First steps towards a deeper understanding of energy efficiency improvement impacts in the age of systems

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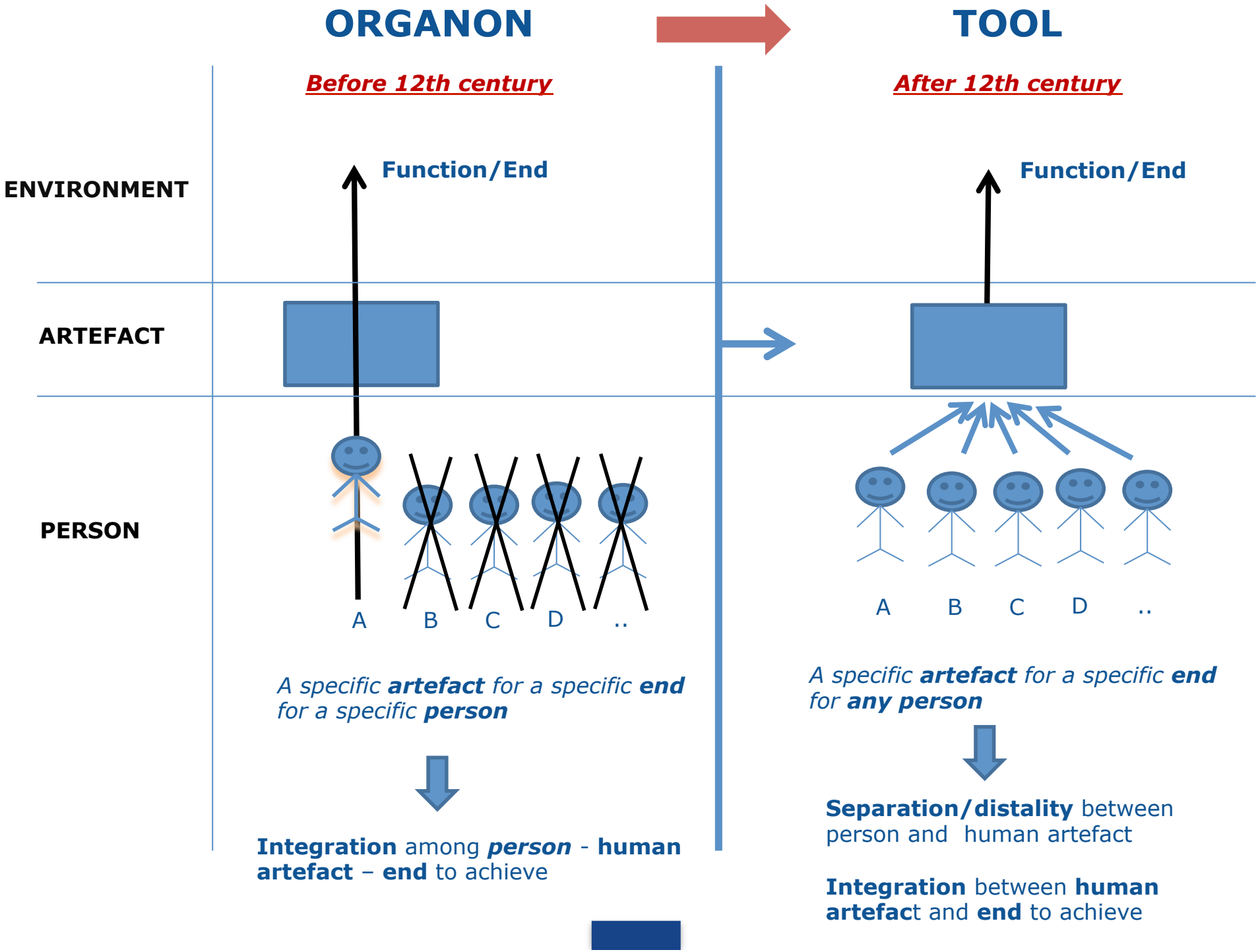
Conclusions

Human made artefacts are becoming systems

Systems tend to maximise their power capacity/diversity

Increased systems' efficiency is functional to power capacity growth and is fundamental in order to ensure systems' integration into the environment

Self-governing and self-organised institutions can markedly contribute to increase systems' diversity/adaptability whereby reducing their burden on energy and material resources (compared to competitive market settings or centrally administered institutional settings), at least at the local scale.


