Two models for philosophy of engineering

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"*this is somewhat out of my comfort zone*"

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Philosophy of Models in Engineering Design, Karlsruhe

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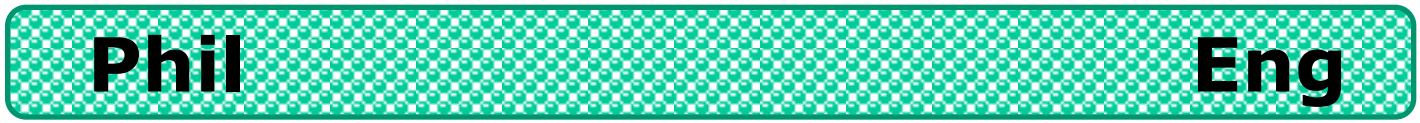
The issue

How to do philosophy of engineering in a constructive way?

constructive?

research

- informed by philosophy and engineering research
- working on a set of common questions
- contributing to philosophy and engineering research



The issue

How to do philosophy of engineering in a constructive way?

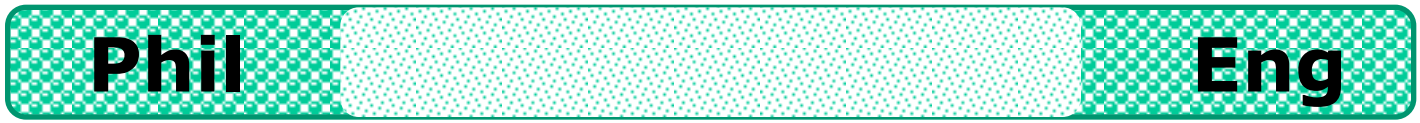
Engineering ethics as a benchmark

- informed by ethics and engineering
- working on a set of common questions
- contributing to ethics and engineering

The issue

How to do ontology, epistemology, methodology, … of engineering in a constructive way?

- informed by philosophy and engineering
- working on a set of common issues
- contributing to philosophy and engineering research



A valley of death?

Some feedback:

- *"This is somewhat out of my comfort zone"*
- *""disambiguate" is not a verb in English ..."*
- *"We engineer researchers do not just point out problems in the work of others"*
- *"You philosophers take writings in engineering research so literally"*

My plan

1. Introduce two models for doing philosophy of engineering, and argue that both models do not work
2. Arrive at a third model, and propose it for philosophy of engineering

Drawing from Delft work on technical functions

A self-reflection

part 1:

Two models for philosophy of engineering

Model 1 – for ourselves

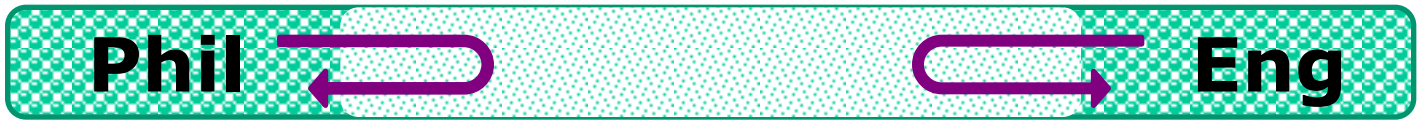
Doing research in philosophy of engineering for our home audiences

Philosophy:

- I give an example

Engineering Research:

- the separate fPET "reflections of practitioners" track



Model 2 – for the others

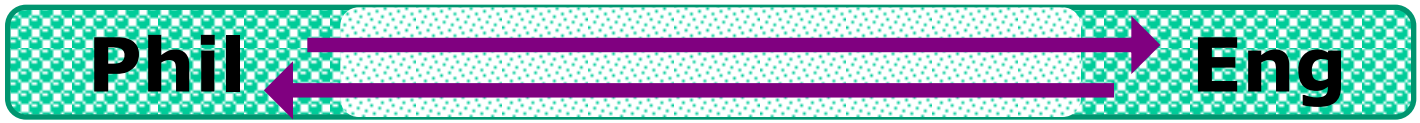
Research in philosophy of engineering for audiences in the other discipline

Philosophy:

- I give an example

Engineering research:

- early fPET/WPE papers

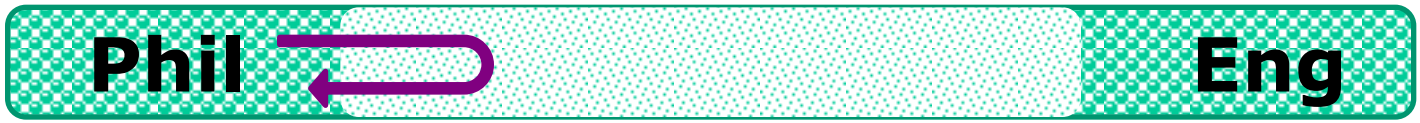


Delft work on functions

The Dual Nature of Technical Artefacts thesis

- Technical artefacts are described in terms of intentional goals and physical structure, and
- The concept of technical function links these two natures

So we started to analyse how engineers use and define technical functions



John Gero's FBS design method

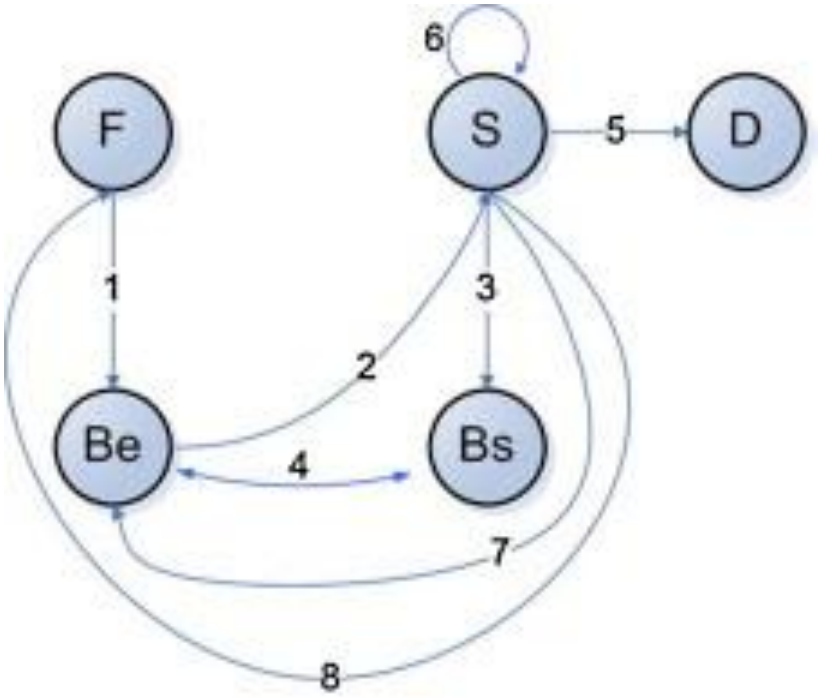
F = function

Be = expected behaviour

Bs = behaviour of S

S = structure

D = description of S



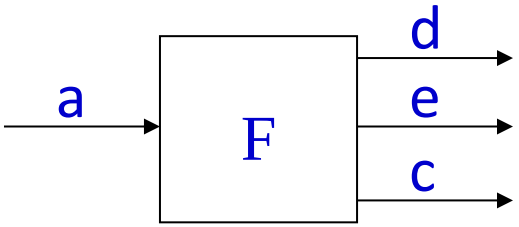
Step 1: use a database with F-B relations

Step 2: use a database with B-S relations

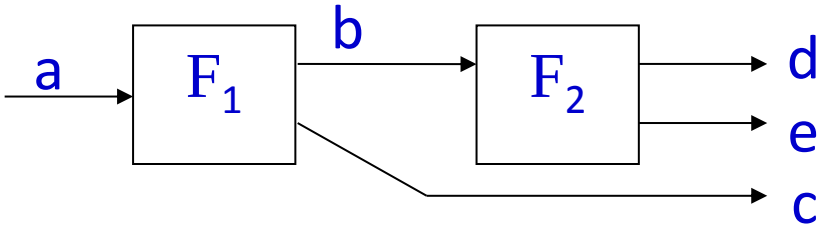
Steps 3 to 8: analyse whether you got what you want

