Design Thinking

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Thinker versus Tinker

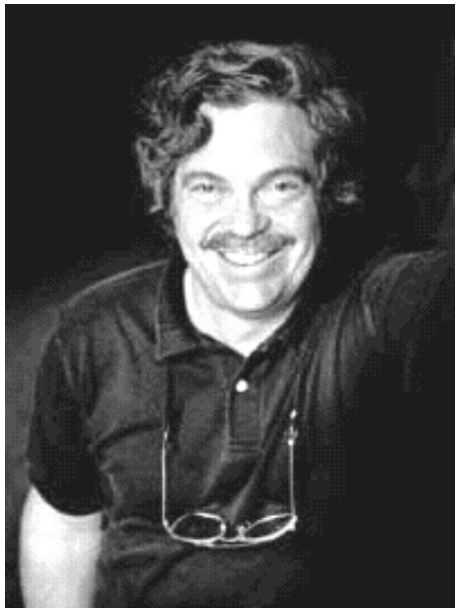
Science

Ludwig BOLTZMANN (1844-1906)

"There is nothing so practical as a good theory."

Design

"Don't worry about what anybody else is going to do… The best way to predict the future is to invent it. Really smart people with reasonable funding can do just about anything that doesn't violate too many of Newton's Laws!" (1971)

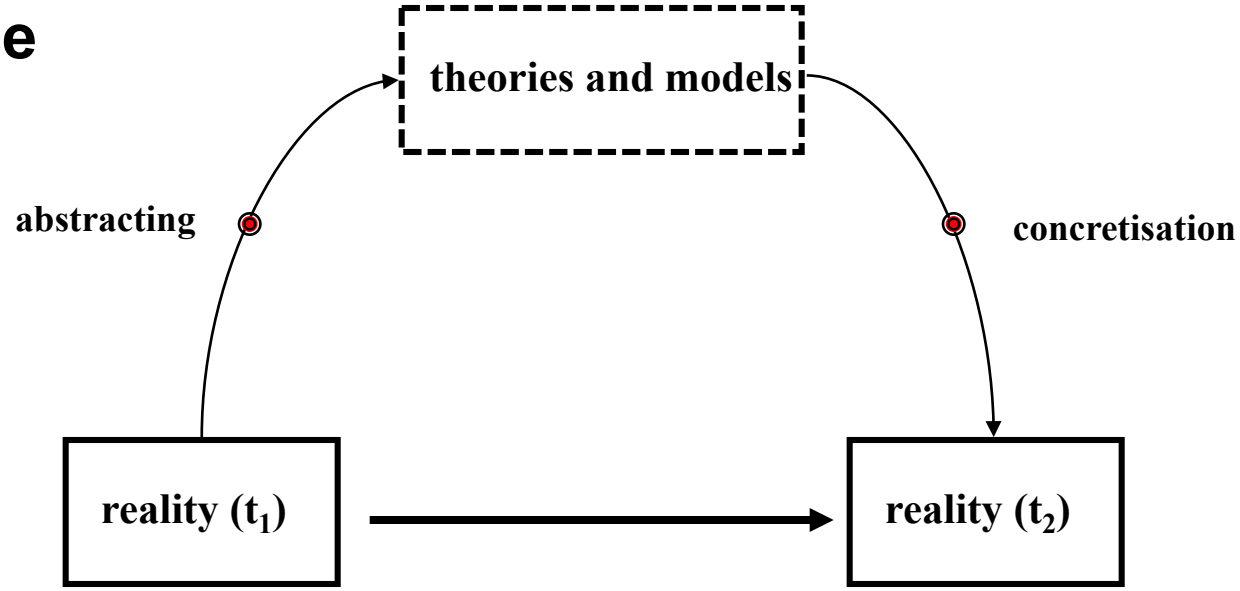


Alan C. KAY (1940-)

A.M. TURING AWARD

From Reality to Theory and back to Reality

Science **Design**



positivism :

{theory, model} ∉ reality

reality (t_1) ≈ reality (t_2)

constructionism :

{theory, model} ∈ reality

reality (t_1) ≠ reality (t_2)

REF: Rauterberg M. (2006). HCI as an engineering discipline: to be or not to be!?. *African Journal of Information and Communication Technology*, vol. 2, no. 4, pp. 163-184

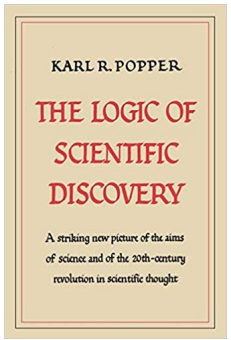
SIENCE: criteria of good science

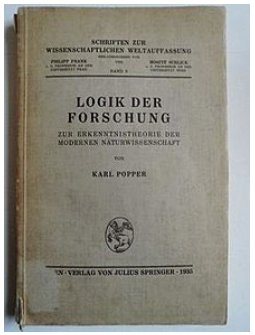
Karl POPPER (1902-1994)

- Induction is replaced with **Falsifiability**.

- Science consists mostly of problem solving.
- There is no unique methodology to any sciences.
- Theories are bold and explains as much as possible.

REF: Popper K. (1934 German, 1959 English). The Logic of Scientific Discovery. Abingdon-on-Thames: Routledge.





SIENCE: criteria of good science

Thomas KUHN (1922-1996)

- **Accuracy** —
  empirical adequacy with experimentation and observation.

- **Consistency** —
  both internally and externally with other theories.

- **Simplicity** —
  the simplest explanation is to be preferred ("Ockham's razor").

