A Philosophical Exploration of Frugal Computing

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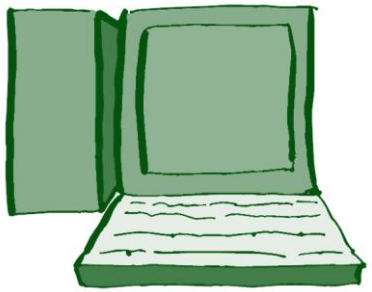
Frugal computing

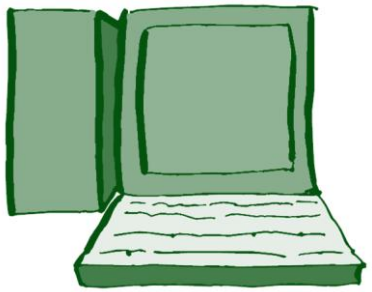


Vanderbauwhede (2021) defined frugal computing as achieving our aims with less energy and material.

Argument:

1. Emissions from computing: > ~4% of global emissions (> aviation); by 2040 (projected): >50% of budget to stay below +1.5°C warming.
2. Capacity for renewable energy can't keep up with growing demand.
3. Moore's Law: could have led to exponential efficiency gains; instead led to bloatware & very short lifetimes of computing devices; has ended, so efficiency gains won't offset growing demand.
4. Due to short lifetimes: device production > operational emissions.
5. Therefore, as a society, we must **treat computational resources as finite** and precious, **extending useful device lifespans** and **using computing resources more frugally**, urgently.

Frugal computing



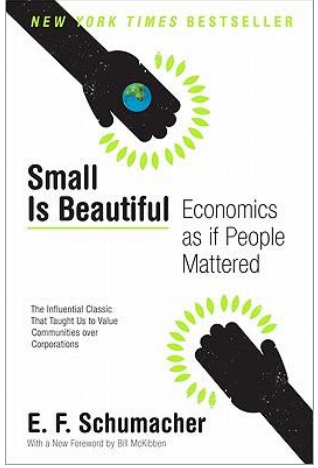
Vanderbauwhede argues for a paradigm shift where we “do more with less” in computing:

- Design technologies for longevity & efficiency:
  - extend useful life of devices;
  - reduce energy consumption (software).
- Be more intentional about when computing is necessary.

To develop this view, look for related ideas:

- from economics
- and philosophy, *e.g.*, environmental virtue ethics.

Economics: *Small is beautiful*



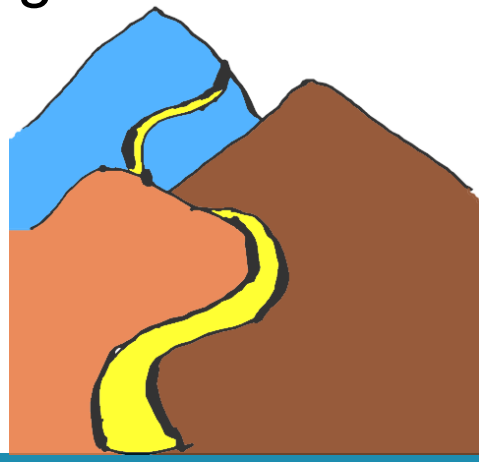
Common view: bigger is better.

↔ Buddist idea of ‘enoughness’

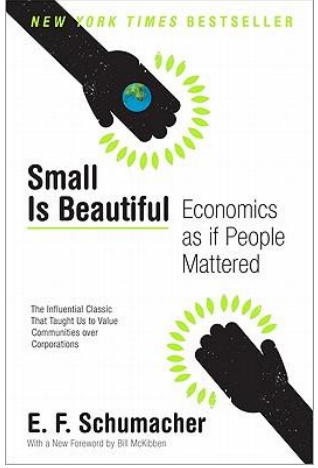
Chinese concept of sufficiency without grasping:

“a moderation of desires, a prioritization of virtues over material wealth, and a cultivation of harmonious relationships for personal and societal well-being” Chen (2025)

Tao Te Ching: “There is no greater misfortune than not knowing when you have enough.”



Economics: *Small is beautiful*



Common view: bigger is better.

