Design Research
- what is a PhD thesis -

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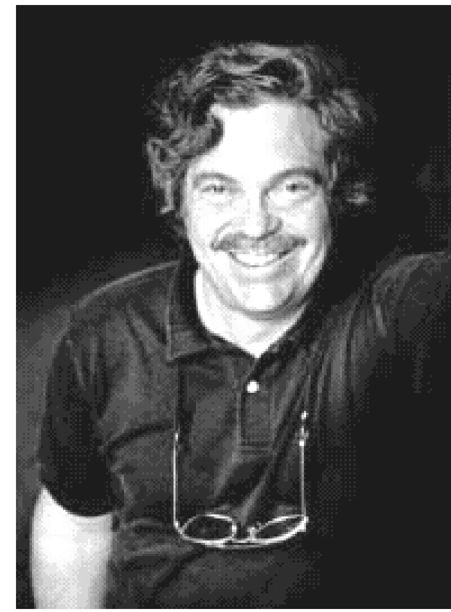
2018

Thinker versus Tinker

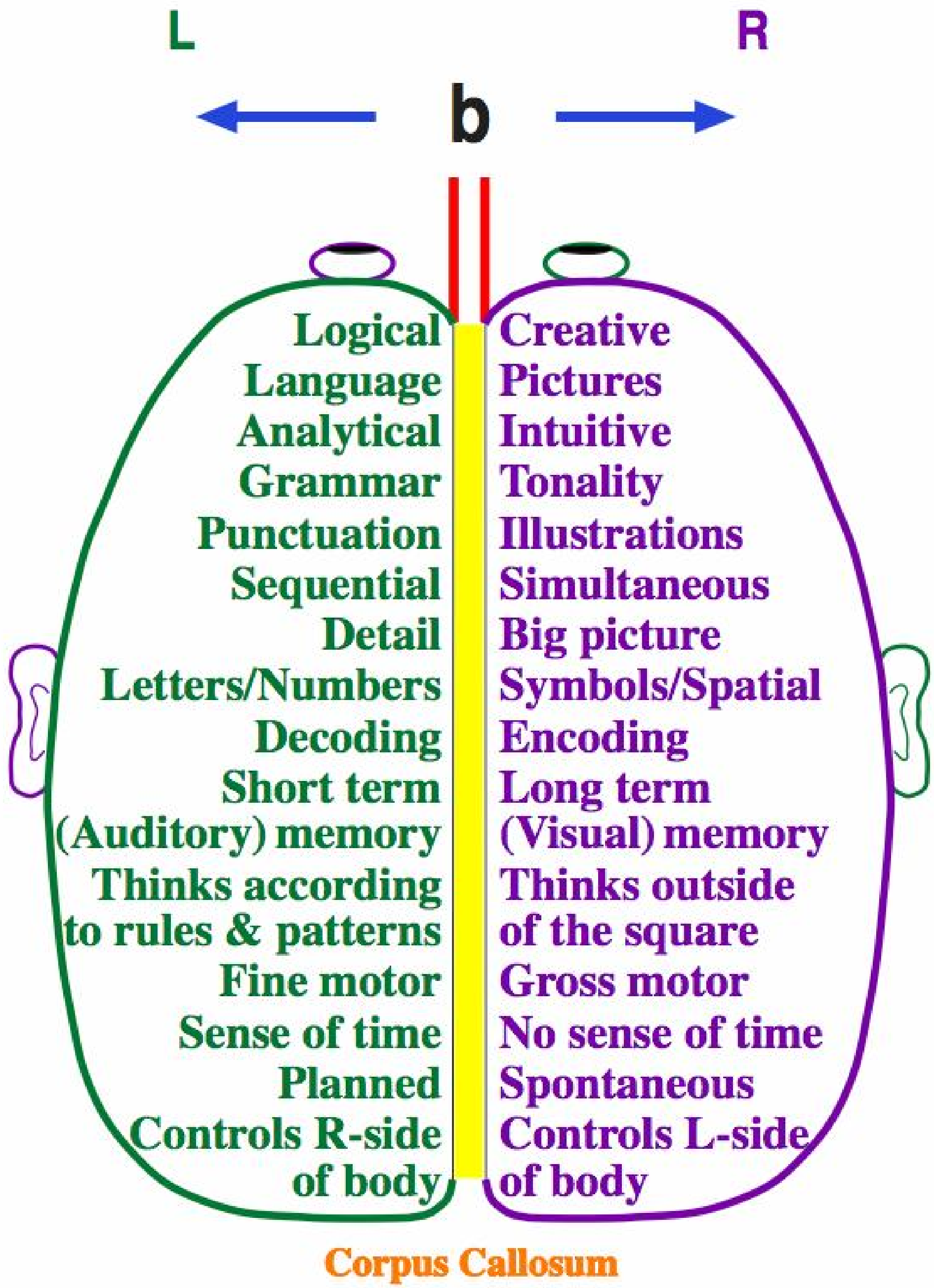
Ludwig BOLTZMANN(1884-1906)