ORGANON
TOOL
Before 12th century
After 12th century
ENVIRONMENT
ARTEFACT
PERSON
Function/End
Function/End
A
B
C
D
..
A
B
C
D
..
A specific artefact for a specific end for a specific person
A specific artefact for a specific end for any person
Integration among person - human artefact – end to achieve
Separation/distality between person and human artefact
Integration between human artefact and end to achieve

TOOL

SYSTEM

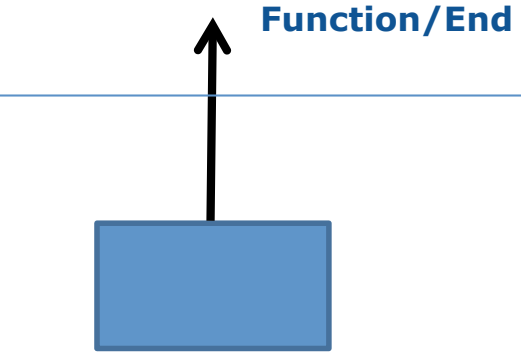
From XII century to 1950s

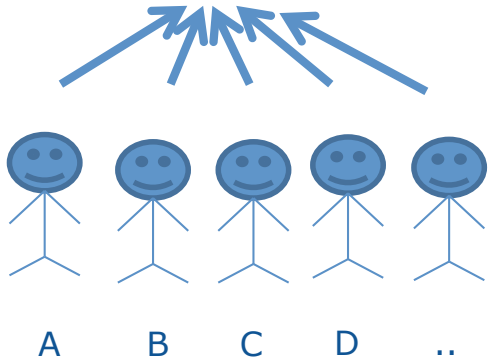
After 1950s

ENVIRONMENT

ARTEFACT

PERSON