↔ Buddist idea of 'enoughness'

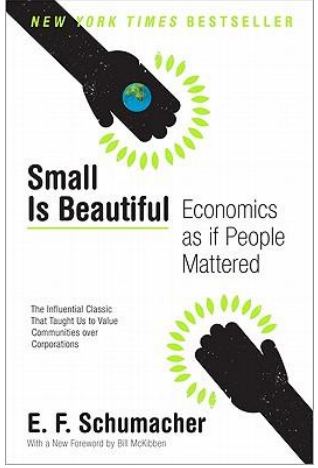
Ghandi: All-India Spinners/Village Industries Association

"doing more, for less, for more"

"Introducing Gandhian Engineering" (Platt, 2010)

- *Ahimsa*: innovation through non-violence;
- *Swadeshi*: self-reliance;
- acting in a selfless, compassionate, but unconventional manner to create a better world for all, not just a few.

Economics: *Small is beautiful*



Common view: bigger is better.

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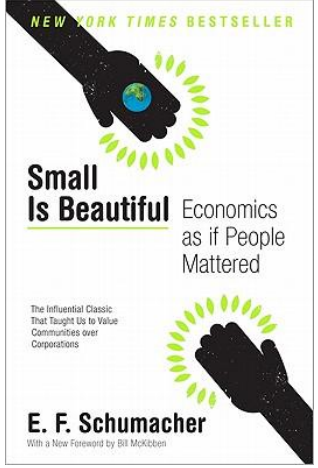
Ghandi: All-India Spinners/Village Industries Association

→ E.F. Schumacher (1973) *Small Is Beautiful*

"Ever **bigger** machines, entailing ever bigger concentrations of economic power and exerting ever **greater violence against the environment**, do **not** represent **progress**: they are a **denial of wisdom**. Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful."

Economics: *Small is beautiful*



Common view: bigger is better.

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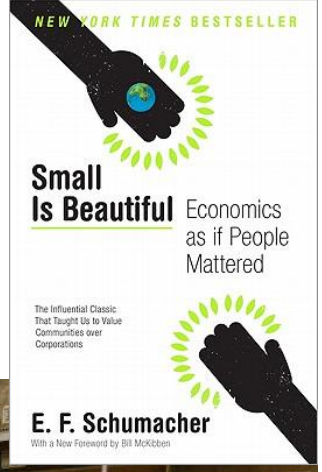
→ E.F. Schumacher (1973) *Small Is Beautiful*

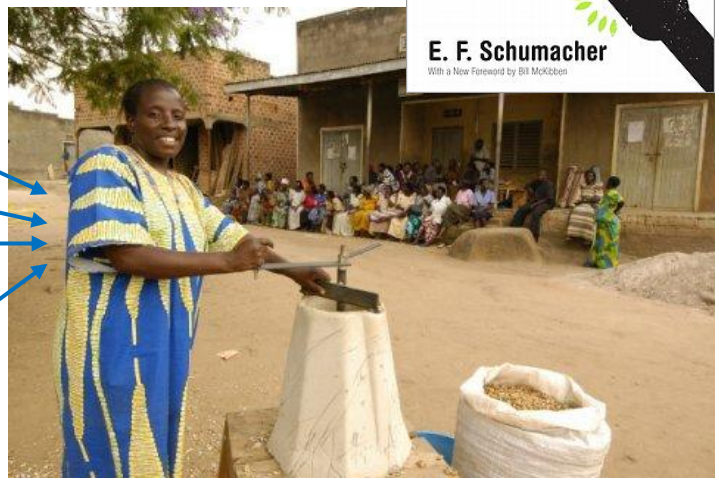
Argued for 'intermediate technologies', which are appropriate in scale (often small-scale).

Appropiate technology (AT)



Appropriate technologies are:

- small-scale
- affordable by its users
- labor-intensive
- energy-efficient
- environmentally sustainable
- locally autonomous.

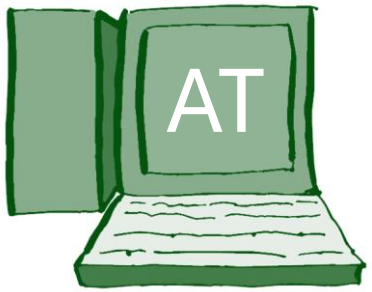


people-centered

Popular in developing countries (*e.g.*, bike-powered tools)
+ developed countries (1970s energy crisis; sustainability)

In computing: open source, OSAT

Frugal computing ⊂ appropiate technology?