- **Scope** —
  broad implications for phenomena beyond those the theory was initially designed to explain.

- **Fecundity** —
  new phenomena or new relationships among phenomena should result.

REF: Ladyman J. (2013). Toward a demarcation of science from pseudoscience. In: Massimo Pigliucci & Maarten Boudry (eds.) *Philosophy of Pseudoscience* (pp. 45-59). The University of Chicago Press, Chicago.

Positivistic Sciences: general criteria

- [***Rationality***] The quality or state of being rational; rationality implies the conformity of one's beliefs with one's reasons to believe, and of one's actions with one's reasons for action.
- [***Objectivity***] The separation of the observer from the observed. So that the results of an inquiry are essentially free from beliefs, interpretations, etc.
- [***Causality***] An assumption of linear causality; there are no effects without causes and no causes without effects.
- [***Reductionism***] A single, tangible reality "out there" that can be broken apart into pieces capable of being studied independently.
- [***Universality***] What is true at one time and place will also be true at another time and place.

REF: Chase, J.M. (1970). Normative criteria for scientific publication. *The American Sociologist*, vol. 5, no. 3, pp. 262-265.

“But life is short, and truth works far and lives long…” Schopenhauer

“Time Saving Truth from Falsehood and Envy”
François Lemoyne, 1737

	Ontological Reference		
	Real Being	**Formal Being**	**Ideal Being**
Epistemo-logical Method	Observation of Reality	Formal proof	Belief based on intuition
Inference Concept	Inductive logic	Deductive logic	Value system
Academic Paradigm	Natural Sciences	Mathe-matics	Humane Sciences

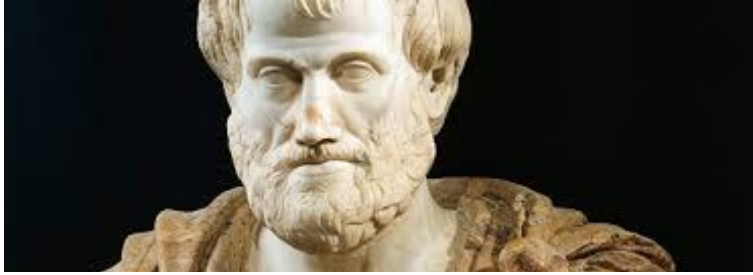
REF: Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research.
In: Norman K Denzin & Yvonna S. Lincoln (eds.) *Handbook of Qualitative Research* (chapter 6; pp. 105-117), Sage Publications.

	Science	Design
• [***Objectivity***]	yes	no, subjective*
• [***Causality***]	1-2 Cs	>4 Cs
• [***Reductionism***]	yes	no, holistic
• [***Universality***]	yes	no, contextual

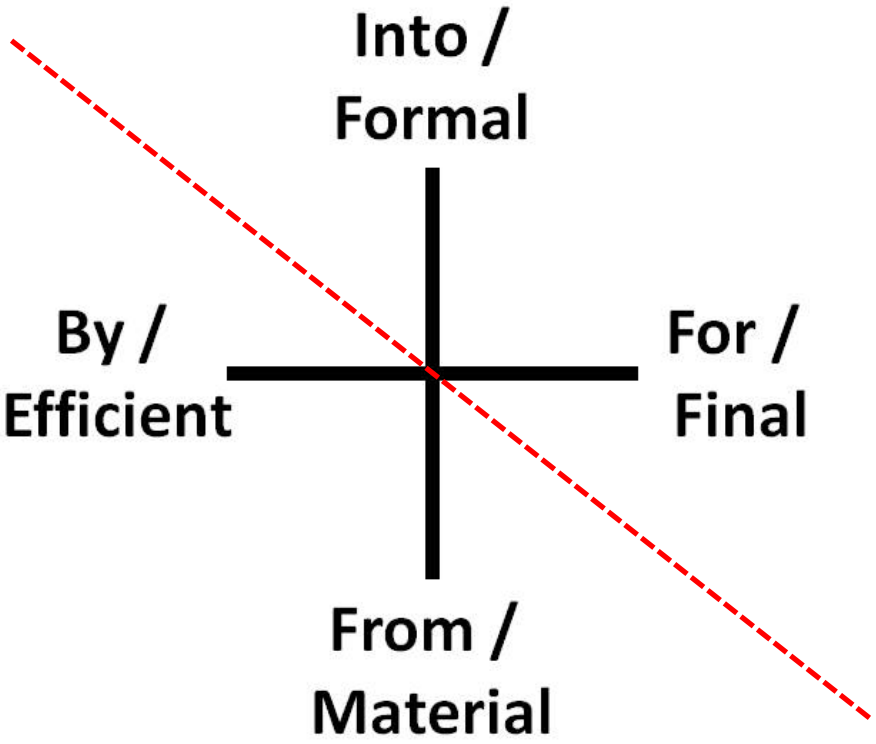
[C means Cause-Effect relationship]

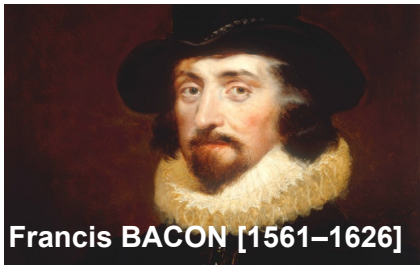
***REF:** Petranker, J. (2001). Who will be the scientists? a review of B. Alan Wallace's' the taboo of subjectivity'. *Journal of Consciousness Studies*, *8*(11), 83-90.