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

"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-)



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

Daniel KAHNEMAN
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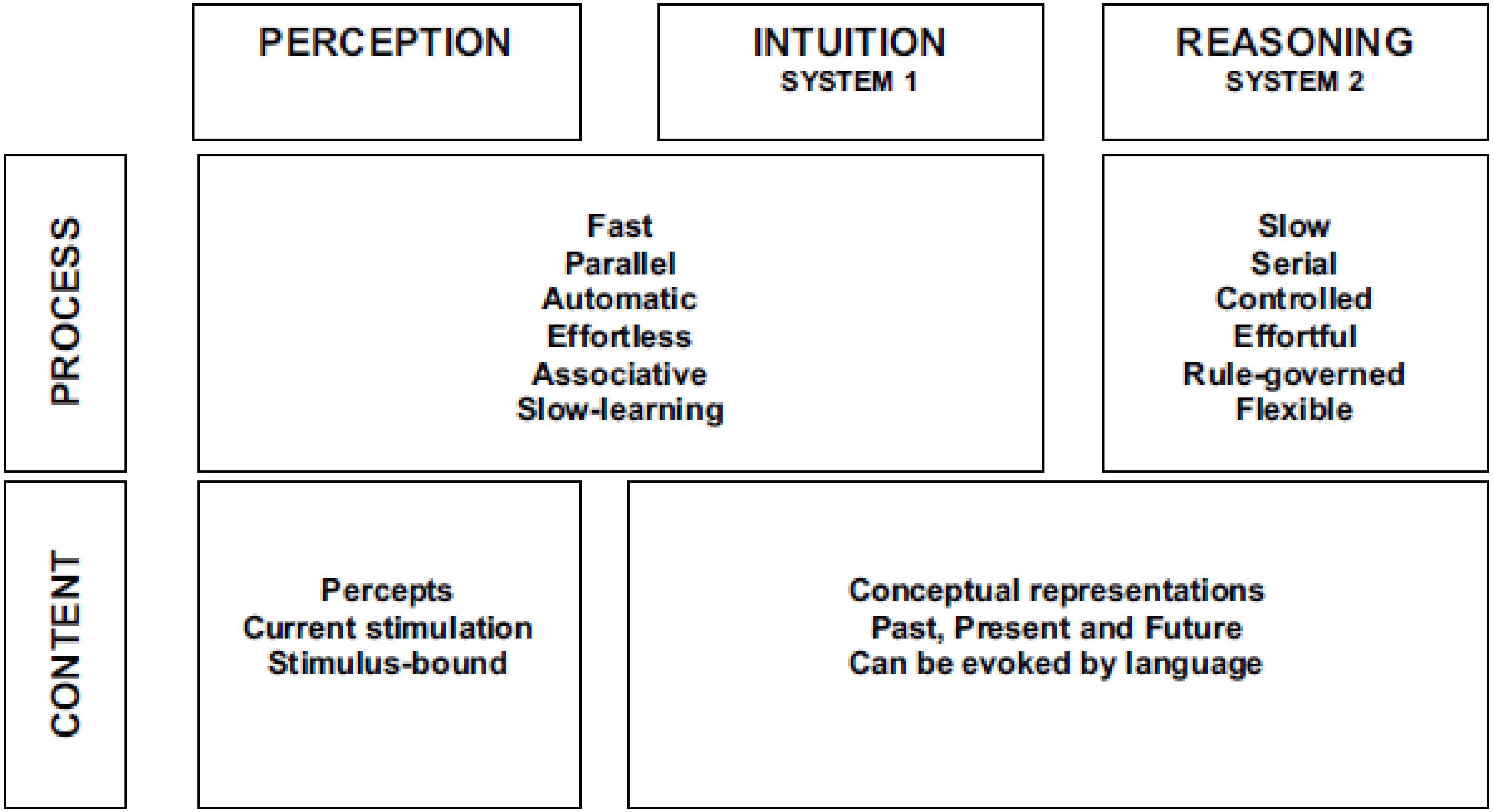