Frugal computing

- Quantitative focus (engineering approach)
  - ‘Small’: less energy / less material
  - Efficiency

Appropriate technology

- Qualitative aspects (social approach)

  People-centered:
  - impact on community
  - relationship to work and human dignity

→ Potential for “appropriate computing”

Philosophy

Philosophy of technology

- Langdon Winner — Is computing political?
- Ivan Illich — Computing in a convivial society?

Environmental ethics

- Virtue ethics — Computing for human flourishing?
- Justice-based — Fair distribution of + & -?

‘Belgian’ Ecophilosophy

Philosophy of Technology: Winner

Langdon Winner (1980) “Do Artifacts Have Politics?”

Artefacts can be political in two ways:

- due to a (contingent) decision;
- out of necessity: they *require* a certain sociological system, or are strongly compatible with one.
    - Such technologies limit further choice.
    - In particular, technologies that require, or are most compatible with **centralization**, are on the rise.

Philosophy of Technology: Winner

Langdon Winner (1980) “Do Artifacts Have Politics?”

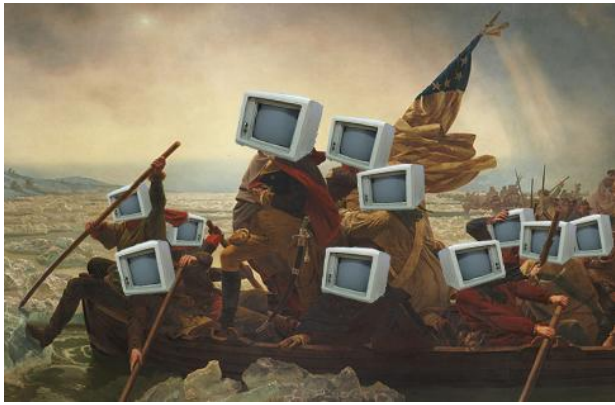
“In our times people are often willing to make drastic changes in the way they live to accord with technological innovation [while] at the same time they would resist similar kinds of changes justified on political grounds.” (p. 135)

Philosophy of Technology: Winner

Langdon Winner (1980) “Do Artifacts Have Politics?”

Lewis Mumford (1964)
“Authoritarian and democratic technics”:

“from late neolithic times in the Near East,
right down to our own day,
two technologies have recurrently existed
side by side:” (p. 121)



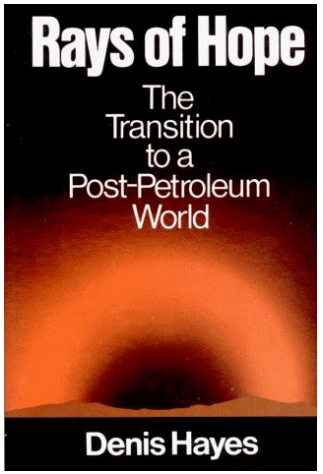
Authoritarian
- system-centered,
- immensely powerful,
- but inherently unstable

Democratic
- [hu]man-centered,
- relatively weak,
- but resourceful and durable

Philosophy of Technology: Winner

Langdon Winner (1980) “Do Artifacts Have Politics?”

Example: nuclear energy vs. solar power.