The Four Causations



ARISTOTLE [384 – 322 BC]



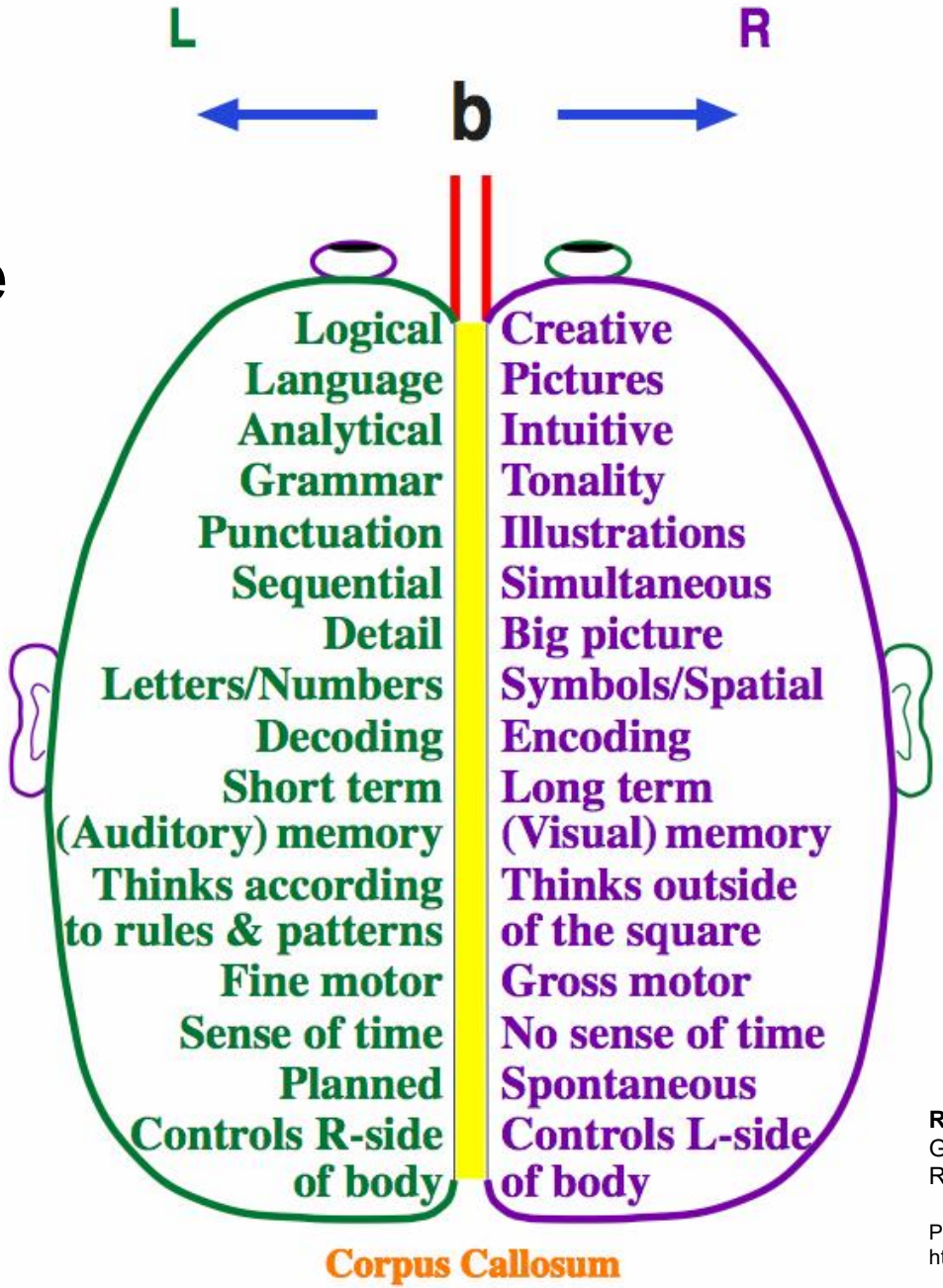


Francis BACON [1561–1626]

REF: Agassi, J. (1975). The nature of scientific problems and their roots in metaphysics. In *Science in flux* (pp. 208-239). Springer, Dordrecht.

Science

Design



REF: Peter F. MacNeilage, Lesley J. Rogers & Giorgio Vallortigara (2009). Origins of the Left & Right Brain. *Scientific American* vol. 301, pp. 60 - 67

Picture source
http://amandaonwriting.tumblr.com/post/27771405479

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Daniel KAHNEMAN
Map of Bounded Rationality: A Perspective on Intuitive Judgement and Choice .
Nobel Prize Lecture, 8 December 2002

	PERCEPTION	INTUITION SYSTEM 1	REASONING SYSTEM 2
PROCESS	Fast Parallel Automatic Effortless Associative Slow-learning		Slow Serial Controlled Effortful Rule-governed Flexible
CONTENT	Percepts Current stimulation Stimulus-bound	Conceptual representations Past, Present and Future Can be evoked by language	