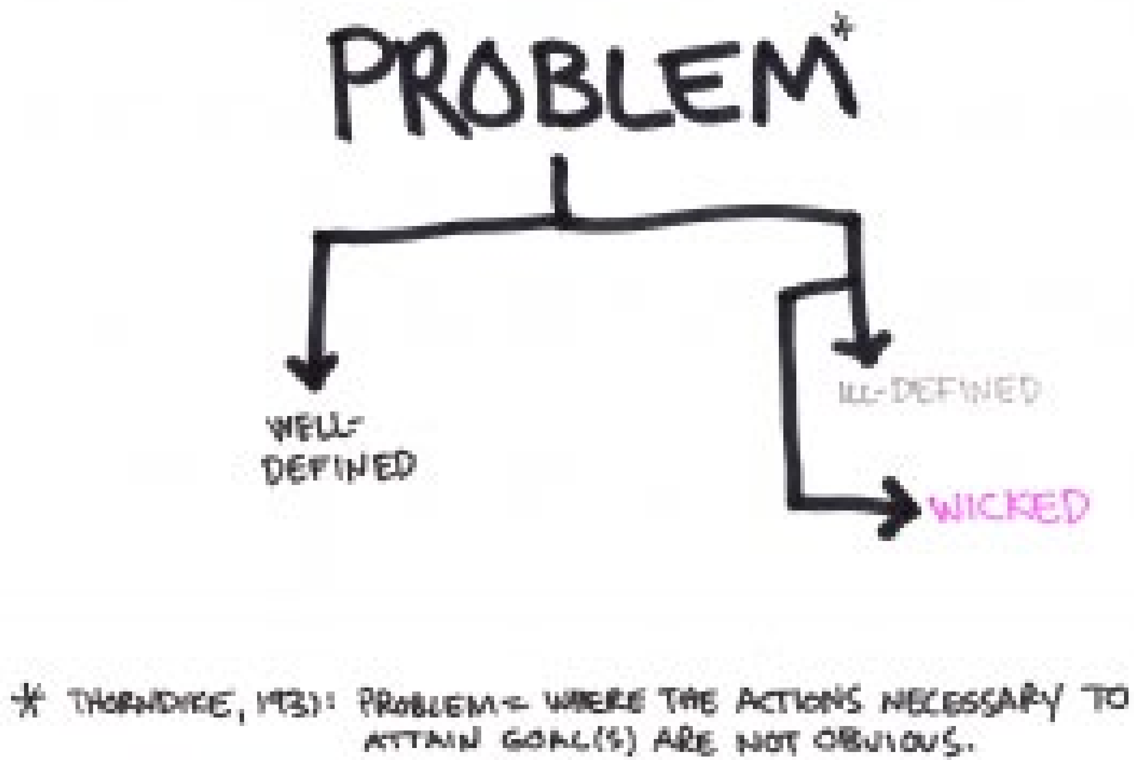

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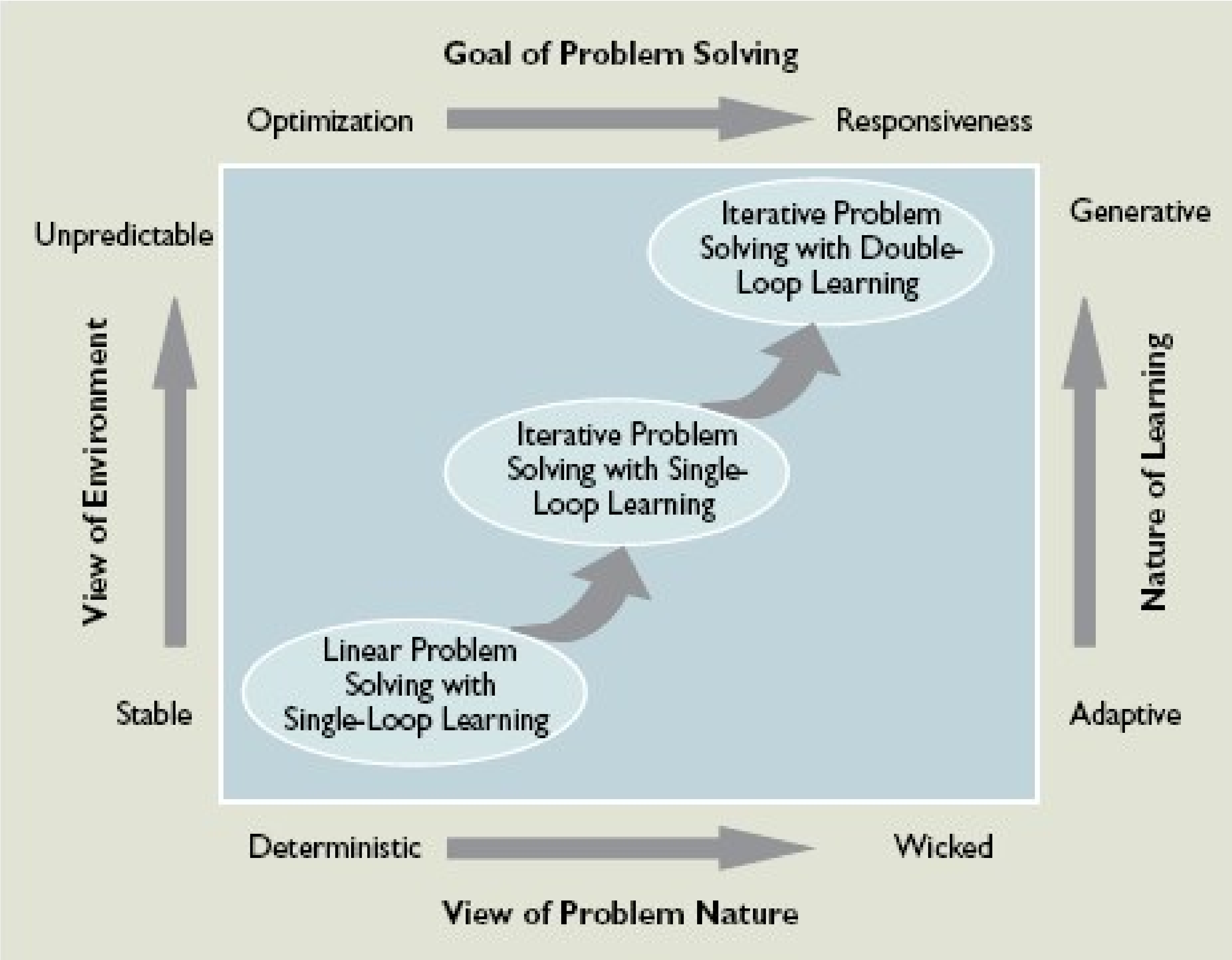
Goal of Problem Solving
Optimization
Responsiveness
Unpredictable
View of Environment
Stable
Generative
Nature of Learning
Adaptive
Iterative Problem Solving with Double-Loop Learning
Iterative Problem Solving with Single-Loop Learning
Linear Problem Solving with Single-Loop Learning
Deterministic
Wicked
View of Problem Nature

Categories of Problem-Solution

Kurtz, CF and Snowden, DJ (IBM Systems Journal 43, 3 Mar 2003)

Category	Qualities
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

Figure 1: The „waterfall"

