: A Designer's Manual.*

It might seem paradoxical to connect permaculture and computation; how can a practice based on the extraction of finite resources be permanent? This connection is rather a question: could we create a place for computer and network technology in a world where humans contribute to the well-being of the biosphere rather than destroy it?[15] In both computing and agriculture, a major issue is that problems are too often "solved" by increasing controllability and resource use. Permaculture takes another way, advocating methods that "let nature do the work" and minimize the dependence on non-renewable energy sources. Localness and decentralization are also major themes. The permacultural philosophy is not "going back in time" but finding clever hacks for turning problems into solutions, competition into co-operation, waste into resources.[16] Permacomputing as a speculative practice is trying to imagine this space exists, so it should be perceived both as utopian and practical. As a concept it tries to research what a permacomputing way of life could be, and what transformative computational culture and aesthetics codes it could bring forward. In which ways nature design systems can teach us to re-center existing technologies and practices? Permacomputing encourages design for disassembly, adaptability to individual's needs, compatibility on a variety of architecture, modularity, minimization of power and memory.[17] It values care for chips and life, keeps it small and flexible, hopes for the best, prepares for the worst, responds to changes. It is about using computation only when it has a strengthening effect on ecosystems.[18]

2.1. Countering with Permacomputing - with (E-)Waste as a Resource.

The resource-sensitivity is crucial for permaculture, so when we think about the permanence of physical resources, modern computers are bad at using electricity. They consume a lot of energy, silicon and miscellaneous materials. Their legacy "calculation factories" guarantees to use all the resources they "need", so primarily for permacomputing it means adapting to

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[15] Permacomputing wiki, 2022.
[16] Heikkilä, „Permacomputing ", 2020.
[17] Permacomputing, *Permacomputing*.
[18] Ibid.

changes in energy and using it wisely. It is wise to store the energy for later use. For instance, flywheels (mechanical battery) are a potential alternative to chemical batteries, they have similar energy densities but do not require rare-earth materials and last for centuries instead of a couple of years. In IC fabrication, the microchips are treasured like gems or rare exotic spices, because of the amounts of energy it requires to produce them. Permacomputing manifests: "use what is available", broken devices should be repaired, the non-existing devices should be built from existing components that have fallen out of use, chips should be designed flexible to be reappropriated for the purposes they were never intended for.[19] For instance, after a long history of fighting consumers with anti-repair legislation, Apple launched its first self-repair program, a first of its kind that allows owners of recent iPhone models to order genuine Apple parts and tools to conduct basic smartphone repairs, like screen and battery replacement, at home. More such initiatives come from Samsung, Google, and Microsoft. These steps will help consumers to repair and maintain their devices indefinitely rather than being forced to upgrade every few years.[20] The idea of designing for disassembly is about having all elements of a product be possible for repair and for *end of life.*[21]

"*That which cannot be repaired is already broken*."

This means using simple mechanical fasteners instead of adhesives, clearly labeling components with their material type, and ensuring components can be disassembled with everyday tools. Unlike the nebulous goal of designing a sustainable product, designing a product for disassembly is a more concrete, quantifiable approach to ecologically sound making and to consumption.[22]

In a multicore CPU many partially functioning cores could be combines into one which is fully functioning. Outdated chips could find artistic use, or be stored until they are needed again, so called "shelf-life", reverse-engineering their black boxes could help reappropriate their usage (Bitcoin-mining ASICs for

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[19] Heikkilä, „Permacomputing ", 2020.
[20] Stone, Grist, "Apple just launched its first self-repair program."
[21] Permacomputing, *Design for disassembly*.
[22] Ibid.

something artistically interesting or useful). The densest chips should be used for tasks where the increased computation is truly necessary, rather than for non-essential purposes like entertainment, where its merely about the aesthetics. Smaller chips allow more efficiency but also increase the risk of damage and reduce the lifespan. For example, living cells (fungal computer using fungi Basidiomycetes[23]) wetware computer using leech neurons or solar powered website[24] sometime in the future might be able to replace.[25]