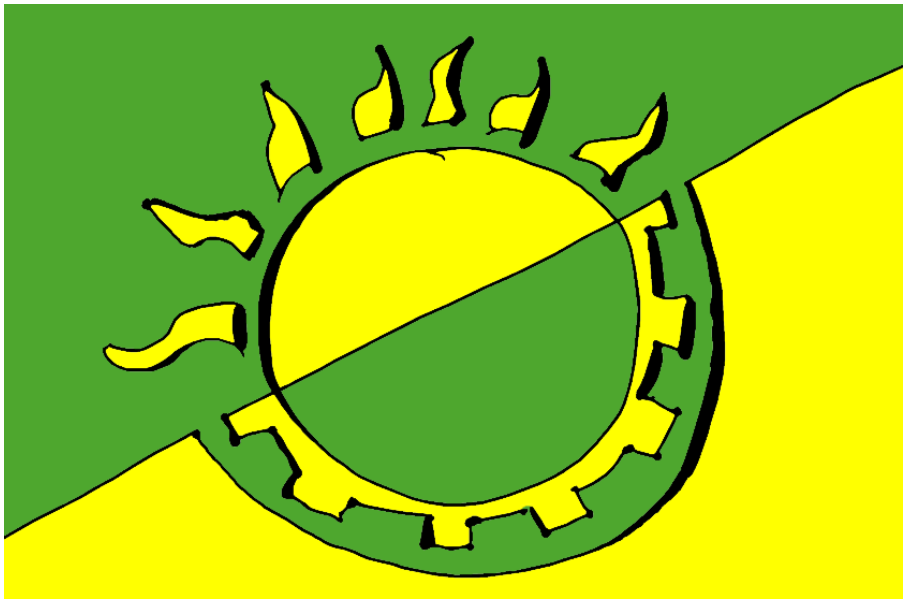


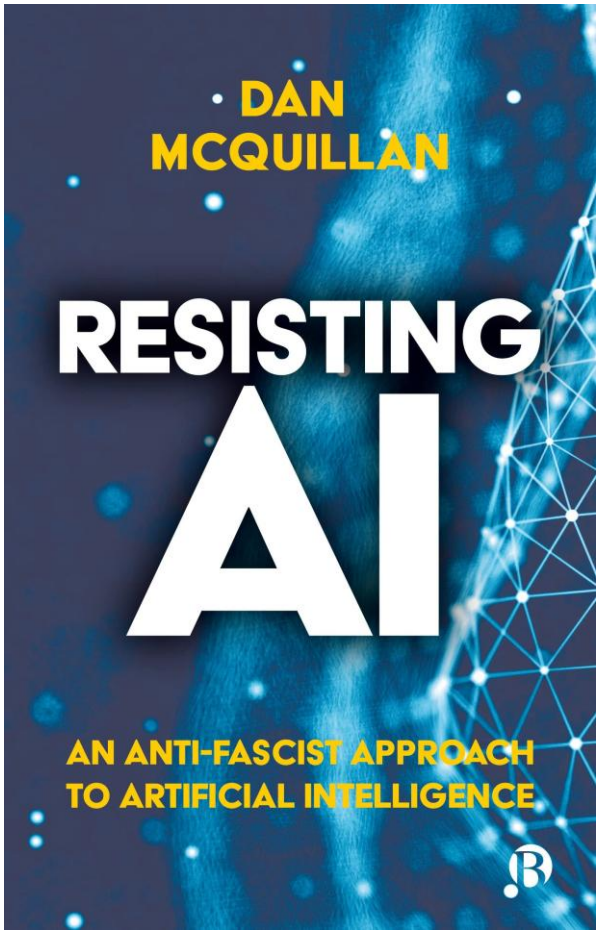
Denis Hayes (1977; as cited by Winner, p. 121):
“The increased deployment of nuclear power facilities must lead society toward **authoritarianism**. Indeed, safe reliance upon nuclear power as the principal source of energy may be possible only in a **totalitarian state**.”

“dispersed solar sources are more compatible than centralized technologies with social equity, freedom and cultural pluralism.”

Post-petroleum world priorities:
“thrift, renewability, decentralization, simplicity and safety.”

Philosophy of Technology

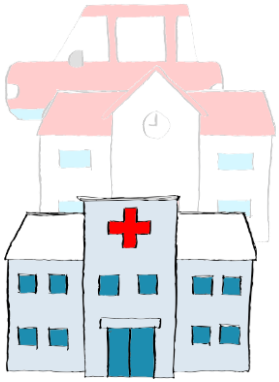




Philosophy of Technology: Ivan Illich

‘Tools’: technology, institutions, …

Theory of two turning points:



(1) upon introduction	(2) radical monopoly
increase mobility	dominate public space, traffic jams, …
promote learning	stifle learning
promote public health	hospital bacteria

Convivial approach: ‘tools’ should be responsibly limited to maximize human agency

Philosophy of Technology: Ivan Illich

"**Social scientists can build a computer model of traffic** in Calcutta or Santiago, and **engineers can design monorail webs** according to abstract notions of traffic flow. Since **these planners are true believers in problem solving by industry**, the **real solution for traffic congestion is beyond their grasp**. Their belief in the effectiveness of power blinds them to the **disproportionately greater effectiveness of abstaining from its use**. Traffic engineers have yet to combine in one simulation model the mobility of people with that of vehicles. The **engineer cannot conceive the possibility of renouncing speed and slowing down for the sake of permitting optimal traffic flow**. He would never entertain the thought of programming his computer on the stipulation that no motorized vehicle within any city should ever overtake the speed of a velocipede."