Opportunity-driven problem solving

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

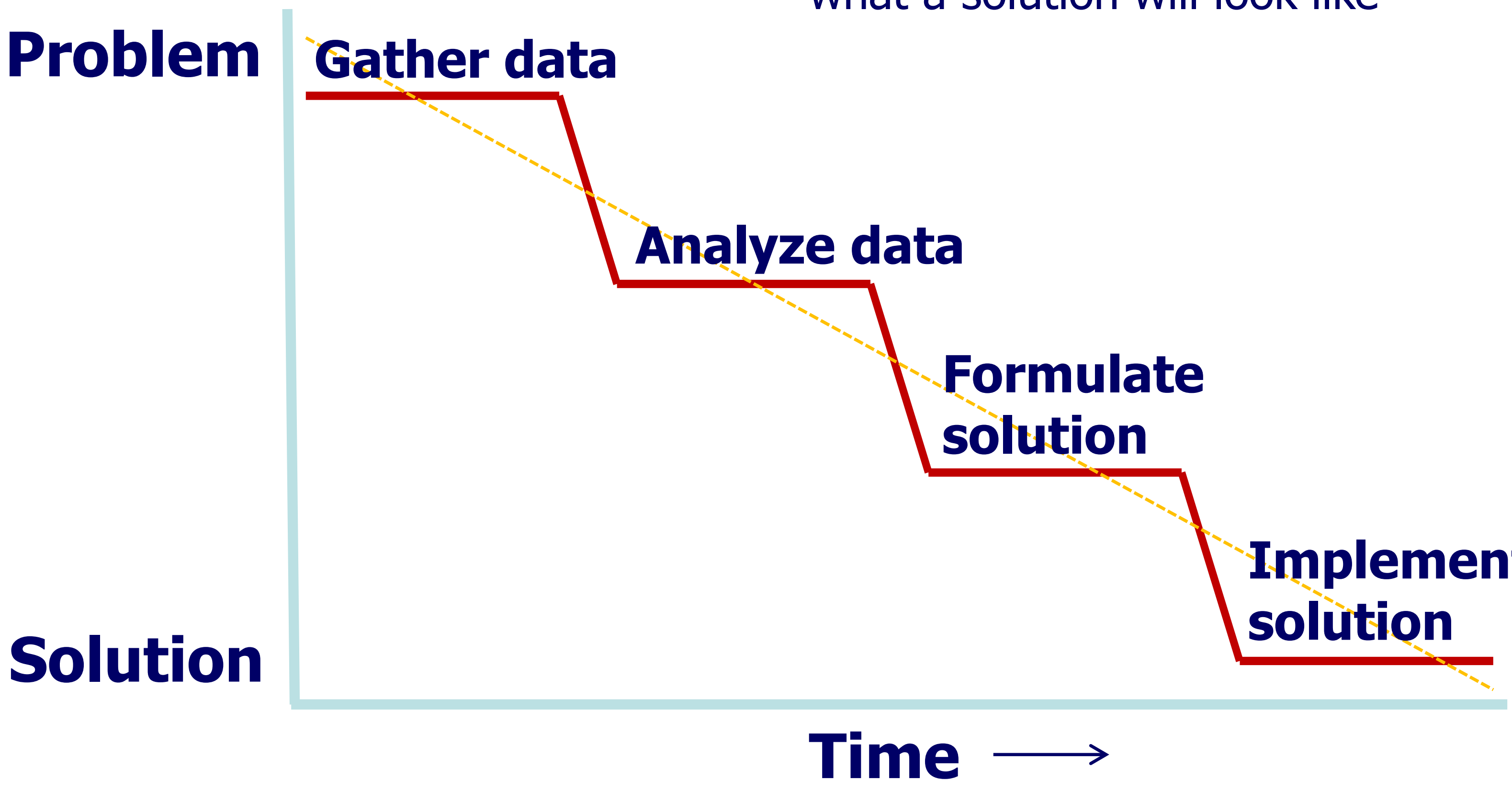

