An Engineer’s Quest for

Universal Method

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Objectives


2. Develop a Philosophical Basis for what an engineer actually does.

My central claim is that...

The Engineering Method (Design)

Use of heuristics to cause the best change in an uncertain situation within the available resources
The Engineering Method (Design)

Use of heuristics to cause the best change in an uncertain situation within the available resources

Approximate Definition of a Heuristic

…first cut

A heuristic is anything that is

(1) helpful, useful, based on experience,

(2) unjustified, unjustifiable, and potentially fallible.
Approximate Definition of a Heuristic
...first cut

A heuristic is anything that is

(1) helpful, useful, based on experience,
(2) unjustified, unjustifiable, and potentially fallible.

Your best bet!

Characteristics of a Heuristic

1. A heuristic does not guarantee a solution
2. It may contradict other heuristics
3. It reduces the search time for solving a problem
4. Its acceptance depends on the immediate context instead of on an absolute standard
Sample Engineering Heuristics

1. **Graphs, empirical correlations, experiments, equations, etc.**

2. **Risk Controlling:**
   “give yourself a chance to retreat”

3. **Resource Allocation:**
   “allocate resources to the weak link”

4. **Appropriate Attitude:**
   “always give an answer”

5. **Rules of Thumb and Orders of Magnitude:**
   “A hamburger helps design cities”

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In **AMERICA** they scale the same.
International “Rules of Thumb”

in France, *le pif* (the nose),

in Germany, *Faustrregel* (the fist),

in Japan,

目的是定, (menoko kanjo or measuring with the eye)

in Russia, *На пальцах* (Na paltsakh or by the fingers).

It is my view that . . .

The **ENGINEERING METHOD** and the **USE OF ENGINEERING HEURISTICS** is an absolute identity.
State-of-the-Art (SOTA)

A set of heuristics identified with a specific label and time stamp i.e.

\[ \text{Sota}^{\text{design; time}} \]
Toyota’s ultra-low-cost car threatens ‘big three’

Toyota, the world’s second-largest carmaker by sales, is working on a radically different approach to car design, development and manufacturing in an attempt to come up with an ultra-low-cost car, according to its president.

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BENCHMARK COMPARISON OF JAPANESE VS. UNITED STATES ENGINEERING CHANGES

Reference: "Quality Function Deployment" by L.P. Sullivan
Quality Progress-Jc". 1986, pg 39, quoted from "Quality Design Engineering: The Missing Link in U.S. Competitiveness" by H. Barry Bobb
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Engineering SOTA

Rule of Judgment

Evaluate an engineer or an engineering design against the sota that represents best practice i.e.

\[ \text{Sota}_{\text{Best Eng.Prac.}} \]

at the time the design was made.
My central claim is that...

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Use of heuristics to cause the best change in an uncertain situation within the available resources

Which is **BEST**?

FORD MUSTANG

MERCEDES
Engineer’s **Best** (Optimum)

Knob Setting

A  B  C

Engineer’s **Best** (Optimum)

Knob Setting

A  B  C

Trade-off
\[ \text{mse}(t) = w_1 f_1(t) + w_2 f_2(t) + w_3 f_3(t) + \ldots \]

Take derivative and set to zero.
Multi-Attribute Decision Theory
Engineer’s BEST

\[ \text{mse}(t) = w_1 f_1(t) + w_2 f_2(t) + w_3 f_3(t) + \ldots \]

Take derivative and set to zero.

Two Views of Best

Plato’s Engineer’s
My central claim is that...

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References:


“The best description of engineering that I have ever seen …

--Dr. William Wulf, President, National Academy of Engineering
“The best description of engineering that I have ever seen ... and one of the most provocative hypotheses about science and nature that I have ever seen! ”

--Dr. William Wulf, President, National Academy of Engineering

Audacious Philosophical Claim

All Is Heuristic.
Audacious Philosophical Claim

**All Is Heuristic.** *(More radical than the ancient skeptics)*

Arithmetic
Arithmetic

... is either incomplete or inconsistent.

Gödel's Proof
Mathematics

. . . is either incomplete or inconsistent.

Gödel's Proof

Any Axiomatic System
(at least as powerful as arithmetic)

. . . is either incomplete or inconsistent.

Gödel's Proof
Logic
Causality
Causality

EPR Experiment
(Einstein-Podolsky-Rosen)

Bell’s Inequality
(Bell’s Theorem, Bell’s Paradox, or Bell’s Proof)
Perception
(Smell)

- Women smell more acutely than men
- 1.2% do not have a sense of smell at all
- Ability to smell is heterogeneous with respect to age, health, gender, nationality, etc.

1.5 million 1986
Perception
(Sight)

Perception
(Taste)

Phenylthio-carbamide
Perception (Taste)

Phenylthio-carbamide

Only 70% taste as bitter.

Perception

1. Tropes of Aenesidemus
2. Arguments of other skeptics
3. Optical Illusions
4. Mirages
5. Dream hypothesis
6. Hallucinations
7. Descartes’ Génie Malin
8. G.E. Moore, Dr. Johnson, and Diogenes the Cynic
# Perception

1. Tropes of Aenesidemus  
2. Arguments of other skeptics  
3. Optical Illusions  
4. Mirages  
5. Dream hypothesis  
6. Hallucinations  
7. Descartes’ *Génie Malin*  
8. G.E. Moore, Dr. Johnson, and Diogenes the Cynic

To this well-known list, I add my own original contribution:

**Hypnotism**
“We have arranged for ourselves a world in which we can live—by the postulating of bodies, lines, surfaces, causes and effects, motion and rest, form and content; without these articles of faith no one could manage to live at present. But for all that they are still unproved. Life is no argument; error might be among the conditions of life.”
All Is Heuristic.

“along” “way”

_Phaedrus_ by Plato

“Steps along the way to an end”
Engineering Method

I want to do engineering design; I seek the method of the engineer.

- Do I want change?
- Do I want the best change?
- Do I want the best change in an uncertain situation?
- Do I want the best change in an uncertain situation within the available resources?

In sum, what do I do?

*Use the heuristics of the engineer.*
Scientific Method

I want to do scientific research; I seek the method of the scientist.

- Should I use MATHEMATICS?
- Should I use LOGIC?
- Should I use CAUSALITY?
- Should I use PERCEPTION?

In sum, what do I do?

Use the heuristics of the scientist.
Writer’s Method

I want to write a book; I seek the method of the writer.

• Should I maintain a constant rhetorical profile?
• Should I address the reader directly?
• Should I include an ablative absolute or a fragment?
• Should I use the first person pronoun, I?

In sum, what do I do?

Use the heuristics of the writer.
I want to paint a picture; I seek the method of the artist.

- Do I apply gesso and make a preliminary sketch?
- Do I develop the picture as a whole?
- Do I reaffirm my line periodically?
- Do I appeal to the emotion or the intellect?

In sum, what do I do?

*Use the heuristics of the artist.*
Universal Method

I want to do anything; I seek the universal method.

In sum, what do I do?

Use heuristics
“You and I are participating in a magnificent experiment to see whether Nature’s latest wrinkle—the human species armed with its new weapon, intelligence—has survival value.”
Rule of Judgment

Evaluate the human species or human survival against the sota that represents best practice i.e.

\[ \text{Sota} \mid \text{Best Human Practice;} \]

at the time the judgment is made.

Rule of Judgment

May Nature’s judgment of the human species not be too harsh.