– Ivan Illich, *Energy and Equity* (1974) pp. 65–66.

Frugal computing ⊂ convivial tools?

Frugal computing

- Quantitative focus (engineering approach)
  - Efficiency as main ideal
- Being intentional about when computing is necessary

Convivial approach

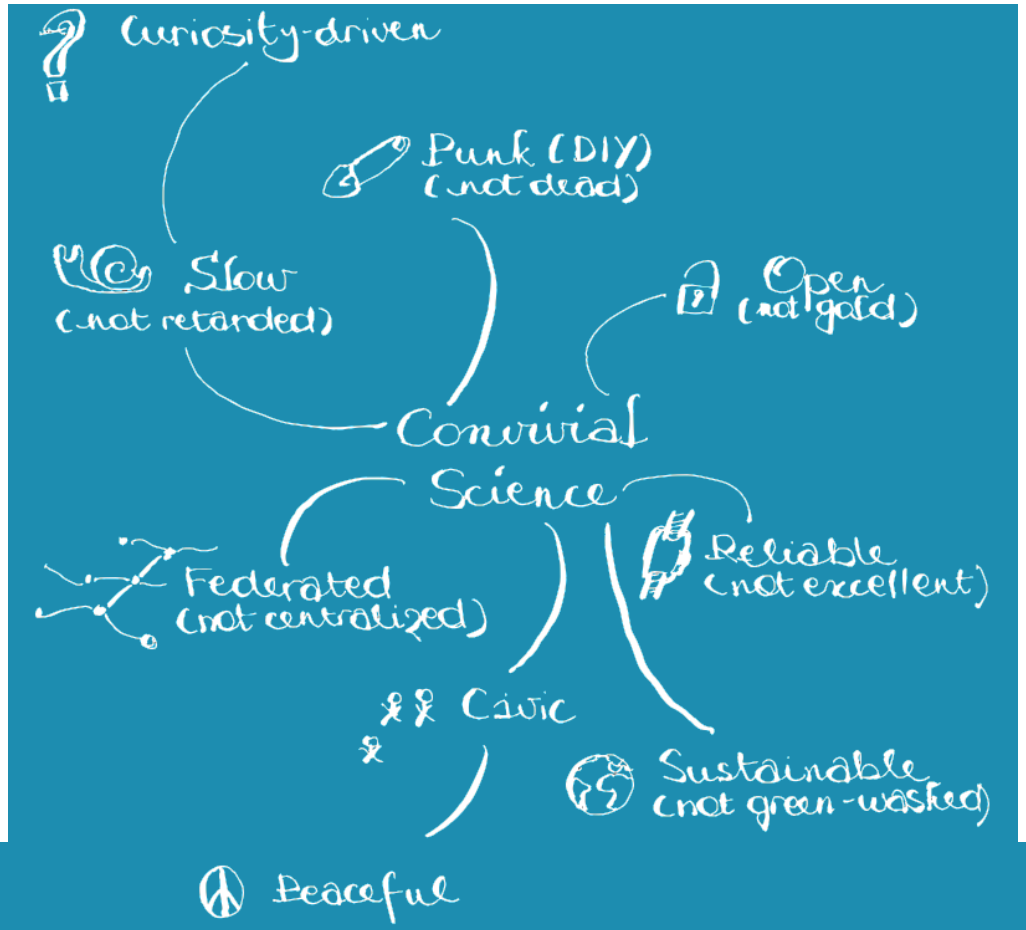
- Effectiveness of abstaining from some computations.
- Renouncing speed and slowing down for the sake of other collective goals (climate).