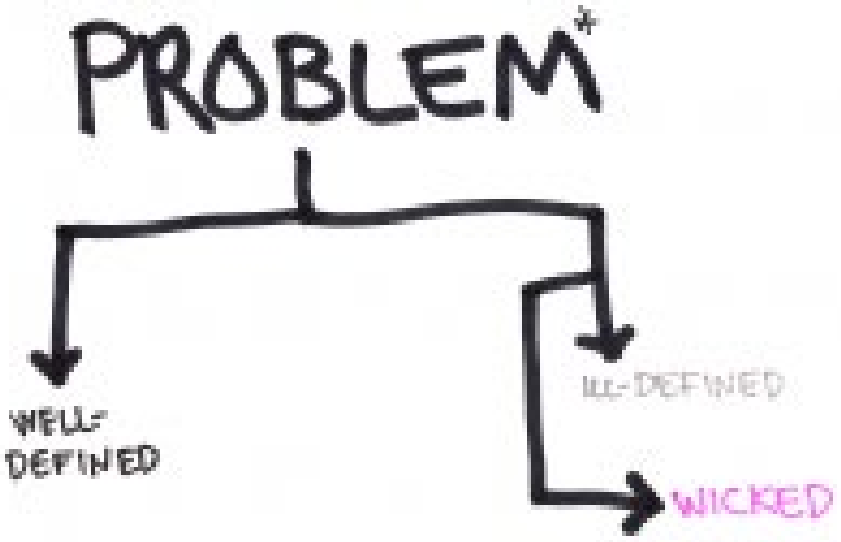
Amos Nathan TVERSKY
(1937-1996)

Science Design

	System 2	System 1
Characteristics	Slow Effortful Conscious Logical Deliberative Can handle abstract concepts	Fast Effortless Unconscious Triggers emotions Associative Looks for patterns Looks for causation Creates stories to explain events
Advantages	Allows reflection and consideration of the "bigger picture", options, pros and cons, consequences Can handle logic, maths, statistics Good for reductive thinking	Speed of response in a crisis Easy completion of routine or repetitive tasks Creativity through associations, so good for expansive thinking
Disadvantages	Slow, so requires time Requires effort and energy, which can lead to decision fatigue	Jumps to conclusions Unhelpful emotional responses Can make errors that are not detected and corrected, such as wrong assumptions, poor judgements, false causal links

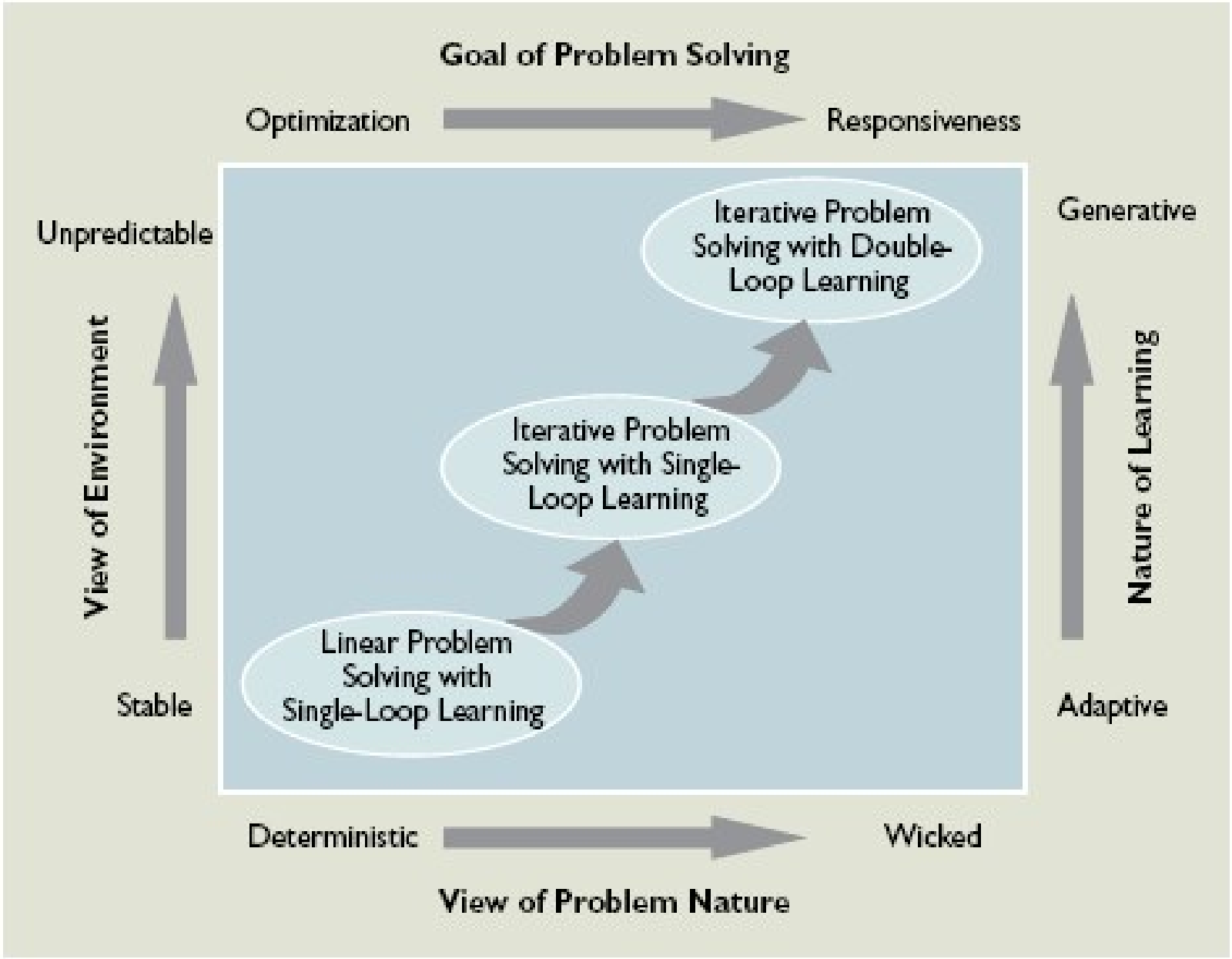
copied from http://mrzepczynski.blogspot.com/2014/12/kahnemans-system-1-and-system-2.html