Stone & Wood's functional modelling method

Step 1: model the function F:

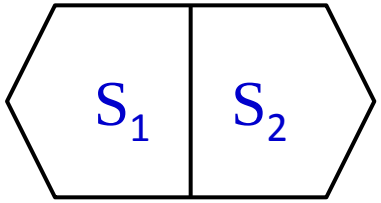


Step 2: decompose the function F in subfunctions {F_1, F_2, ...}:



Step 3: find structures S*x* for each F*x* with an F-S database

Step 4: compose a design solution, and analyse the result



Concepts, *somewhat colloquial in engineering*

Structure:

The material arrangement of a product, and the relations between these materials

Behaviour:

The processes in a product and its interactions with the environment

Technical function:

Gero: a purpose for which a product is designed

Stone & Wood: a task of a product, expressed by a verb-object form

Say, the function of a hair dryer

Gero:

function: getting dry hair

Stone & Wood:

function: transforming cold air and electricity into hot air,

Multiple meanings of function in engineering

Gero: - a purpose for which a product is designed

- the design intentions or purposes.
- the results of the artefact's behaviours

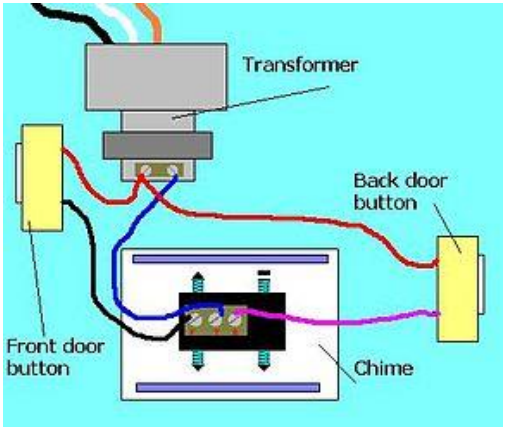
Stone & Wood:

- a task of a product, expressed by a verb-object form

Chandrasekaran & Josephson:

- device-centric meanings (behaviour)
- environment-centric meaning (effect)

or anything in between



Engineering ambiguity, *a philosophy mission*

- Engineers have 18 accounts of functions
- Engineers have communication issues, in design and for their data bases

Engineering ambiguity, *a philosophy mission*

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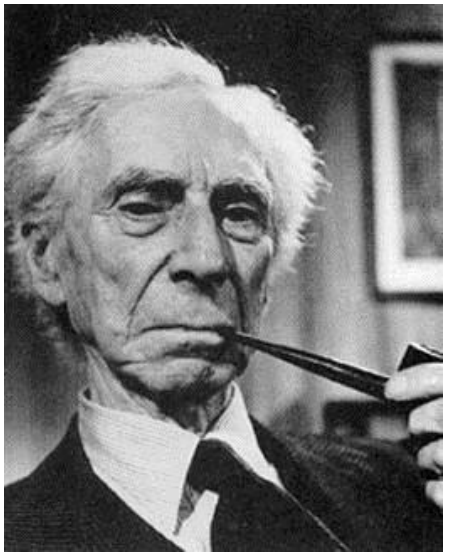
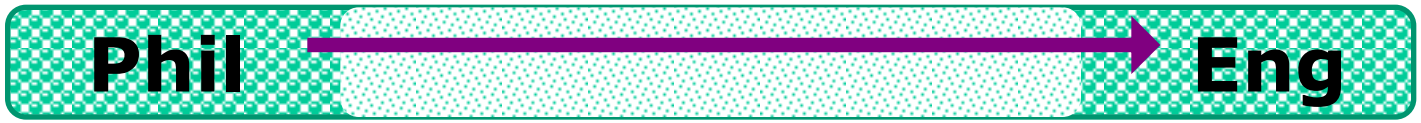
Let us philosophers help engineers by disambiguating their concepts





Towards a philosophical function theory

We studies function theories from philosophy

- Intentionalist accounts (Searle, Dennett ...)
- Causal-role accounts (Cummins, ...)
- Etiological accounts (Millikan, Neander, ...)