→ Potential for “convivial frugality”

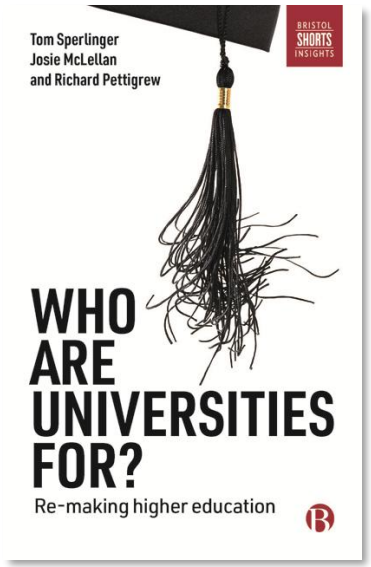
Frugal computing ⊂ convivial science?

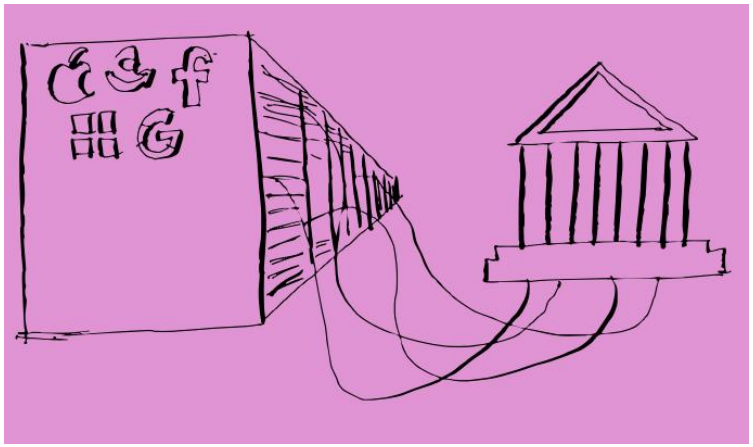
“Towards convivial science” (2023)

https://qspace.fqxi.org/competitions/entry/2310

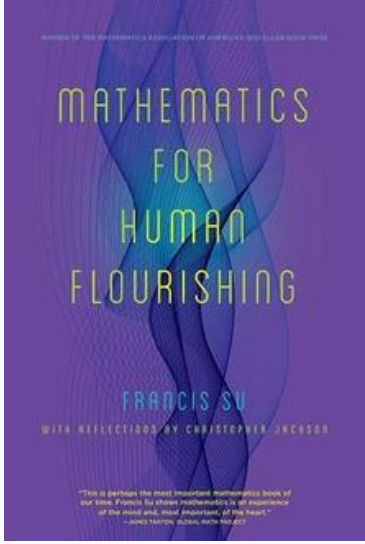


Who are we computing for?



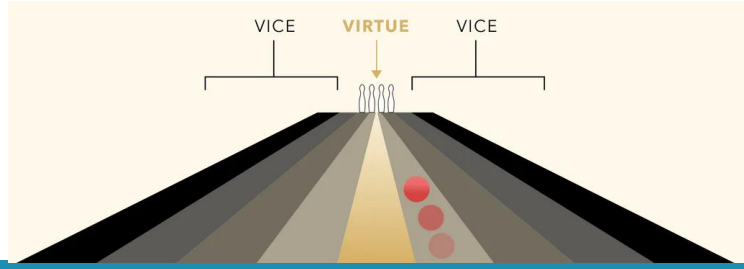


Environmental ethics



Environmental virtue ethics

- What would ‘computing for human flourishing’ look like?
- Consider frugality as an ideal.
  - Which character traits should computer scientists and users cultivate to achieve ideal of frugality?
  - Virtues: temperance, humility, care, stewardship,…
- *Phronesis*: practical wisdom
  - No universal solutions
  - Concrete, context-dependent



Environmental ethics

Ecological justice frameworks

- Distributional aspects of computing resources:
  - Consider who bears the environmental benefits vs. burdens of computing practices.
- Address global inequities in computing access
- Procedural justice in decision-making
- Intergenerational justice:
  - Consider intergenerational impacts of e-waste and resource depletion.
- Recognition of different ways of knowing:
  - Incorporate diverse knowledge systems about appropriate technology use.