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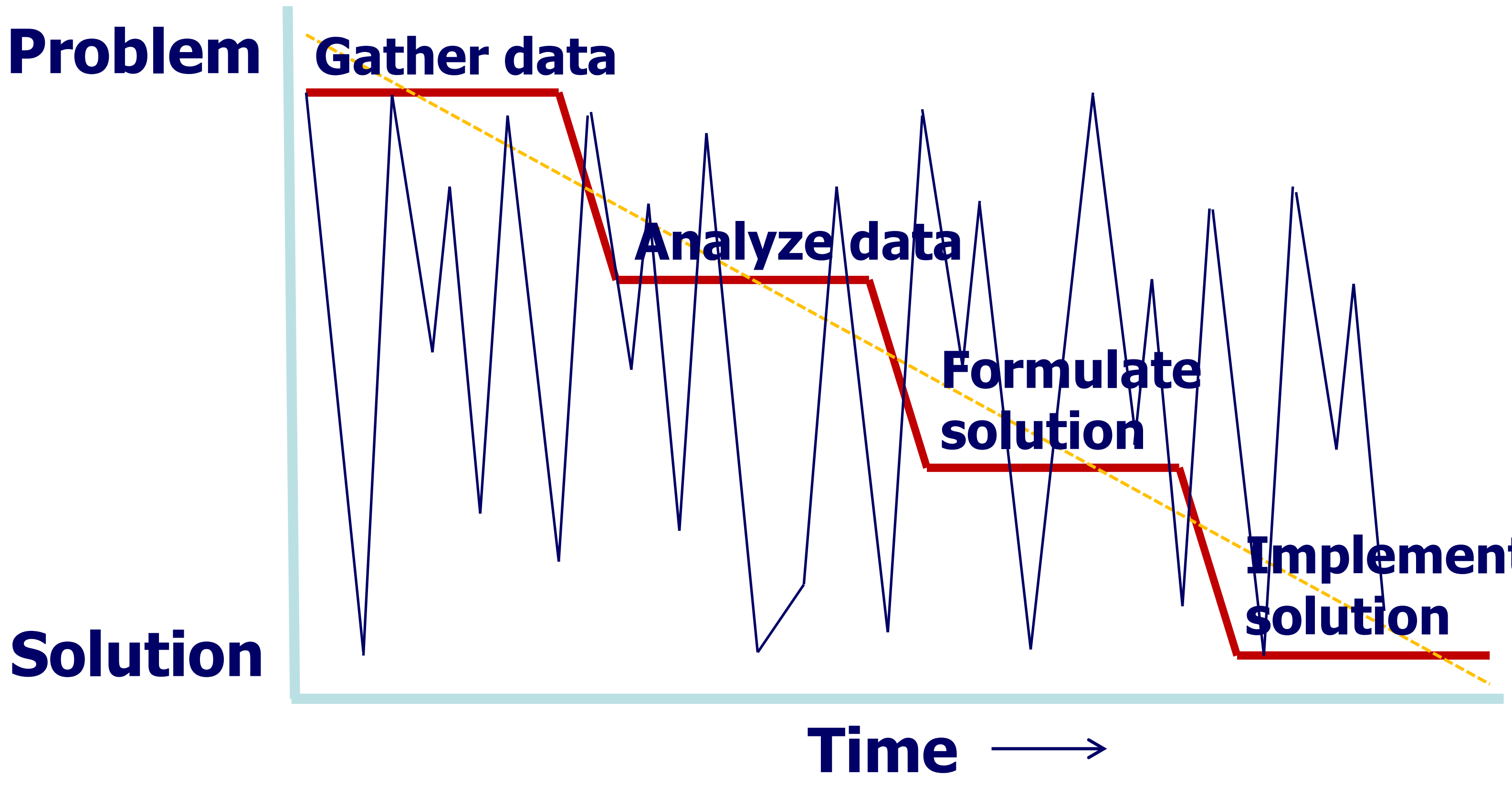
Figure 2: The „jagged" line