Science



Design

REF: Buchanan R.: Wicked problems in design thinking. *Design Issues*, Vol. 8, No. 2 (Spring, 1992), pp. 5-21



REF: Sridhar Nerur, VenuGopal Balijepally (2007). Theoretical Reflections on Agile Development Methodologies. *Communications of the ACM*, vol. 50, no. 3, pp. 79-83

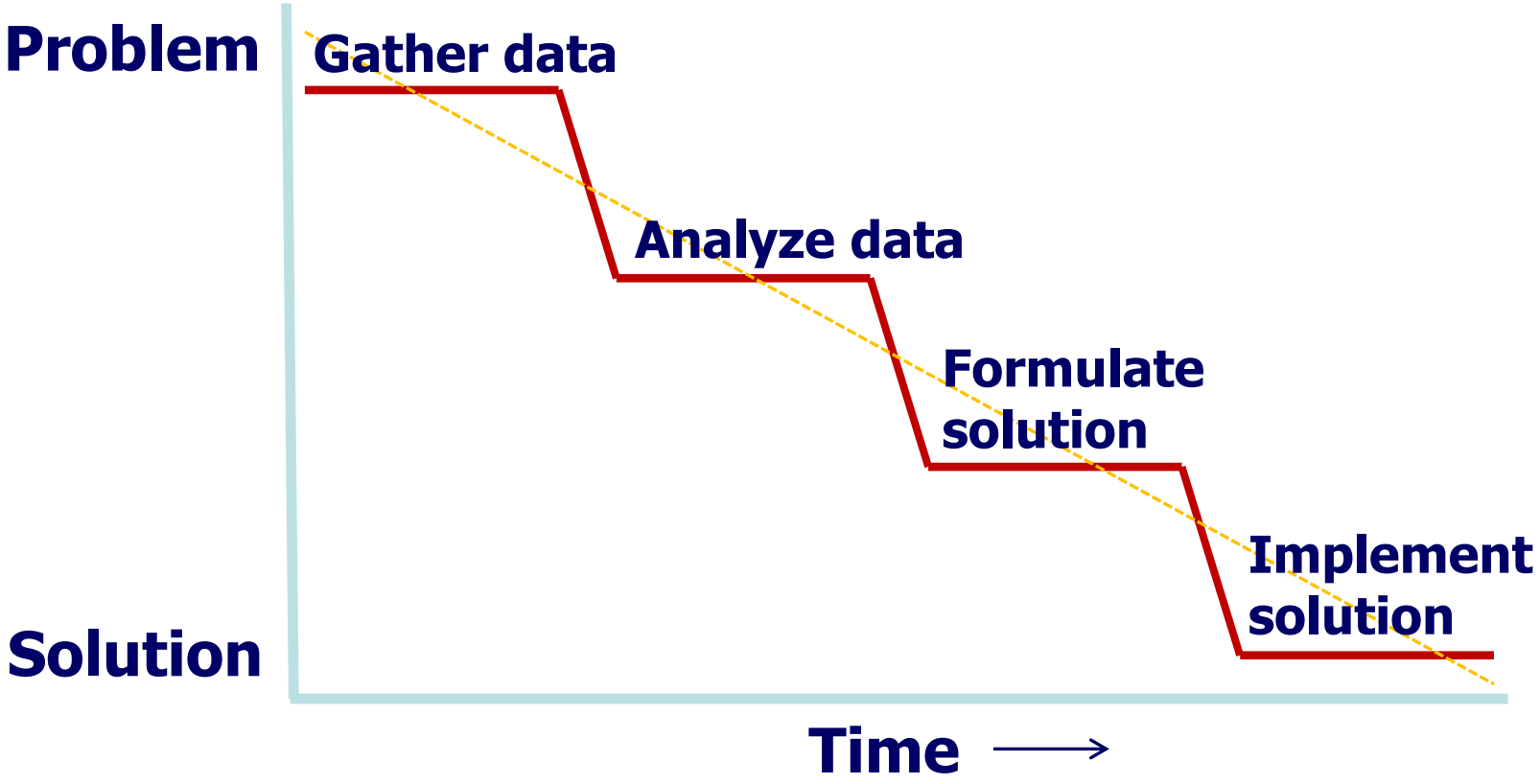
Categories of Problem-Solution

Category	Definition
I	Solution knowledge exists in your domain
II	Solution knowledge in another domain
III	No solution exists. Complex, but responds consistently to same stimuli
IV (Wicked)	No solution exist. Chaotic and adaptive

REF: Kurtz, CF and Snowden, DJ (2003). The new dynamics of strategy: Sense-making in a complex and complicated world. *IBM Systems Journal* vol. 43, no. 3, pp. 462-483.