Another important aspect of permaculture that is integrated in permacomputing is – observation. It is one of the most important human skills computers can augment, difficult things for humans to observe could be, for instance, calculated by various computational processes and visualized, emphasizing pattern deviances. Bill Mollison said: "Information is the critical potential resource. It becomes a resource only when obtained and acted upon". Modern computing systems do not let the user know what is going on, websites and apps rarely show the error messages, when something is obviously not functioning, which causes technological alienation among computer users. Following the above-mentioned thesis Heikkilä suggests that, the visualizations are needed to create a pleasant and tranquil user experience. In this way, human tendency to observe the natural environment could be applicable when designing visualisers.[26] Permaculture is trying to develop systems where nature does most of the work and humans maintain and design. Computerized automation would therefore be somewhere between natural processes and human labor. Modern houses are full of devices that waste energy, but automation would be the best at continuous and repetitive tasks that require a lot of time or effort from humans but only a small number of resources from a programmable device.[27]

It is much easier to (re)create a software program from scratch than a garden, it mostly grows in its size, and this effect should balance with refactoring (reduce the

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[23] Adamatzky, "Towards fungal computer."
[24] De Decker, "How sustainable is a Solar Powered Website?"
[25] Heikkilä, „Permacomputing ", 2020.
[26] Heikkilä, „Permacomputing ", 2020.
[27] Heikkilä, „Permacomputing ", 2020.

size/complexity). This need is often overseen in Moore's law world, where software is constantly upgrading; ideally the maintenance of a software would be better to make it smaller and faster. If the function of the program does not change it should only require preservation. Heikkilä suggests compatibility platforms that are defined, static and easy to emulate/virtualize, such as extreme file size limits or a choice of hardware with very little computational power.[28] Maximalist techno-aesthetics is increasing density of information for its own sake: more pixels, more details equal more potential, and yet this very often broken and falls short of expectations. It is especially applicable in the context of art, design and cultural production, where the constant rush and pressure to adopt new tools and techniques, while simultaneously accelerating the creation of new discourses around novel aesthetics that entirely avoid critique around these new tools.[29] This concept finds a lot of support, for instance, at the *Smallthingy*, small file media-arts festival founded in 2020, which promotes the idea of saving the world, one pixel at a time. It began as a practice raising awareness about the high carbon footprint of streaming media, which is calculated to contribute 1% of greenhouse gas emissions and rising fast. Their research offers a solution through the creation and dissemination of Small-File-Ecomedia, low-bandwidth movies at a rate of 1/mb per minute each, showing that good cinema does not have to mean big files which allows them to be streamed with no damage to the planet. Artists can use free, cross-platform apps including Handbrake, Any Video Converter and AVIDMUX to compress moving-image content to a fraction of its original size.[30]

Marloes de Valke underlines that countering within permacomputing is working with (e-)waste as a resource, emphasizing repair and maintenance rather than production of new devices, planned longevity rather than planned obsolescence. It counters tech corporations' claims to universality through a decentralized and local approach.[31]

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[28] Heikkilä, „Permacomputing ", 2020.
[29] Mansoux, "Permacomputing Aesthetics."
[30] Small File, "Smallthingy. "
[31] De Valk, Heikkilä, *Permacomputing*.

2.2. Super-, Feminist, Dreamful-, Minimal-, Perma-computing — N-computing(s), or N-futuring(s).

The mainstream history of computing is often a "winners' history", told from a Moore's law point of view. We therefore need more varied approaches to the history of computing in order to better situate ourselves in it. A lot of European local computing cultures were "colonized" by Silicon Valley culture, with its constant growth and obsolescence, which is also called Siliconization.[32] Therefore, keeping pre-siliconization ideals and practices can amplify creativity, small is beautiful, no platform is obsolete, creating an "alternative world" to contrast mainstream computing.[33]