Opportunity-driven problem solving

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



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*

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!

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

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

How can we cope with Wicked Problems?

Two approaches:

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*	

Analysis & Synthesis, Deduction & Induction

Analysis (reduction): Separating of any material or abstract entity into its constituent elements.

Synthesis: Combining of the constituent elements or separate material or abstract entities into a single or unified entity.

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Deduction: A form of inference; if the premises are true, the conclusion must be true, i.e., deduction preserves the truth (equivalent to analysis).

Scientific induction: a form of inference in which the conclusion, though supported by the premises, does not follow from them necessarily, i.e., induction does not necessarily preserve the truth (equivalent to synthesis).

“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?

Kees DORST
Deduction-Induction-Abduction

Deduction, Induction and Abduction

Deduction:	major premise:	All balls in the box are black	A => B A --------- B
	minor premise:	These balls are from the box	
	conclusion:	These balls are black	
Induction:	case:	These balls are from the box	Whenever A then B ------------- Possibly A => B
	observation:	These balls are black	
	hypothesized rule:	All ball in the box are black	
Abduction:	rule:	All balls in the box are black	A => B B ------------- Possibly A
	observation:	These balls are black	
	explanation:	These balls are from the box	

Deduction reasons from causes to effects
Induction reasons from specific cases to general rules
Abduction reasons from effects to causes

Positivistic sciences

- An assumption of linear causality; there are no effects without causes and no causes without effects. [***Causality***]
- A single, tangible reality "out there" that can be broken apart into pieces capable of being studied independently. [***Reductionism***]
- The separation of the observer from the observed. [***Objectivity***]
  - So that the results of an inquiry are essentially free from beliefs, interpretations, etc.
- What is true at one time and place will also be true at another time and place. [***Universality***]

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

“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

Scientific methods

Nomothetic research (in natural sciences and engineering): the aim is to find general causal laws to explain phenomena, theories are usually axiomatic (deductive) systems or sets of models.

Constructive research (in engineering and design): the solution of the problem is not only shown to exist but it is also constructed.

Idiographic (ideographic) research trying to provide all possible explanations of a particular case, for example in history.

Scientific methods (cont'd)

Action research (in design sciences): the problem is solved by certain actions whose consequences are evaluated and new actions are specified (iterative improvement, trial and error).

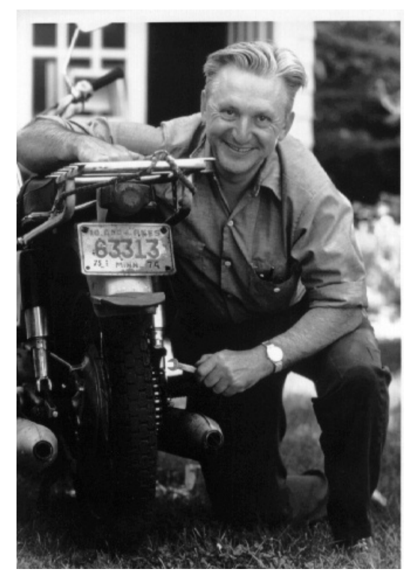
Case study (in design sciences): an in-depth, longitudinal examination of a single instance or event, which is called a case.