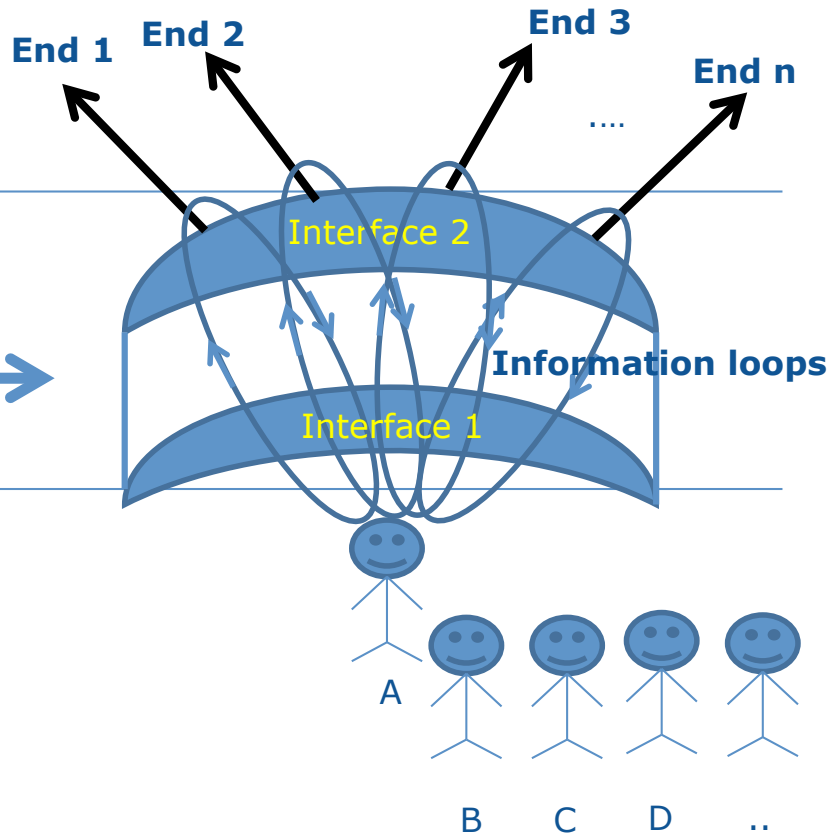




*A specific **artefact** for a specific **end** for **any person***

Separation/distality between person and human artefact

Integration between **human artefact** and **end** to achieve

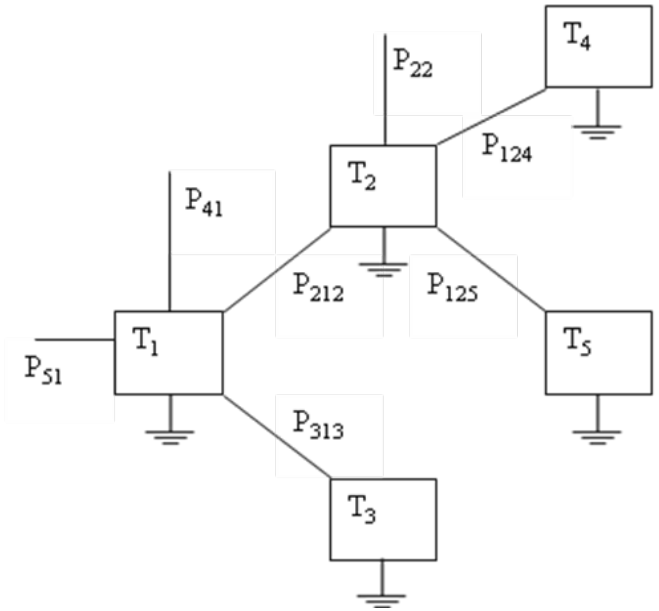


*A specific **artefact** for **multiple ends** for **any person***

Separation between ends and artefact

Integration of person and artefact into a ***system***

Systems as a network of practices and technologies

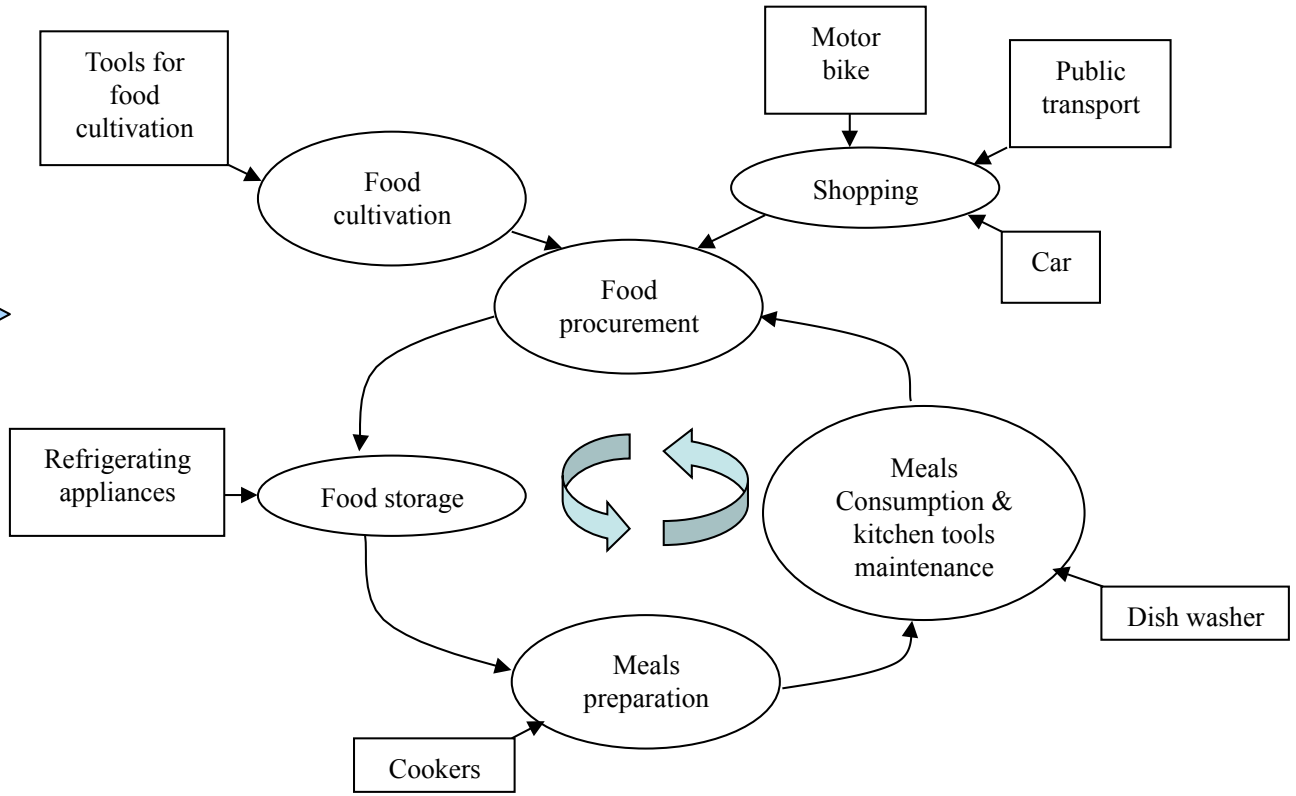


Legenda:
Ti: technology n. i
Tj: technology n. j
Pkij: practice k involving Ti and Tj