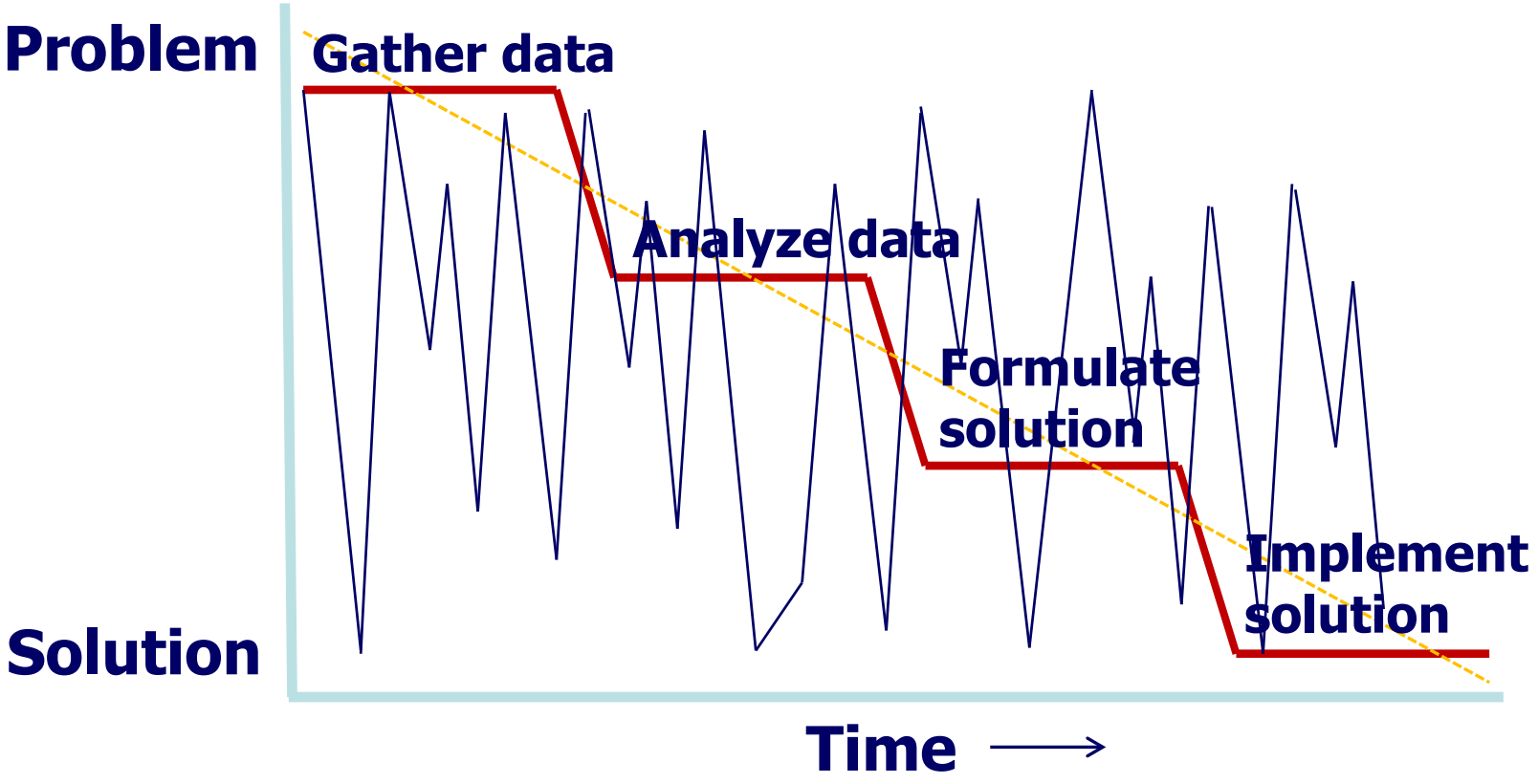
The „waterfall“ approach

The waterfall is a picture of already knowing – you already know about the problem and its domain, you know about the right process and tools to solve it, and you know what a solution will look like



The „jagged" line as reality

The jagged line of opportunity-driven problem solving is a picture of *learning*.



REF: Guindon, R. (1990). Designing the design process: Exploiting opportunistic thoughts. *Human-Computer Interaction*, *5*(2), 305-344.

Science deals mainly with Tame Problems

1	*Has a well defined and stable problem statement*
2	*Has a definite stopping point (i.e. when solution is reached)*
3	*Has s solution that can be objectively evaluated as right or wrong*
4	*Belongs to a class of similar problems that are solved in the same similar way*
5	*Has solutions that can be easily tried and abandoned*
6	*Comes with a limited set of alternative solutions*

REF: von Foerster, H. (2003). Responsibilities of competence.
In: H. von Foerster (ed.) Understanding understanding. Chapter 6, pp. 191-197, Springer

"The hard sciences are successful because they deal with the soft problems; the soft sciences are struggling because they deal with the hard problems."

Heinz von FOERSTER (1911-2002)

Design deals mainly with Wicked Problems

Any problem is a nail problem if I have only a hammer.

1	You don't understand the problem until you have developed a solution	Every solution exposes new aspects of the problem
2	Wicked problems have no stopping rule	No-definitive solution
3	Solutions to wicked problems are not right or wrong	Solution quality is not objective or based on formula
4	Every wicked problem is essentially unique and novel	Solutions need to be custom designed and fitted
5	Every solution to a wicked problem is a //one-shot" operation	You can't learn about the problem without trying solutions
6	Wicked problems have no given alternative solutions	You need creativity to devise solutions, and judgment to determine which is valid

A problem doesn't have to possess all six characteristics in order to be wicked!

REF: Rittel, H. W. J. & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, 4, 155-169

PHILIPS

Stefano MARZANO

HE Jiankui

REF: Marzano S. (2009) A Vision on Healthcare in 2050. ICSID World Design Congress, Singapore, Nov. 24, 2009

How can we cope with Wicked Problems?

Two steps for coping!