Questionnaire study (in social sciences): a series of questions are used for the purpose of gathering information, which is usually analyzed statistically.

Thank you for your attention…

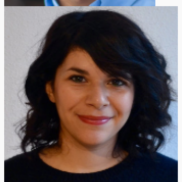
“Traditional scientific method has always been at the very best 20-20 hindsight.
It’s good for seeing where you’ve been.
It’s good for testing the truth of what you think you know, **but**
it can’t tell you where you ought to go.”

Robert Pirsig, 1974
“Zen and the art of motorcycle maintenance”

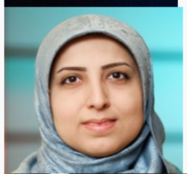


My favourite 26 PhD students [BACK TO TOP]

Juan Sebastián OLIER JAUREGUI (2018). Dynamic Representations - Building knowledge through an active representational process based on deep generative models. [2014-2018]
PhD Thesis. Eindhoven University of Technology & Università degli Studi di Genova.



Giulia PERUGIA (2018). ENGAGE-DEM - A model of engagement of people with dementia. [2014-2018]
PhD Thesis. Eindhoven University of Technology & Universitat Politècnica de Catalunya .
PostDoc at Uppsala University, Sweden



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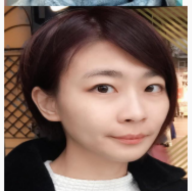

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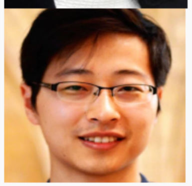
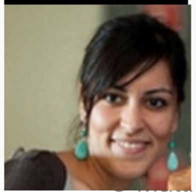


Chao WANG (2017). The Social Car - Enhancing communication between drivers by digital augmentation. [2013-2017]
PhD Thesis, Eindhoven University of Technology.

Yu ZHANG (2017). Drama Story Production Interaction - A design approach towards interactive installations. [2013-2017]
PhD Thesis, Eindhoven University of Technology.
Lecturer at College of Furniture and Industrial Design, Nanjing Forest University, China



Mehrnoosh VAHDAT (2017). Learning analytics and educational data mining for inquiry-based learning. [2014-2017]
PhD Thesis, Eindhoven University of Technology & Università degli Studi di Genova.

Veranika LIM (2017). Design opportunites in reducing domestic food waste - A collective approach. [2013-2017]
PhD Thesis, Eindhoven University of Technology & Università degli Studi di Genova.
PostDoc Researcher at Imperial College, U.K.

Maira BRANDAO CARVALHO (2017). Serious games for learning. [2014-2017]
PhD Thesis, Eindhoven University of Technology & Università degli Studi di Genova.
PostDoc Researcher at Tilburg University, Netherlands

Alejandro BETANCOURT (2017). Ego Hands - A unified framework for hand-based methods in first person vision videos. [2014-2017]
PhD Thesis, Eindhoven University of Technology & Università degli Studi di Genova.
Awarded in 2017 with CUM LAUDE, the top 5% thesis at TU/e.
Business Analytics Leader at Ecopetrol, Colombia

Pongpanote GONGSOOK (2016). Interactive diagnostic game for time perception. [2011-2016]
PhD Thesis, Eindhoven University of Technology & Università degli Studi di Genova.
Software Engineer at SeaChange Software Solutions B.V., Eindhoven, Netherlands

Danu PRANANTHA (2015). Experiments on flow and learning in games. [2011-2015]
PhD Thesis, Eindhoven University of Technology & Università degli Studi di Genova.
Lecturer at Institut Teknologi Sepuluh Nopember, Indonesia.

Marija NAKEVSKA (2015). Interactive storytelling in mixed reality. [2010-2015]
PhD Thesis, Eindhoven University of Technology.
Technical Integration Specialist at Adyen, Netherlands

Boris TAKAC (2014). Context-aware home monitoring system for Parkinson’s disease patients. [2011-2014]
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Software Engineer at MEYN – Food Processing Technology B.V., Oostzaan, Netherlands

Huang Ming CHANG (2014). Emotions in archetypal media content. [2011-2014]
PhD Thesis, Eindhoven University of Technology & Universitat Politècnica de Catalunya.
Awarded in 2014 with CUM LAUDE, the top 5% thesis at TU/e.
Front-end Developer at Connectis B.V., Rotterdam, Netherlands

Leonid IVONIN (2014). Digitizing archetypal human experience through physiological signals. [2011-2014]
PhD Thesis, Eindhoven University of Technology & Universitat Politècnica de Catalunya.
Awarded in 2014 with CUM LAUDE, the top 5% thesis at TU/e.
SAP consultant and Owner/CEO of HX research, Moscow, Russia.
Marie Skłodowska-Curie Fellowship at Bristol Interaction and Graphics Group

