

Design in Practical Application, Creativity and Process to form an Expertise

April 2020 Johannes Schaede



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Good Afternoon!

It is with great pleasure to welcome you to a new venture, if not adventure. We attempt this year to lead you through our small lecture by providing you with texts and images. We sincerely hope that despite the meagre presentation – nothing can replace a well inflated presentation – you still will profit somehow from our common efforts.

First I want to introduce myself. My educated profession is a mechanical fitter. I have been trained to assemble and put into operation pump systems for power plants. This sounds less exiting than it is in reality, but alas, these large installations appear to be something out of a different (stone)age. It was with some reluctance that I later passed some exams to receive permission to study electrical and mechanical engineering at the ETH in Zürich. My first serious job was at a midsized company in Würzburg, Koenig & Bauer AG. They produce printing machines, something you will consider old technology. However our machines print packages, functional surfaces, Whiskey bottles and in the area of my expertise we print money. This may all appear a dying art to you, however as we will later see, there are areas in our daily life where digital substitutes are not satisfactory such in case of a cold beer or to remain in my area, when you need a fast and. anonymous transfer of value.

Lastly, the whole lessons are in English language. This is not only a complication for me, it is also for you – you are visiting the lectures of an international master – a good exercise for your future, where your mother's tongue will have even importance as the still common technical Esperanto will be and remain for the foreseeable future the language of William Shakespeare and Donald Trump.

We expect you to read through the slides and adjacent texts and questions and to try and make sense of it. I will be available for questions, but I trust that you are well educated to find sense independently from the rambling of an elderly industry hack.

L1 Creativity and design objectives

1. Information vs Knowledge
2. Creativity
3. Limitations to creativity
4. Balancing
5. Creativity Training
6. Task 1 and Book 1



In our first lecture I want to touch some basic principles, which will not leave you until you retire or pursue your career in completely different areas such as theology or micro economics. It is known that our life is ruled by mother nature. She is unforgiving, because her laws apply for everybody and even those who do not appreciate her clarity and unbendable laws. One of them the laws of thermodynamic. Most importantly the 2nd main law, which in more popular terms says that any system without the application of energy will migrate to the state of maximum disorder. You may verify this easily when you inspect your garage, your backpack at the end of your term or the area below your bed.

I want to touch the difference between information and knowledge. If there would be none, you and I would be obsolete as Wikipedia would run the world. (For heaven's sake!)

Then we want to reflect on creativity. It is an element necessary for all engineers and scientists, but an element, which escapes scientific stringent control.

Further I want to advertise the virtues of balancing, something you may observe in preparation of your term papers when you have to negotiate time at your desk, with friends (limited today) and in the beer garden

We want to understand in how far we can train creativity and lastly you may want to learn something by doing a little bit and enlarge your scope by reading something. Should you not be inclined to read books, re-consider your position. It is without fail the best source of knowledge, entertainment and tools to impress in small talk.

Intro Research

Historic conditions :

- Development of scripture
- Tradition and Teaching

First documented science (Egypt) :

- Astronomy
- Mathematics
- Medicine



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Before we head for knowledge let us make a short detour into the question what are the agreed pre-conditions for the existence of science or better of scientific knowledge. As engineers we count ourselves amongst the natural scientist, whilst the true scientists believe that we are just applicators with limited intellectual skills. Whilst this may seem so from the stand-point of an astro-physicist, he may want to consider the quality of his transport systems would we remain with Newton's engineering skills and skip applications of thermodynamics and mechanics from George Stephenson and Rudolf Diesel (by the way, what did these engineers invent??)

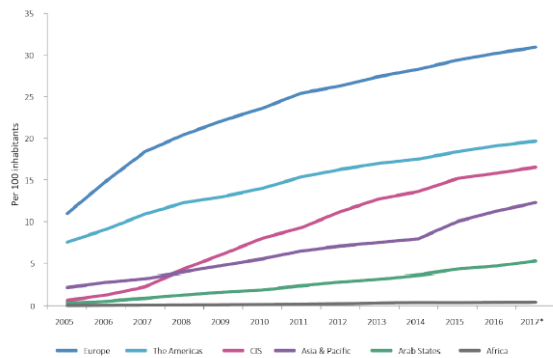
Here I have put together the main pre-conditions for scientific knowledge and research. You should try to answer the following questions:

1. Why are the two historic conditions the kernel of scientific knowledge?
2. Why have the Egyptians – they are the ones we know for sure having these conditions early – chosen the three disciplines mentioned?