Technology

Practice

Example of food preparation and consumption practices



Thermodynamic phenomenological principles and efficiency-power trade-off regulating systems evolution (1/2)

1) Maximum power or maximum exergy degradation principle (Odum, Morowitz, Jørgensen,…)

In a situation of **energy abundance and time scarcity** systems tend to increase the speed of energy intake in order to speed up the activity of existing structures and generate new structures

Situation of time scarcity and energy resources abundance

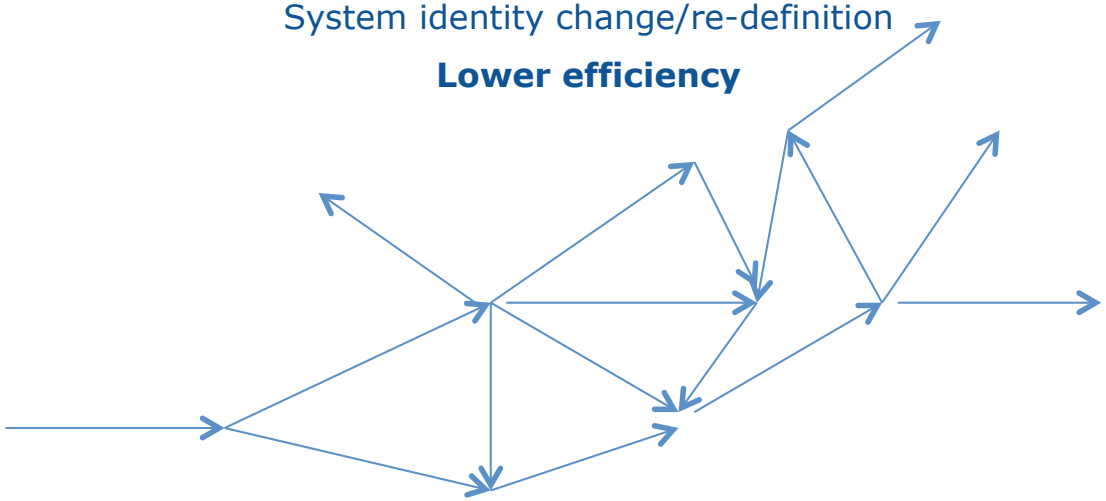
Higher redundancy/diversity/complexity

Higher power capacity

Higher adaptability (in the long term)

System identity change/re-definition

Lower efficiency



Thermodynamic phenomenological principles and efficiency-power trade-off regulating systems evolution (2/2)

2) Minimum entropy production (Prigogine…)

In a condition of **energy supply limitation** and quite stable boundary conditions, system structures and components requiring a lower energy input to produce a given output have a competitive advantage and prevail over less efficient ones