Roman GORBUNOV (2013). Monitoring emotions and cooperative behavior. [2009-2012]
PhD Thesis, Eindhoven University of Technology.
This PhD is Roman's 2nd Doctoral Degree.
Data Scientist at Supercrunch, Nurnberg, Germany

CheeFai TAN (2010). Smart system for aircraft passenger neck support. [2007-2010]
PhD Thesis, Eindhoven University of Technology.
Awarded in 2011 with Bronze Medal at Malaysia Technology Expo [PDF]
Senior Lecturer, Faculty of Mechanical Engineering, Universiti Teknikal Malaysia Melaka, Malaysia

Hao LIU (2010). Biosignal controlled recommendation in entertainment system. [2006-2010]
PhD Thesis, Eindhoven University of Technology.
R&D manager of Xiaomi Inc., Beijing, China

Elise van den HOVEN (2004). Graspable recollection cues. [1999-2004]
PhD Thesis, Eindhoven University of Technology.
Professor, Design Architecture Building, University of Technology Sydney, Australia
NWO **VENI Award Laureate**

Dennis ABRAZHEVICH (2004). Electronic payment systems: A user-centered perspective and interaction design. [1999-2004]
PhD Thesis, Eindhoven University of Technology.
Owner and CEO of Mobilnova, Eindhoven, Netherlands

Sriram SUBRAMANIAN (2004). Tangibles interfaces for volume navigation. [1999-2004]
PhD Thesis, Eindhoven University of Technology.
Professor, Department of Computer Science, University of Bristol, UK

Starter Grant Holder

Arnout FISCHER (2003). User adaptation in user-system interaction. [1999--2003]
PhD Thesis, Eindhoven University of Technology.
Associate Professor, Marketing and Consumer Behaviour Group, Wageningen University, Netherlands

Dzmitry ALIAKSEYEU (2003). A computer support tool for the early stages of architectural design. [1999-2003]
PhD Thesis, Eindhoven University of Technology.
Senior Scientist, Philips Research, Eindhoven, Netherlands

Henning BREUER (2001). Kultivation und Imagination in den neuen Medien. [1998-2000]
PhD Thesis, Otto-von-Guericke-Universität Magdeburg, Germany.
Founder UX Berlin - Innovation Consulting, Berlin, Germany
Professor at University of Applied Sciences for Media, Communication and Management, Germany

Morten FJELD (2001). Designing for tangible interaction. [1997-2001]
PhD Thesis, Swiss Federal Institute of Technology (ETH) Zurich.
Awarded in 2001 with the ETH medal, the top 5% thesis at ETH Zurich.
Professor, Department of Computing Science, Chalmers Göteborg University, Sweden

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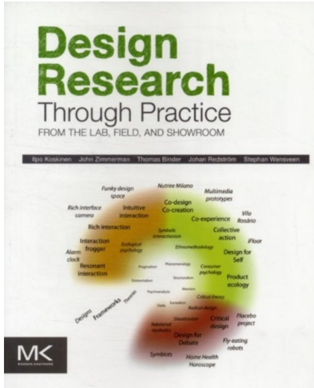

Design Research through Practice.
by Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redstrom, Stephan Wensveen (Authors)
Paperback: 224 pages
Publisher: Morgan Kaufman (September, 2011)
Language: English
ISBN-10:
ISBN-13: 978-0123855022

Design Research: Methods and Perspectives.
by Brenda Laurel (Editor), Peter Lunenfeld (Preface)
Hardcover: 334 pages
Publisher: The MIT Press (October 1, 2003)
Language: English
ISBN-10: 0262122634
ISBN-13: 978-0262122634

Research Methodology: A Step-By-Step for Beginners.
by Ranjit Kumar (Author)
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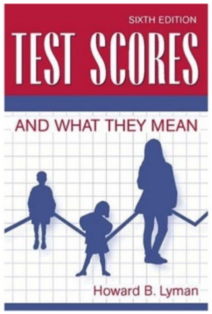

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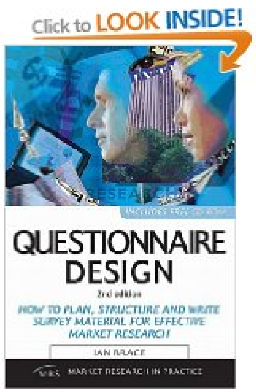

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Language: English
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ISBN-13: 978-0749450281

Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory.
by Anselm C. Strauss (Author), Juliet Corbin (Author)
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