If you need further information on the subject you may want to consult the collection of the British Museum (<https://www.britishmuseum.org/collection/egypt>) or Thomas Mann : Joseph und seine Brüder. (the latter only for those with an inclination to belletrist literature and a lot of time)

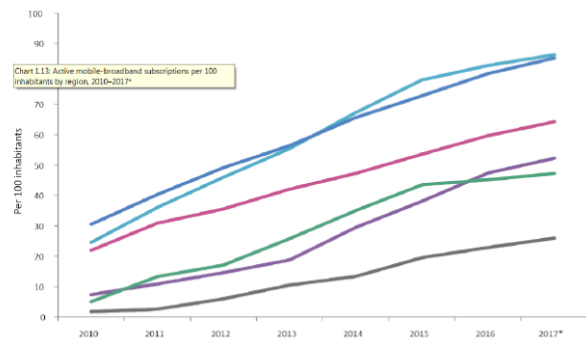
Information versus Knowledge (1)

Chart 1.16: Fixed-broadband subscriptions per 100 inhabitants by region, 2005–2017*



Source : © 2017 ITU International Telecommunication Union, Switzerland

Chart 1.13: Active mobile-broadband subscriptions per 100 inhabitants by region, 2010–2017*



Source : © 2017 ITU International Telecommunication Union, Switzerland

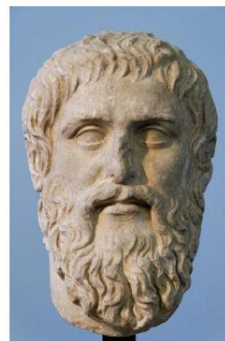
Information versus Knowledge (2)



Bill Gates Quotes

Information technology and business are becoming inextricably interwoven. I don't think anybody can talk meaningfully about one without the talking about the other.

Bill Gates



Platon (427 - 348 BC) :

- Justified
- True
- believed

Source : WIKIPEDIA ;
Roman copy of a portrait bust by Silanion for the Academia in Athens (ca.370 BC)

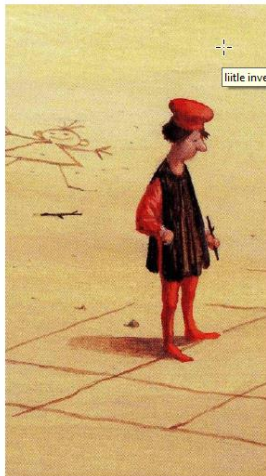
Here you find how information technology is spreading all over the world. Also the portrait of two gentlemen of different generations who have their views on information respectively knowledge.

If you think of the position of these gentlemen in history and society, what are the differences and what do they have in common?

Do you make a distinction between "information" and "knowledge" ?

(of course you should!!) but what is the most decisive difference between these two terms?

Intro Research: information vs knowledge (3)



Scientists :

- Observe
- Explain
- Predict Phenomena

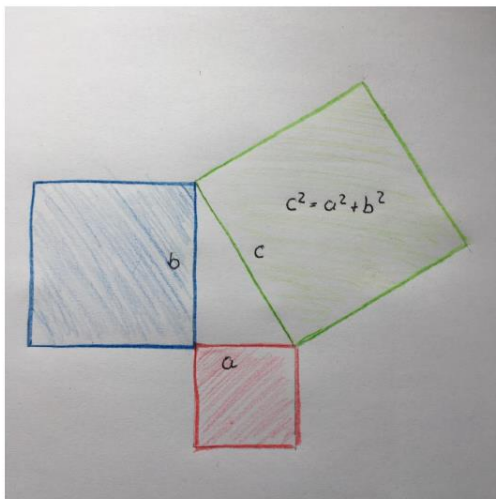


What we know :