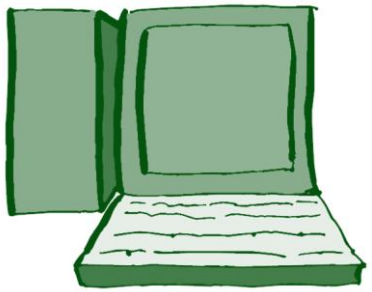
Combining ideas?

Potential tensions!

E.g., Buddhist roots of appropriate technology might clash with ideas about environmental justice.

- Justice is a Western concept ↔ *prajñā*: "recognition of everyone and everything in its nonsubstantial distinctiveness or 'suchness'." (Ives, 1992)
- "… the notion of justice is a double-edged sword. On the one hand, it sharply judges which is right and which is wrong. On the other hand, the judgment based on justice will naturally cause a counter-judgment as a reaction from the side thus judged. Accordingly, **we may fall into endless conflict and struggle between the judge and the judged**." (Abe, 1990)

Frugal computing ⊂ environmental virtue ethics?



Frugal computing

- Quantitative focus (engineering approach)
  - Efficiency as main ideal
- Being intentional about when computing is necessary

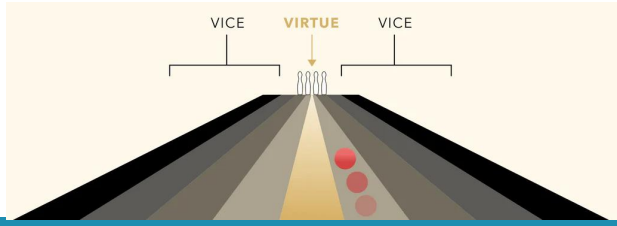
Environmental virtue ethics

Qualitative aspects (ethical approach)

Ultimate goal: human flourishing

- Building character: practicing human virtues
  - Cultivating a certain relationship to resources: one of respect, care, and appropriate restraint
- Possibility to err and correct

→ Potential for “virtuous frugality”



Potential pitfall

Frugal computing is developed in the context of a capitalist society, where technosolutionism is the norm.

- One aspect of frugal computing is focused on efficiency (perhaps with different weighing of the factors), which aligns with the existing system.
- Risk: becoming just another optimization paradigm.
- Care is needed to put sufficient emphasis on the other aspect: questioning the very purpose of computing.
    - Are we applying computational power to appropriate ends? *E.g.*, does the current scale of video streaming, algorithmic trading, or cryptocurrency mining represent genuine human need or manufactured desire?

Ecophilosophy

Belgian philosopher, Etienne Vermeersch (2001):

"Since the structure in which *science*, *technology* and *capitalist economics* stimulate each other – the STC system – came about in an unplanned manner, the 'question of who is to blame' for its cause is irrelevant."

Ecophilosophy

Belgian philosopher, Etienne Vermeersch (2001):

"Rather, we need to find out why this system is evolving in a negative, destructive way. What seems essential here is that it **links micro-rationality to macro-irrationality**: it shows astonishing efficiency in solving individual problems, but as a total system it is irrational: its development has no goal in itself and is characterised above all by an unlimited drive for expansion, while it functions in a finite world. Sooner or later, it must therefore come up against the limits of this finiteness."

Ecophilosophy

Belgian philosopher, Etienne Vermeersch (2001):

argued for “a thoughtful or enlightened anthropocentrism”.

“Humans are the only creatures on earth capable of reflective thinking and communicating the content of that thinking to others. Only humans can act on decisions made after rational consideration. It follows that relationships exist between humans that are not possible with any other living creature.”

Ecophilosophy

Belgian philosopher, Etienne Vermeersch (2001):

argued for “a thoughtful or enlightened anthropocentrism”.

“Questions relating to human beings have the distinctive feature that establishing existing *facts* is not necessarily the most relevant activity. For example, *eradicating* poverty, famine or smallpox is much more important than conducting a thorough *study* of these phenomena.”

Ecophilosophy

Belgian philosopher, Etienne Vermeersch (2001):

argued for “a thoughtful or enlightened anthropocentrism”.

“There is no ‘royal road’ to solving environmental problems. Only by controlling the expanding STC system through halting population growth and introducing a **stationary production and consumption system** can a solution be found for the earth and for humanity. If the study of what needs to be done takes precedence over the investigation of the facts themselves, then environmental philosophy is the anthropology, the human science of the future.”

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