Communities of like-minded people are currently building new discourses around digital and physical spaces, sharing their interrelated ideas in the *demoscene*, indie publishing and workshops. They appreciate the value in a more local, decentralized, and diverse computer culture. There is a lot of overlap between permacomputing and concepts such "feminist computing", "dreamful computing", and "minimal computing" and other ecological alternative computing concepts that in the following paragraph I will introduce and shortly review. Many of these new computing concepts come from the annual Computing within Limits workshops.[34]

Computing Within Limits

Computing within Limits brings together three principles, according to a 2018 paper by Nardi et al.: it questions growth and aims instead for a steadystate economy, it considers models of scarcity in order to promote resilience in a diversity of current and future contexts, and lastly it aims at reducing energy and material consumption while avoiding the Jevons paradox or rebound effect, in which gains in efficiency often result in lower costs, a subsequent growing demand, and increased resource consumption.The workshop's focus and the interpretation of its title have shifted a little over the years, starting with an emphasis on designing in the abundant present

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[32] De Valk, Heikkilä, *Permacomputing*.
[33] Ibid.
[34] Ibid.

for the use in a future of limits, to designing for the present with an awareness of current realworld limits.[35] One important paper is Jang et al.´s *Unplanned Obsolescence: Hardware and Software After Collapse* that estimates lifetimes for various hardware details and concludes that it may be possible to maintain some of current computer hardware for several human generations even if the entire semiconductor industry collapsed right now.[36] "Collapsology" and collapse computing prioritize community needs and aims to contribute to a knowledge commons in order to sustain the practice of computation through infrastructure collapse, it is the practice of engaging with the discarded to transform what is exhausted and wasted into renewed resources.[37]

Dreamful Computing

Another term that is worth mentioning is Dreamful computing; it proposes escape and futurity, from social media and data extractivism. It is inquiring into ways to store, transmit and process data for working on seemingly societal problems, such as distribution of wealth, the occurrence of injustice, climate change. It aims to problematize existing forms of computation, and offers productive ways to go sideways, says Shintaro Miyazaki. It is related to socialist computing in terms of its issues and to feminist computing in terms of its aims to empower women and abolish inequalities based on gender. It is dreamful because it believes that computation is not inherently unjust or biased. It is related to practices of communing as it is pursued by small communities, for example, formed by post-growth-oriented housing cooperatives.[38]

Feminist Computing

The above-mentioned Feminist computing is a movement that focuses on social justice issues around technology (perma-computing is mainly on the why's and how's of the technology itself). Heikkilä compares it to the 19th century activists who raised issues about the exploitation that took place in

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[35] De Valk, Heikkilä, *Permacomputing*.
[36] Ibid.
[37] Jang, "Unplanned Obsolescence: Hardware and Software After Collapse."
[38] Miyazaki, "Dreamful Computing – A Very Short Provocation."

factories, while others questioned the maximalist production model that factories represented, where both are equally important.[39] The Feminist Server Manifesto states "not to strive for seamlessness. Talk of transparency too often signals that something is being made invisible"[40].

Minimal Computing

"As soon as programs are competing for CPU time, memory, etc. the question of how to optimize your system for what you would actually like it to do inevitably arises", explains Andrew Lison, "minimalist computationalist" and former theorist of computing. His philosophy extends to the way he tends to engage with desktop operating systems: "less is more", which interconnects with permacomputing principles. Minimal computing is in line with Alex Gil, who was one of the earliest digital humanities writers on the topic: an emphasis on the sparsest of configurations necessary for a given task or set of tasks at hand. "There is a contradiction, or — what is probably a better way to describe it — a dialectic between machinic and human effort such that the less of one you employ the more of the other is engaged." "Minimal computing aligns well with other movements like feminist or queer computing that focuses on re-envisioning the experience of and access to computation and its culture along more equitable grounds, since the purpose of these systems and the open-source ecosystem that surrounds them is to encourage a wider range of participation in computer science specifically and computing more broadly." Lison makes an example of the Raspberry Pi, a phenomenal device that runs a variety of operating systems and configurations, but its core system software is the Raspberry Pi OS (based on the Debian Linux distribution), it is converted to a 64-bit base a "regular" computer. It uses very cheap SD card media for a storage, and by swapping the cards one can swap out operating systems easily. The spirit of minimal computing is building your own install from the command line up, it is a great way to learn more about these lower levels of computing, believes Andrew. Minimal

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[39] De Valk, Heikkilä, *Permacomputing*.