	1. *Studying* the problem:	**2. *Taming* it:**
1	*Lock down the problem definition*	Descibe it in a way that you can solve it or split it in a sub-problem and declare that to be a PROBLEM
2	*Assert that the problem is solved*	
3	*Specify objective parameters by which to measure the solution's success*	What is measured becomes the problem
4	*Cast the problem as „just like" a previous problem that has been solved*	Ignore or filter out evidences that do not fit
5	*Give up on trying to get a good solution to the problem*	Just follow orders, do your job
6	*Declare that there are just a few possible solutions, and focus on selecting one of them*	

REF: Churchman, C. W. (1967). Wicked problems. *Management Science*, 14 (4), B-141-B-142.

Deduction-Induction-Abduction

"Other reasoning patterns" especially traditional science ***> analytic thought***	**Deduction**	what + how > (*result*)	Known: what is observed + how it works > makes predictions of results possible
	Induction	what + (*how*) > observation	Known: what is observed + unknown: how does it work? > known: changes observed > leads to theorising, hypothesising; explaining observations
Design thinking designers ***> creative thought***	**Abduction 1**	(*what*) + how > value	Known: value to create + how this can be done > unknown: what is needed?
	Abduction 2	(*what*) + (*how*) > value	Known: value to create < unknown: what is needed? + how to get there?

REF: Dorst K. (2011). The core of 'design thinking' and its application. *Design Studies*, vol. 32, no. 6, pp.521-532

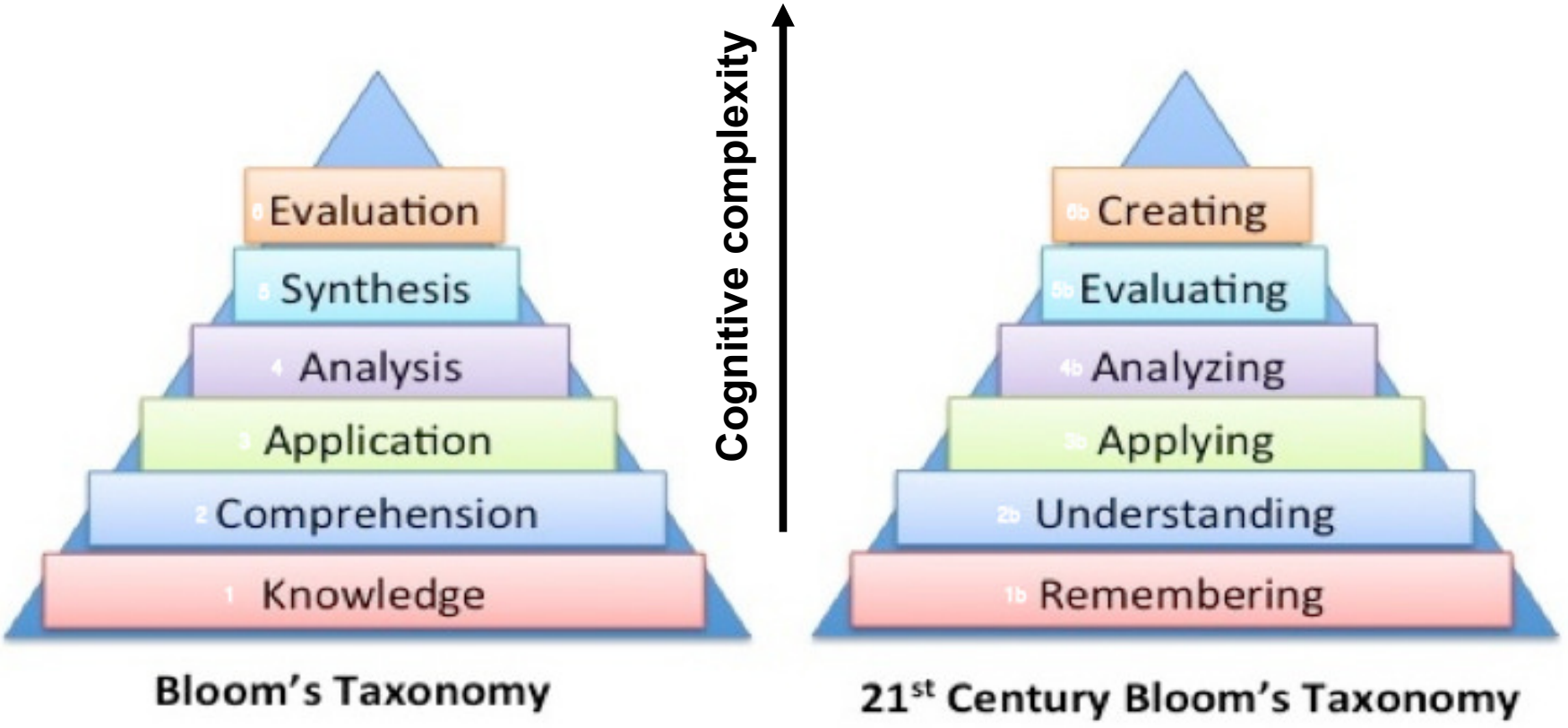
Science

Design

Rule-based thinking	Associative thinking
As few concepts as possible	Many different concepts
Serial processing of ideas	Parallel processing of ideas
Associations between concepts restrained by “rules”	Associations between concepts may be novel
Theory-based categorizations	Similarity-based categorizations
Reasoning is precise but may be in error due to belief bias	Reasoning is open but not always precise

REF: Benedek M., Könen T., & Neubauer A.C. (2012). Associative abilities underlying creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *6*(3), 273-281.