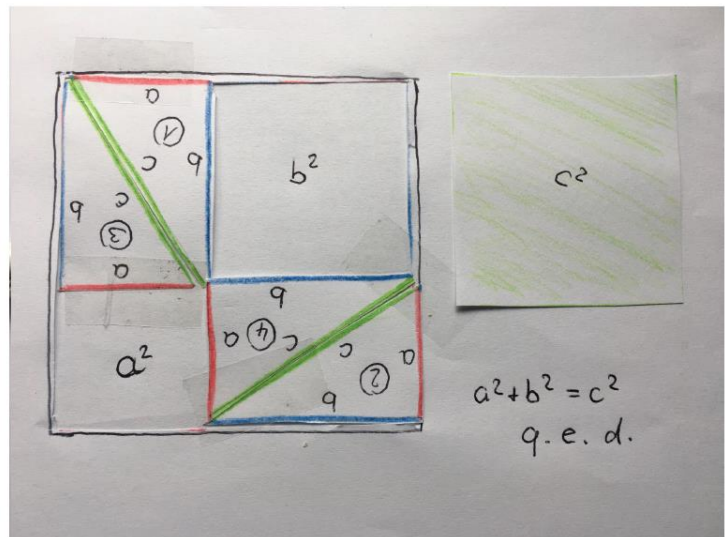
- Empirical
- Theoretical
- Practical



Intro Research : information vs knowledge (2)



Pythagoras Theorem



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These two slides refer to the well-known Pythagoras theorem. If you ask GOOGLE you get a 7-digit volume of responses.

But is this in the portfolio of your knowledge? To manifest this, the second image represents one of the multiple proofs of evidence of this theorem. Use your colouring pens, paper and scissors to demonstrate it to yourself.

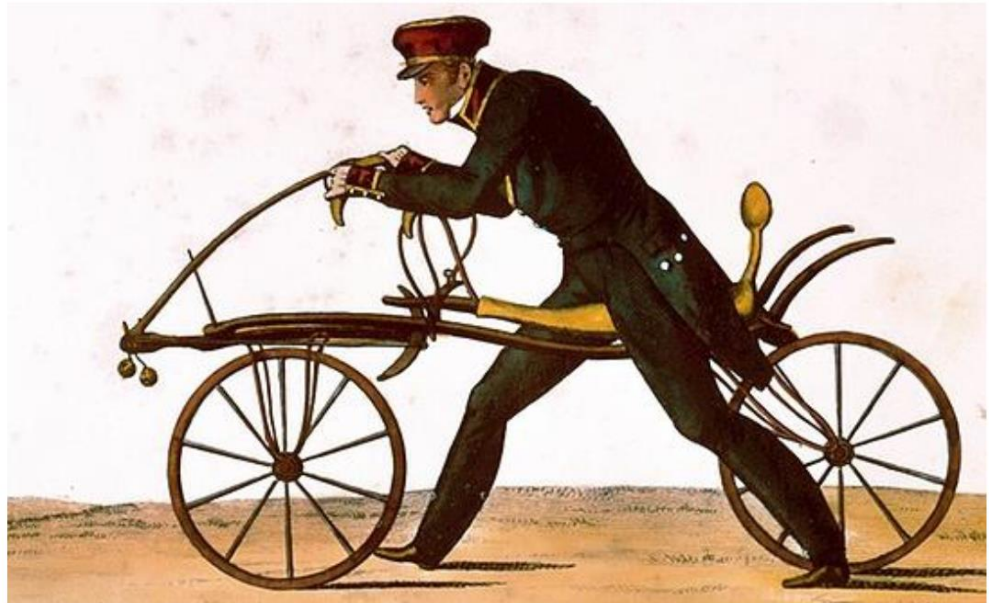
Where in your daily life do you rely on this piece of evidence? (minimum one, bonus : three)

Creativity (1)

What is it ?

It creates something :

- New
- Valuable
- appropriate



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Creativity is to science what yeast is to the dough. As immaterial and volatile as it is, I truly hope that you possess a good portion of it. Otherwise your life as an engineer will be difficult.

In this image you find an example of a creative invention.