[40] De Valk, Heikkilä, *Permacomputing*.

computing can help reorient our thinking, whether to build cloud-based services or reject that paradigm altogether.[41]

The above listed alternative computing methods forming an "experimental approach" and ideology critique, from people who build discourses and awareness around inequalities to everyday users of Linux as countercultural appeal; in this way with alternative N-computing(s) we could build more efficient computation systems.

As a juxtaposition to these forms of sustainability focused computing we have design philosophies like supercomputing, that aims to maximize computer performance at any cost (photorealism in consumer computer graphics, precise weather forecasting, big data, cloud services, etc).

3.Conclusion

This potato patch of permaculture and permacomputing parallels need a temporal and historical context to fully place the discussion. Unlike permaculture, which has been dealing with the same technological advancements of the carrot for the last 10,000 years, computing develops at a rate that becomes increasingly difficult to fathom. It is nearly impossible to find a red thread within a field developing so rapidly. For instance, the accelerated growth of NVIDIA, a company at the forefront of developing an extremely large-scale AI factory they call "EOS", currently the 9th fastest supercomputer in the world.[42]

Referring to collapse informatics, Heikkilä is convinced even if our civilization faces a collapse, the entire society needs to reduce energy consumption, lengthen technological lifespans and reduce superfluous dependencies. Permacomputing acknowledges that mainly realizing the possibility of collapse may help coordinate these changes. The most efficient way would be designing for disassembly, it supports hardware longevity in collapse and non-collapse scenarios.[43] We do not need to turn our lives into a chapter from the book "The Ministry for the

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[41] Lison, *Minimal Computing*.
[42] NVIDIA, "Eos: The Supercomputer Powering NVIDIA AI's Breakthroughs."
[43] Heikkilä, *Permacomputing*, 2021.

Future" by Kim Stanley Robinson to realize the importance to be critical toward the way we design, manufacture, (re)use, maintain, and repair our technology within our cultural and ecological needs.

Permacomputing perpetuates the idea that we should develop a deep relationship to technology, where it would be allowed to freely connect and grow roots to all kinds of areas of human and non-human life. Communities would develop a local understanding of each practical aspect of technology, but also the cultural, artistic, ecological, philosophical and historical aspects to make it locally relevant. "Theoretical and practical understanding are equally important and support one another", claims Heikkilä. An academic who is be able to code would be able to bridge the gap of understanding between theory and practice.[44] The community is growing, from symposium on practicing Permacomputing, where people gather to learn reusing technologies for digital resilience[45] to online community initiatives as *The Modding Fridays*. The latter is a good example of an "online community of people who are interested to learn together about the maintenance and repurposing of consumer electronics, for fun and profit". They are broadening conversations on post-digital and repair culture, showing how to clean and improve the appearance of old equipment.[46] Permacomputing is about reimagining, dreaming, and experimenting with alternative ways of engaging with computer and network technology. And it is up to artists, designers and cultural workers to begin to critically examine the ways we are dependent on the ICT industry by introducing a notion of technological constraint. Permacomputing could therefore be an effective cultural counter-voice to a digital aesthetic that encourages maximisation, for example high bandwidth, high resolution, more computing power at any cost, for anything, sensing and capturing more, while making less and less sense, ultimately rendering us insensitive to the harm and damage we legitimise.[47]

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[44] Heikkilä, „Permacomputing", 2020.
[45] "Reassemble Lab 5: Practising Permacomputing."
[46] Wiki, "Modding Fridays."
[47] Mansoux, "Permacomputing Aesthetics."

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Eigenständigkeitserklärung

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