Future of Higher Education

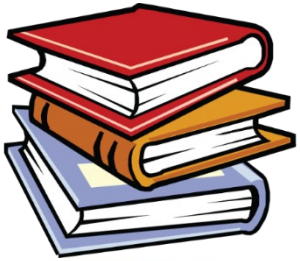


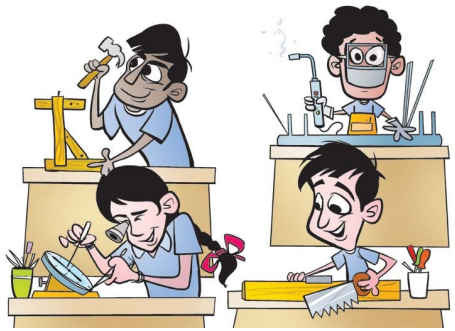
Bloom's Taxonomy Old and New by Global Change Lab! (2016) https://www.flickr.com/photos/149065276@N07/25358925239/
Attribution (http://creativecommons.org/licenses/by/2.0/)
Photo Attribution by PhotosForClass.com

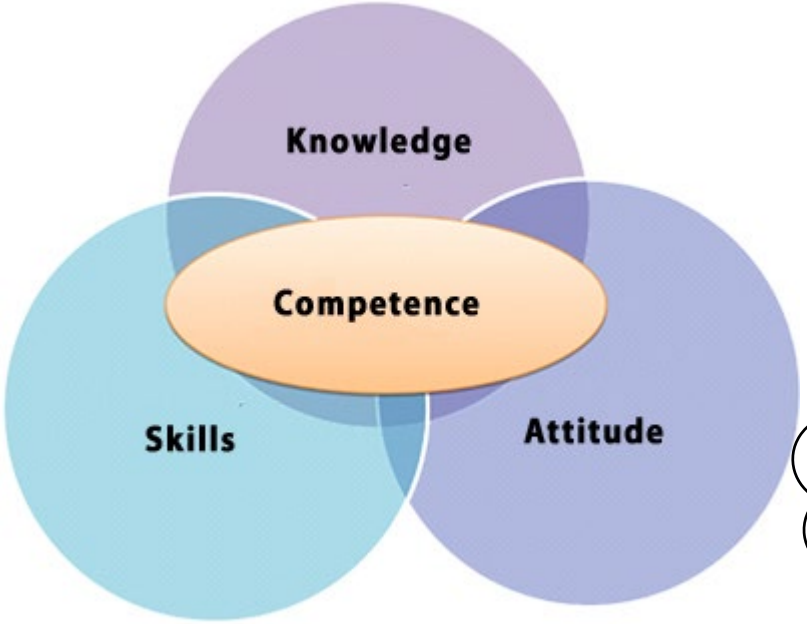
REF: Krathwohl, D. R.(2002). A Revision of Bloom's Taxonomy: An Overview. *Theory Into Practice*, vol. 41, no. 4, pp. 212-218.

REF: Jackson N. (2006). Developing Creativity in Higher Education - Appreciating what we do, imagining a more creative curriculum. PPT

What is a Competence?







Source: https://borealist.com/best-mba-studies/

Ref: DeHaan, R. L. (2011). Teaching creative science thinking. *Science*, *334*(6062), 1499-1500.

3 competent in designing

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Colophon:
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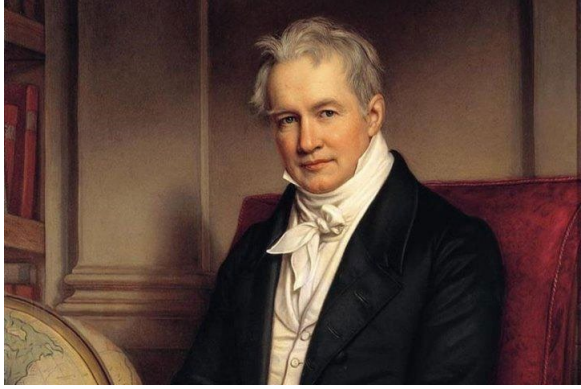
Bachelor	Master
Is able to reformulate ill-structured design problems. Also takes account of the system boundaries in this. Is able to defend this new interpretation against the parties involved. [ksa]	Idem, for design problems of a more complex nature. [ksa]
Has creativity and synthetic skills with respect to design problems. [ksa]	Idem. [ksa]
Is able (with supervision) to produce and execute a design plan. [ks]	Idem, independently. [ks]
Is able to work at different levels of abstraction including the system level. [ks]	Given the process stage of the design problem, chooses the appropriate level of abstraction. [ksa]
Understands, where necessary, the importance of other disciplines (interdisciplinarity). [ks]	Is able, and has the attitude, where necessary, to draw upon other disciplines in his or her own design. [ksa]
Is aware of the changeability of the design process through external circumstances or advancing insight. [ka]	Is able to deal with the changeability of the design process through external circumstances or advancing insight. Is able to steer the process on the basis of this. [ksa]
Is able to integrate existing knowledge in a design. [ks]	Is able to formulate new research questions on the basis of a design problem. [ks]
Has the skill to take design decisions, and to justify and evaluate these in a systematic manner. [ks]	Idem. [ksa]

Better: design challenges

k=knowledge, s=skill and a=attitude

Thank you for your attention…



Wilhelm von HUMBOLDT (1767-1835)

Design Thinking is…

- able to address wicked problems;
- utilizing on associative thinking;
- not causal but contextualized;
- intuition based and subjective;

- a competence we need for the future!

all references can be downloaded from
http://www.idemployee.id.tue.nl/g.w.m.rauterberg/presentations/2018%20EIT%20design_thinking/references.zip