Situation of energy scarcity

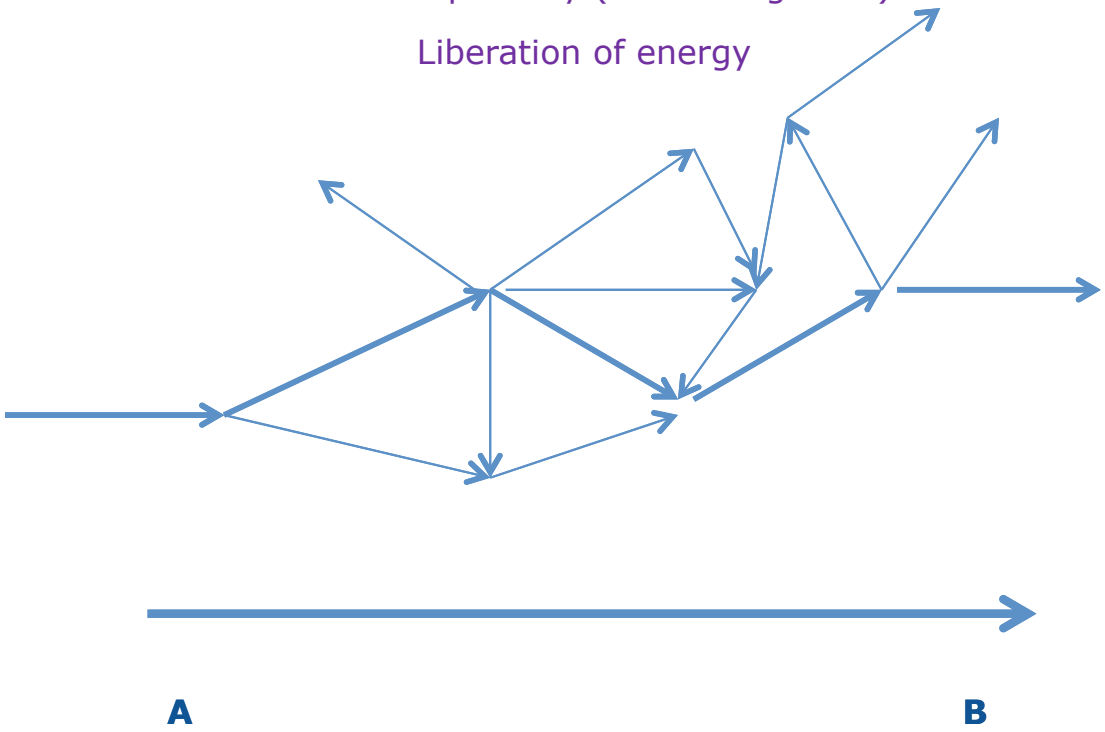
Higher efficiency

Lower redundancy/diversity (in the short term)

Lower power capacity (in the short term)

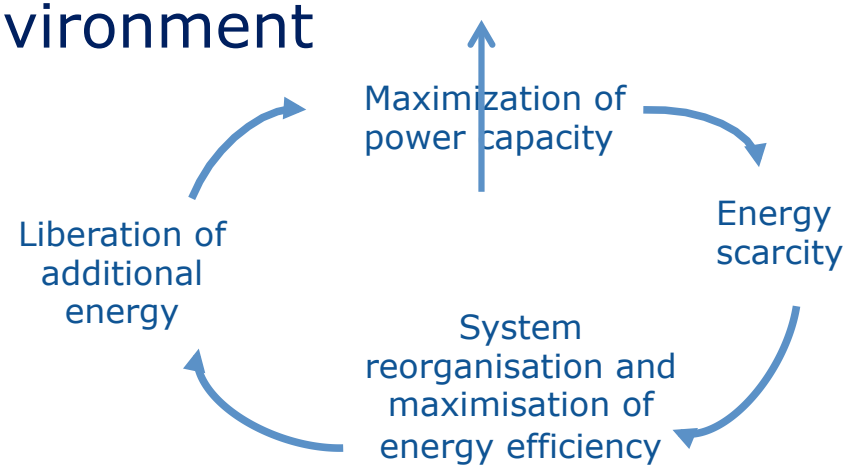
Lower adaptability (in the long term)

Liberation of energy

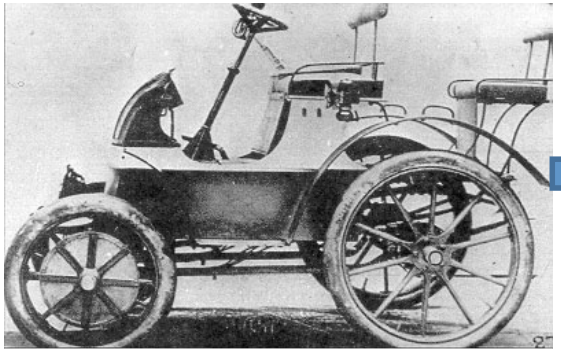


Increased systems' power capacity is the main driver of systems' evolution

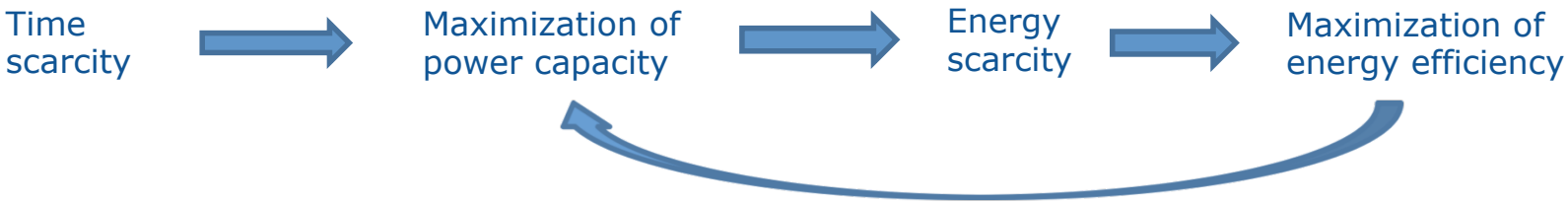
Increased systems' efficiency is functional to power capacity growth and to a better system integration into the environment



Very efficient new generation car with higher volume, more mileage, air conditioning, GPS, TV displays, etc.