We adapted them to engineering by engineering criteria

- Proper vs accidental functions
- Malfunctioning, wrt proper functions
- Support for functions
- Innovative artefacts

The ICE function theory

Agent *a* ascribes the capacity ϕ as a function to an artefact *x* relative to a use plan *p* for *x* with goal *g* and relative to an account *A*, iff:

I: • *a* believes that *x* has the capacity ϕ

• *a* believes that *x* contributes to *g* by capacity ϕ

C: • *a* can justify these beliefs with *A*

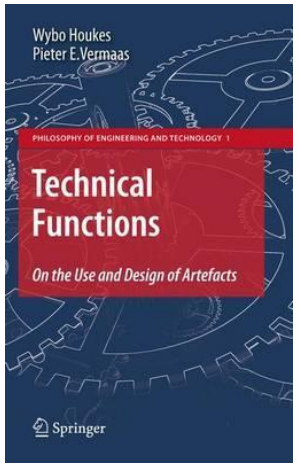
E: • the designers of the plan *p* have selected *x* for the capacity ϕ and communicated *p* to users

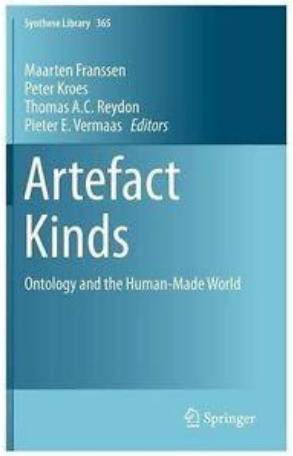
Progress in philosophy .....

Progress in philosophy .....

Uptake in

- Philosophy of technology
- Philosophy of biology
- Metaphysics
- Philosophy of science





..... but without much uptake in engineering

..... but without much uptake in engineering

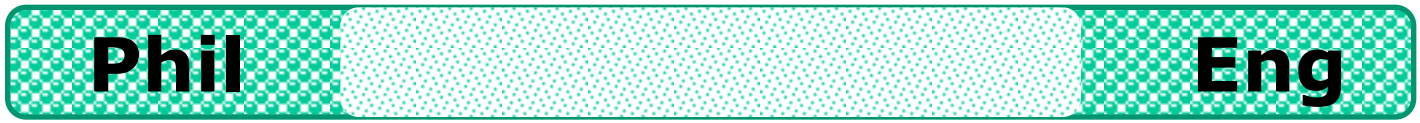
The ICE function theory did not make it to engineering research

(Analyses of design methods and engineering concepts had

Why Models 1 and 2 do not work

A constructive philosophy of engineering

- informed by philosophy and engineering
- working on a set of common questions
- contributing to philosophy and engineering

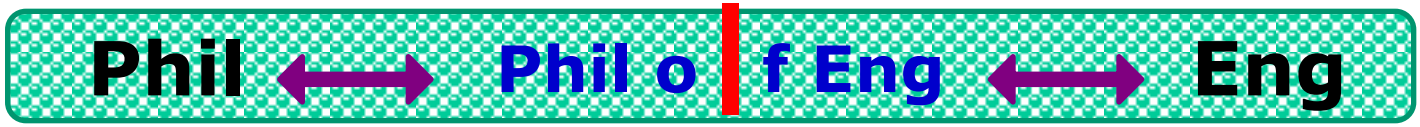


Model 1 – for ourselves

A constructive philosophy of engineering

- informed by philosophy and engineering *single-sided*
- working on a set of common questions *possibly*
- contributing to philosophy and engineering *single-sided*

May lead to a split discipline



Model 2 – for the others

A constructive philosophy of engineering

- informed by philosophy and engineering *single-sided*
- working on a set of common questions *possibly*
- contributing to philosophy and engineering *paternalistic*

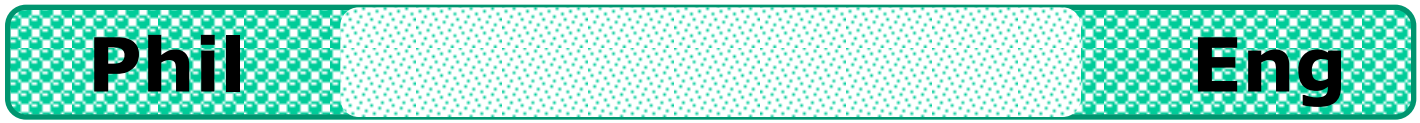
May lead to a fighting marriage

part 2:

How to arrive at a philosophy of engineering?