1. Which characteristics of this invention comply with the three basic elements mentioned?
2. What design elements do you find in today's bicycle – though with different materials and design?
3. Bonus : Who was the inventor (he is shown in the image) and why did his professional life call for his invention?

Creativity (2)

It is relevant to :

- solve issues in job and every day life

Will lead to :

- new scientific findings
- new objects of art
- new inventions
- New social programs
- New political movements

BUT ! What is it really ?

... it is of paramount economic importance



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Some examples where creativity is of paramount importance.

Instead of presenting them to you, identify at least three of the categories in the last 10 years, which have impressed you.

What is creativity ?

It is what the Muses will fill in the empty contain of our souls : inspiration (Plato)

It is a special way of thinking(s) (data based, intuitive, critical, generative . . .) (deBono)

It arises from the tension between conscious reality and unconscious drives (desires) (Freud)

It is measurable in simple testing : fluency (n), flexibility (cat); originality ; elaboration (Torrance)

It is generative and explorative thinking (smith Ward and Finke)

It is a synthesis of out-of-the-box, analytical-critical and practical-contextual (Sternberg)

BUT ! What is it really ?



Torrance Test



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Some very clever and intelligent people have thought about what creativity is. The headers of their findings are mentioned here.

1. After having thought about it, which of these definitions appeal to you ?
2. If all or several of them appeal to you, what do they have in common?
3. If none of them appeal to you, do you have a better definition?

What is creativity ? Torrance Test

This is a shoe box



You have 5 min:

- Imagine different use(s)
- Give an elevator talk

BUT ! What is it really ?



... it is 90% transpiration and 10% inspiration !

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Here is a little test for you and your creativity. You are given this anonymous shoe box. Now you have 5 minutes to think about a different use of this box. It can be anything. From a toy to a scientific experiment. Note your ideas down and think about it how you would present your idea to your big boss in 30 seconds (so called elevator talk)

If you find this unusually difficult, don't worry. It is quite normal as it is easier to fill hundreds of pages with complex ideas than to have and present one ingenious solution

Limitations to creativity

Money : controlling cost is always at the core of any successful enterprise (project)
Time : Time is Money but also , it cannot be bought for money
Mother Nature : her laws are to be observed under any circumstances
Customer : At the end it only counts his/her satisfaction
Capacity : you have to win the championship with your team
The law makers : There is no better way to spoil your day

BUT. . . are these really limitations ?



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Balancing

Money :	Development Budget and Business Plan	2
Time :	Realistic estimation of steps and gateways (-30% rule)	4
Mother Nature :	Knowledge in theory and experience	3
Customer :	know your customer's thinking	1
Capacity :	you are as good as the team behind you	5
The law makers :	Read things which are absolutely boring	6



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Real life has its limitations and especially for the creative mind. Here you find the main limits to your creativity and their ranking in importance for industrial engineers, inventors and managers.

These limits are evident in themselves. If you have difficulties to grasp them the next small exercise may help you.

Creativity Training

A small little test for you :

In a cramped environment (bath room, garden shed) you need a table of 800mm (width) x 700 mm (depth) It shall carry a little baby or 4 to 5 flower pots . It shall be movable to make room when it is not used. It shall be put in place single handed.	
You shall not spend more than 40€	CUSTOMER
You shall build and install in max. 1 to 2 hrs.	MOTHER N
You shall be done in 15min	
Group 1 : paper and pencil	TIME
Group 2 : laptop	