The efficiency-power tension may have in principle different intensities depending on whether we act under the systems paradigm or not…



How do we enter the system paradigm when using a given material/substance/entity?

Definition of a situation of resource scarcity

1) Operative definition of a physical quantity (i.e. the resource) and of the related metrics to assess the number of available resource units

2) Establishment of a conservation principle for this resource

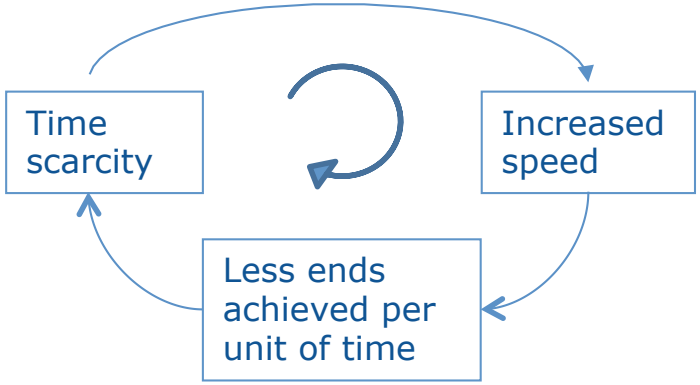
3) REDUCTION of the given material/substance/entity to a number of resource units available

4) Transformation process producing a certain number of specific and highly standardised outputs for each resource units consumed

This limits the number and the diversity of ends that can be achieved by using the given material/substance/entity !!

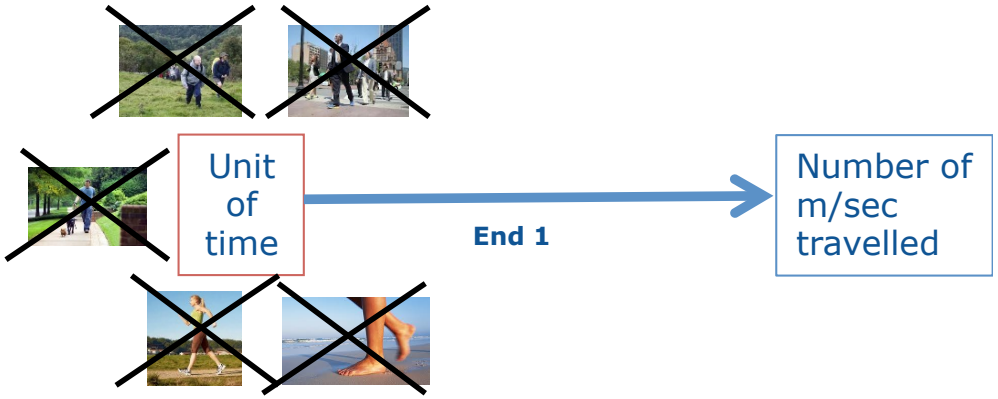
Is it time scarcity that determines power capacity increase or is the power capacity increase that determines an increased perception of time scarcity under the systems paradigm?

The example of speed…



HUMAN SPEED…

INCREASED SPEED BY TECHNICAL DEVICES …



Increased speed implies that a unit of time is mostly used to produce m/sec travelled and that additional time units can be needed for activities that cannot be performed while travelling by using this time unit…

Can the DIVERSITY and the NUMBER of outputs generated PER SINGLE RESOURCE UNIT consumed be increased by exiting the systems paradigm ?

Rules established to administer the usage of technical equipments and resource systems have an important role to play in this respect...

Technical equipments and resource systems may be owned:

a) individually (according to competitive market settings established by a market regulator)

b) by a central authority (e.g. the state)

Maximising the flow of measurable and highly standardised system outputs

Minimising the associated increase in the input flow of energy and material resources

c) in common by people

Increased diversity/adaptability of technological systems outputs and reduction of their burden on the resource system at the local scale?

Thank you !

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