A third model?

How to arrive at a constructive philosophy of engineering?

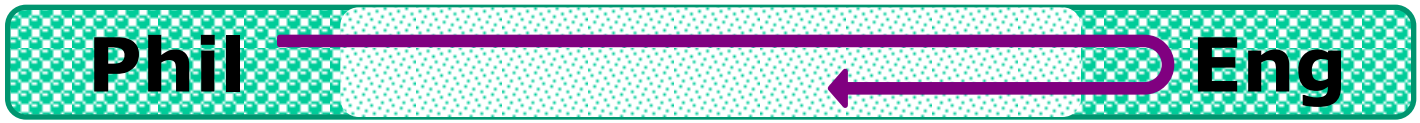


Model 3 – for philosophy of engineering

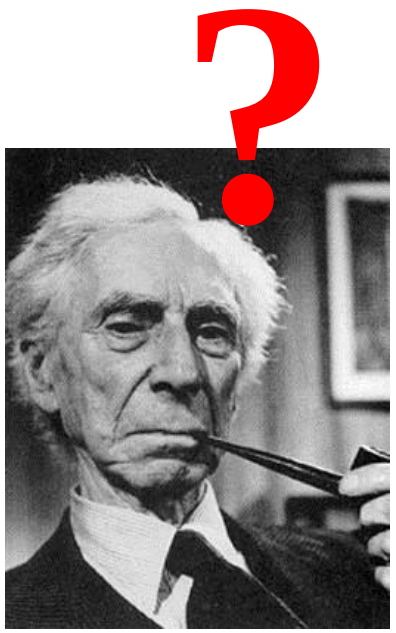
Do philosophy of engineering via visiting the other discipline to collect their problems

From philosophy via engineering research:

- I give an example



Revisit the issue: is there a problem?



Multiple meanings of function in engineering

Gero: - a purpose for which a product is designed

- the design intentions or purposes.
- the results of the artefact's behaviours

Stone & Wood:

- a task of a product, expressed by a verb-object form

Chandrasekaran & Josephson:

- device-centric meanings (behaviour)
- environment-centric meaning (effect)

or anything in between

Why do engineers not care about this issue?

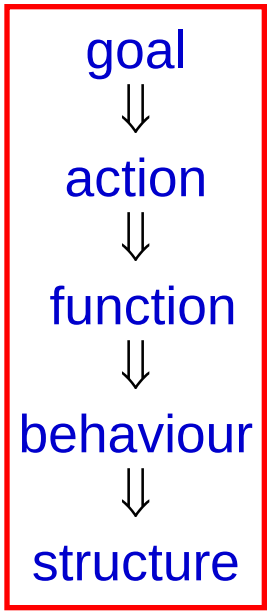
- Engineers have 18 accounts of functions
- Engineers have communication issues, in design and for their data bases

- Why do engineers accept multiple function concepts?
- Why are these concepts defined is a colloquial way?
- How can the communication issues be resolved?

