Brooke 21:17
dogma

系 why 啊- 21:17
put the cart before the horse

土豆 21:17
domain & realm

Alex 21:17
wherewithal

chenxiaohui 21:17
dogma, doctrine, gospel

土豆 21:18
knows one's onions

Brooke 21:18
specific knowledge

May 21:18
anticlimactic

Sachraa 21:18
flesh it/them out

Jing 20:54
flesh out

Jing 20:58
20/80 rule

Sachraa 21:00
flesh out

剪影 21:01
增强现实

阿拉伯土著[???] 21:01
augment

剪影 21:13
farmer and chicken theory

Sachraa 21:17
know my stuff/shit/onions

Brooke 21:17
goings-on

阿拉伯土著[???] 20:49
Trajectory

Sachraa 20:49
what's the meaning of "under my belt" again?

ARIANA 20:49
Trajectory

jing 20:50
fluency

ARIANA 20:51
Fluency

jing 20:51
maintain

Jing 20:51
knowledge gets updated, and so too must your circ

Jing 20:53
curiosity, desire to learn, monitoring and feedback

jing 20:43
know my staff/ onions

Ho'oponopono撤回了一条消息

阿拉伯土著[???] 20:43
I got stumped

ARIANA 20:43
Stump

Ho'oponopono 20:44
i got stumped 被难住了

July 20:44
domain/realm

Jing 20:44
under your belt

jing 20:45
under my belt

阿拉伯土著[???] 20:45
I got experience under my belt.

系 why 啊- 20:49
trajectory

Ho'oponopono 20:40
No detail of the goings-on in the town has escaped his notice over the years

系 why 啊- 20:40
know something like the back of my hand

Ho'oponopono撤回了一条消息

Ho'oponopono 20:40
know something like the back of my hand

Jing 20:42
know one's onions

Jing 20:36
Almanack of Naval Ravikant

Ho'oponopono 20:36
productize yourself

Alex 20:38
ominiscient

belt

正在同步...

belt 1

搜索

词典 | 百科 | 学习 | 翻译 | 背单词 | 管理 | 历史记录 | 标签

單詞搜尋

belt

柯林斯高階英漢雙解學習詞典

英漢大詞典（第2版）

朗文雙解

Macmillan English Dictionary 2n

Six Thesaurus

LLA

英漢－漢英詞典

近義、反義、聯想詞

片語｜習慣用語

12个匹配 under 2 上个单词 下个单词 完成

明擺著，要是你入不敷出，你就得省著點了。

3

9 [PHRASE 短語] 已經取得或完成；If you have something under your belt, you have already achieved it or done it. [have/with n PHR]

Clare is now a full-time author with six books, including four novels, under her belt.
克萊爾現在是全職作家，著有6本書，其中有4部小說。

相關片語：
belt out belt up

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under one's belt meaning

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under one's belt

Overview | Similar and opposite words | Usage examples

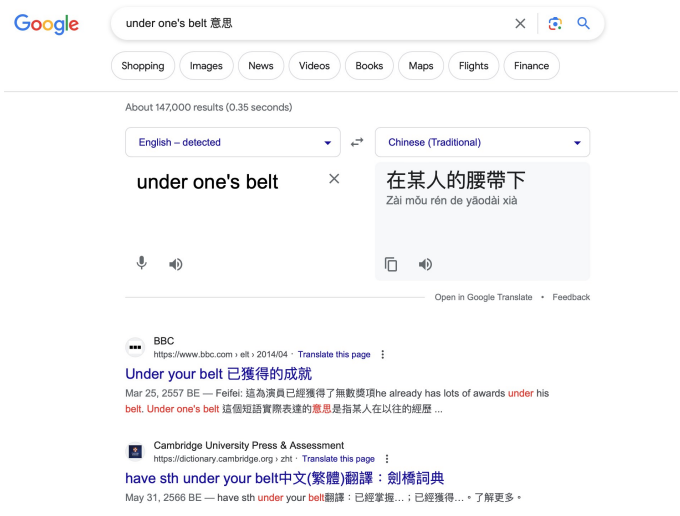
Dictionary

Definitions from Oxford Languages · Learn more

under one's belt

phrase of belt

1. safely or satisfactorily achieved, experienced, or acquired.
   "he now has almost a year as president under his belt"
2. (of food or drink) consumed.
   "Gus already had a large brandy under his belt"

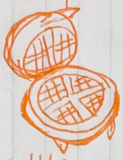


5:00 a.m.