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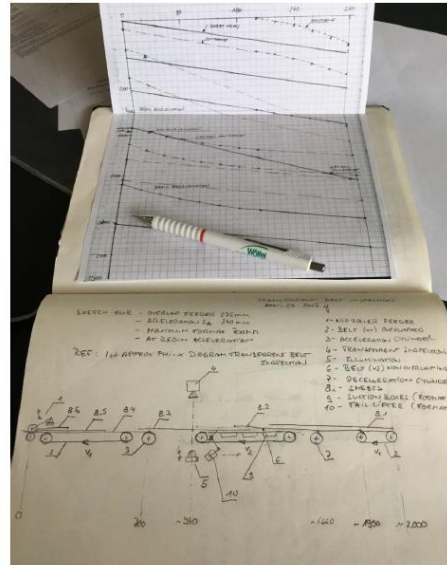
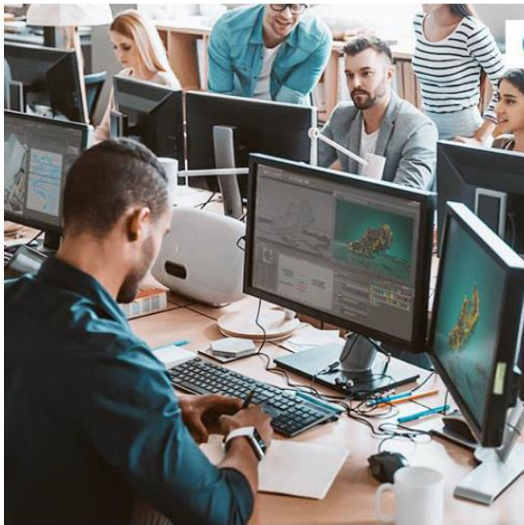
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In this example form (my) real life (I have here kids – long grown and a garden), which may also come across to you I have given the basic specification of a device, which any engineer (also those which are more on the informatics side of things) should be able to solve.

1. Now you may choose, whether you want to use paper and pencil or your computer (laptop, tablet, smart phone) to design the device. BUT once you have chosen your method you have to stick to it (and do not read any further, it takes all the fun out of it)
2. Write down why you have chosen the medium and method you apply
3. Solve the problem in a way which allows you to present it to your peers in 5 minutes (this is 10 elevator rides)

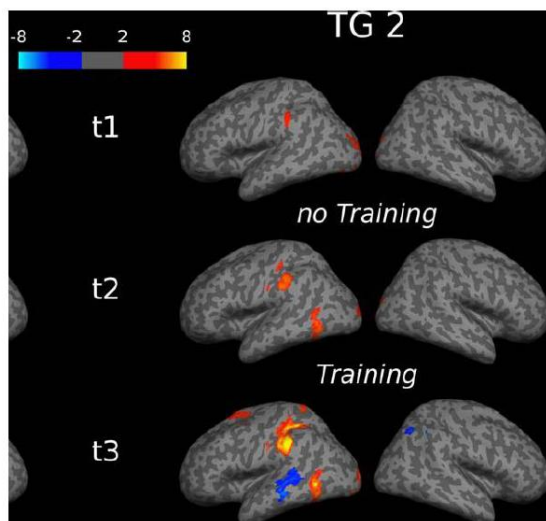
Creative Tools (2)



Anything you can design with a sheet of DIN4 paper and pencil cannot be too complicated to manufacture (Wolfgang Richter)

Whatever your choice for the last small test, you may find, if you take your time to compare with your peers that the paper and pencil approach is mostly the paper and pencil approach. The reason is the limitation of your internal computer, which is blocked with non-creative operative stuff, when you have to operate a stupid digital device (even if it claims to possess AI)

Creative Tools



Source : Human Brain Mapping 36:4104–4115 (2015)

Training of Verbal Creativity Modulates Brain Activity in Regions Associated with language- and memory-Related Demands

Creativity demands computing capacity in your cortex

Computing Capacity is about 10 FLOPS

i.e. our capacity is limited

A small little exercise

A small little exercise for you :

You have learned about the most important limits and balancing parameters for creativity.

It is always good to apply the theory to a practical exercise.

- Select one of your favorite projects you have realized (at school or in industry) and identify the parameters in this project
- Point out what your most difficult parameter has been
- Make a 5min presentation for your colleagues for next lesson to explain



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This last exercise will help you to get over the upcoming boredom at home.

I also leave you a recommendation for reading. Please note that the overwhelming majority of successful engineers, scientist and managers **do read books**.

A reading recommendation

https://www.google.ch/url?sa=i&ict=jq&sc=s&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwifE268nbTaAhUPy6Q0Hby8psQr6f6AgAEAU&url=https://emotions.cio.usg/product/thinking-fast-slow/&prg=AO-Vaw3i2Vxof9aCq_nRP0fncz7&ust=1523693103141239