The co-existing meanings of function

Design by Herbert Simon (Brown & Blessing)

- devise courses of action aimed at changing existing situations into preferred ones



The flexible co-existing meanings of function

Design by Herbert Simon (Brown & Blessing)

- devise courses of action aimed at changing existing situations into preferred ones

goal
⇓
action
⇓
function
⇓
behaviour
⇓
structure

Design of technical artefacts (Gero)

- find via behaviour a physical structure that can realise a function

function
⇓
behaviour
⇓
structure

or (Stone & Wood)

- find a physical structure that can realise a function

function
⇓
structure

The flexible co-existing meanings of function

Design by Herbert Simon (Brown & Blessing)

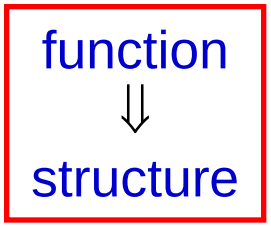
- function ≈ capacity of the artefact
- supporting the transition from action to artefact

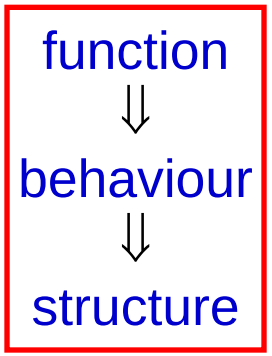
Design of technical artefacts (Gero)

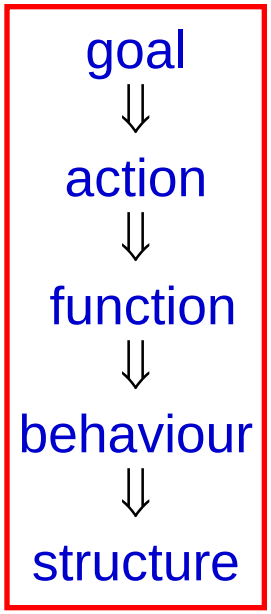
- function ≈ goal
- black-boxing actions

or (Stone & Wood)

- function ≈ intended behaviour
- collapsing goal and behaviour







Design for incremental changes of hair dryers

Focus on current hair dryers; ignore other ways to dry hair

- The function ≈ intended behaviour of the artefact is "transforming cold air and electricity into hot air"
- Find a structure that realises this behaviour better

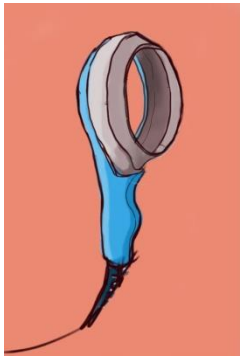
function
⇓
structure

Design hairdryers with more exploration

Abstract and focus on drying hair, ignore current hairdryers

- The function ≈ goal of the artefact is "getting dry hair"
- Find any behaviour and then structure of an artefact that realises this goal

function
⇓
behaviour
⇓
structure

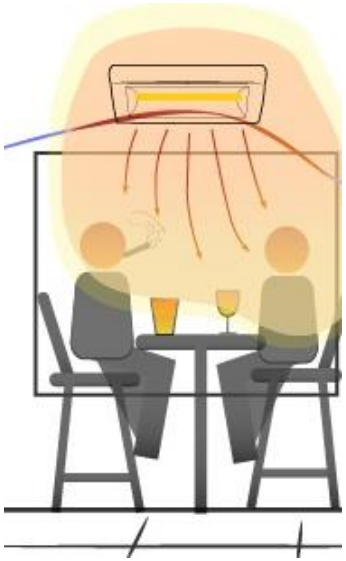


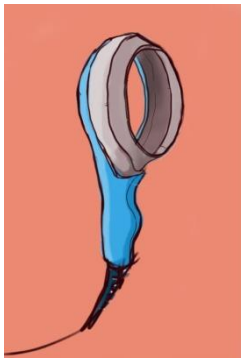
Innovative design for drying your hair

Abstract fully from existing hairdryers and drying actions

- Determine the user's goal and how s/he can realise it
- Later fix what function ≈ capacity of the artefact is needed

goal
⇓
action
⇓
function
⇓
behaviour
⇓
structure





The flexible co-existing meanings of function

Why do engineers accept multiple function concepts?

- Because engineers have various design methods for various tasks, and the meaning of function used in these methods is adjusted to the specific task

Why are these concepts defined is a colloquial way?

- Because innovative design evolves into incremental design and then the concept of function can evolve with the task

How can the communication issues be resolved?

Progress in philosophy of engineering?

The future will tell, but

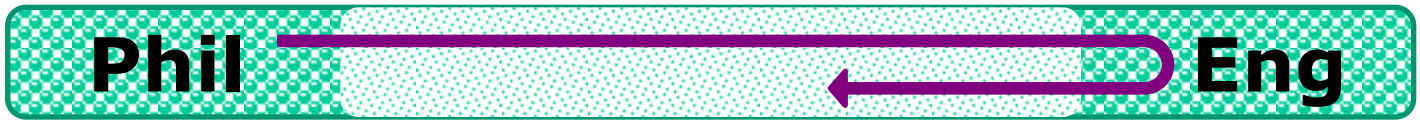
It is philosohical work that attracted engineering attention and uptake

Model 3 – for philosophy of engineering

Do philosophy of engineering via visiting the other discipline to collect their problems

From philosophy via engineering research:

- I gave an example

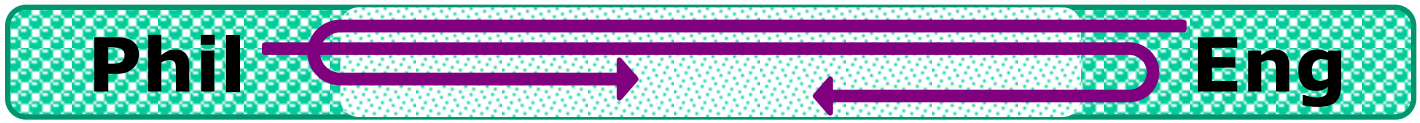


Model 3 – for philosophy of engineering

A constructive philosophy of engineering

- informed by philosophy and engineering *yes*
- working on a set of common questions *good basis*
- contributing to philosophy and engineering *yes*

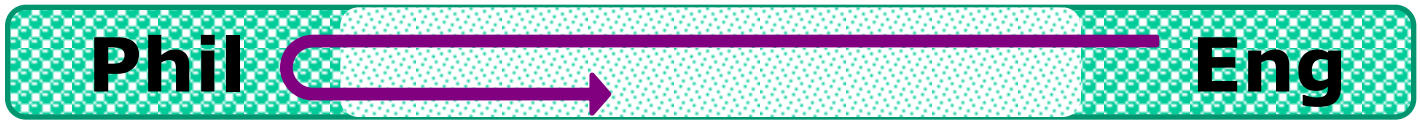
May work



Model 3 – for philosophy of engineering

Philosophy of engineering from engineering research via philosophy?

- No idea, so let's discuss



A community and meetings

We have

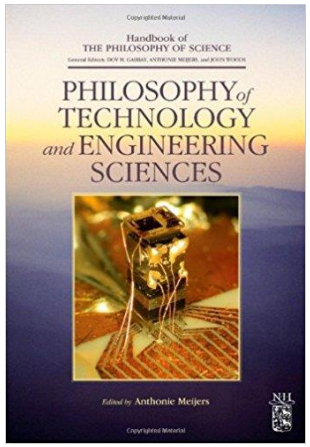
- this workshop on philosophy and models in engineering
- the fPET biennial meetings
- workshops at the biennial SPT conferences
- Design Society SIGs on design theory and on modelling and management of engineering processes

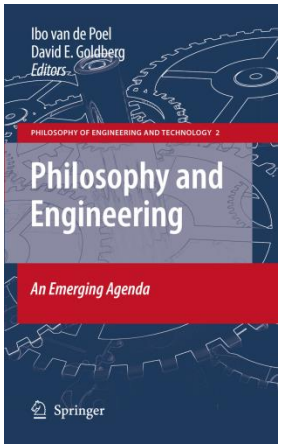
We have

- ourselves and our colleagues attending these meetings

Publication outlets

Handbook, book series and journals





Phil ⟷ Phil of Eng ⟷ Eng

No joint research tradition

- *"This is somewhat out of my comfort zone"*
- *""disambiguate" is not a verb in English ..."*
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To a comfortable philosophy of engineering

Collecting common issues via

- philosophy exploring engineering problems
- engineering exploring philosophy problems

Finding a common research tradition

- no gentlemen agnosticism from engineering research
- no fabricated cases from philosophy
- more literal claims than in engineering research
- less close reading than in philosophy