= crop up

online reading class

2:00 p.m.

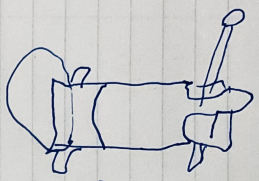


I love it

I loathe it.

waffle maker

7:00 pm



Pilates

FLESH

OUT

Getting up early is not an excute to not sign up for Eric's course.

dessert making skills are a good thing to have under my belt.

There were some goings-on during my waffle making process.

- I Pontificate with my tutor a bit, but I fall short.
- I say your legging agrees with you. It goes with you perfectly.
- ~~I was two~~ I am two days into it, So it is a tall order.

剪影 20:34

Static dynamic

Jing 20:35

It reminds me about cooking Chinese food abroad: you strickly follow the "authentic recipe", then you will hit walls all the time because you don't get all tl original ingredients as what you can find back in China. Better to follow the big direction of this cookin map, but not 100% the same. Adjust according to your reality, what you can find and wha are more at hand. The purpose is to make the dish as delious as you can.

check the grammar and revise if necessary: It reminds me about cooking Chinese food abroad: if you strickly follow the "authentic recipe", then you will hit walls all the time because you don't get all the original ingredients as what you can find back in China. Better to follow the big direction of this cookin map, but not 100% the same. Adjust according to your reality, what you can find and what are more at hand. The purpose is to make the dish as delious as you can.

Here's the revised version of the text:

"It reminds me of cooking Chinese food abroad: if you strictly follow the 'authentic recipe,' you will constantly hit walls because you won't have access to all the original ingredients found in China. It's better to follow the general direction provided by the cooking map, but not necessarily replicate it 100%. Adjust it according to your reality, based on what you can find and what is more readily available. The purpose is to make the dish as delicious as possible."

名字

Eric老师午好 今天预习版什么时候发呢 中午休息时间想看看

你的客服 Eric

我准备好了就会发出，也可能不会发，这不是我承诺会做的事情。大家要自己预习，去看电子版的资料就好了。

周一把整个预习材料看了一遍，不难，就是用的时间长😂

你的客服 Eric

英文阅读的第一性原理

说点大实话，讲个小道理

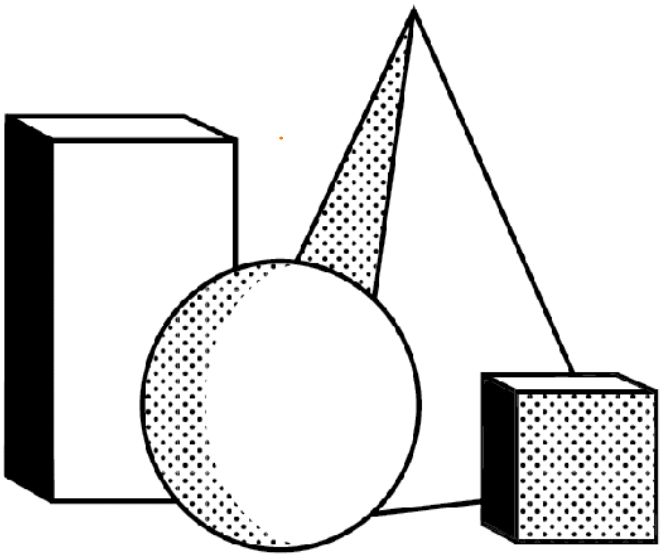
英语学习笔记

13:06

你的客服 Eric

一个学以致用：借用昨天的 The Circle of Competence，说明读英文这件事情还没有到你的 circle 里，在这上面的积累和训练还不够，整体还是一个 Stranger。如果想要 build 这个 circle，那就去添砖加瓦，把评判比较的注意力放在建造上🫨

First Principles Thinking

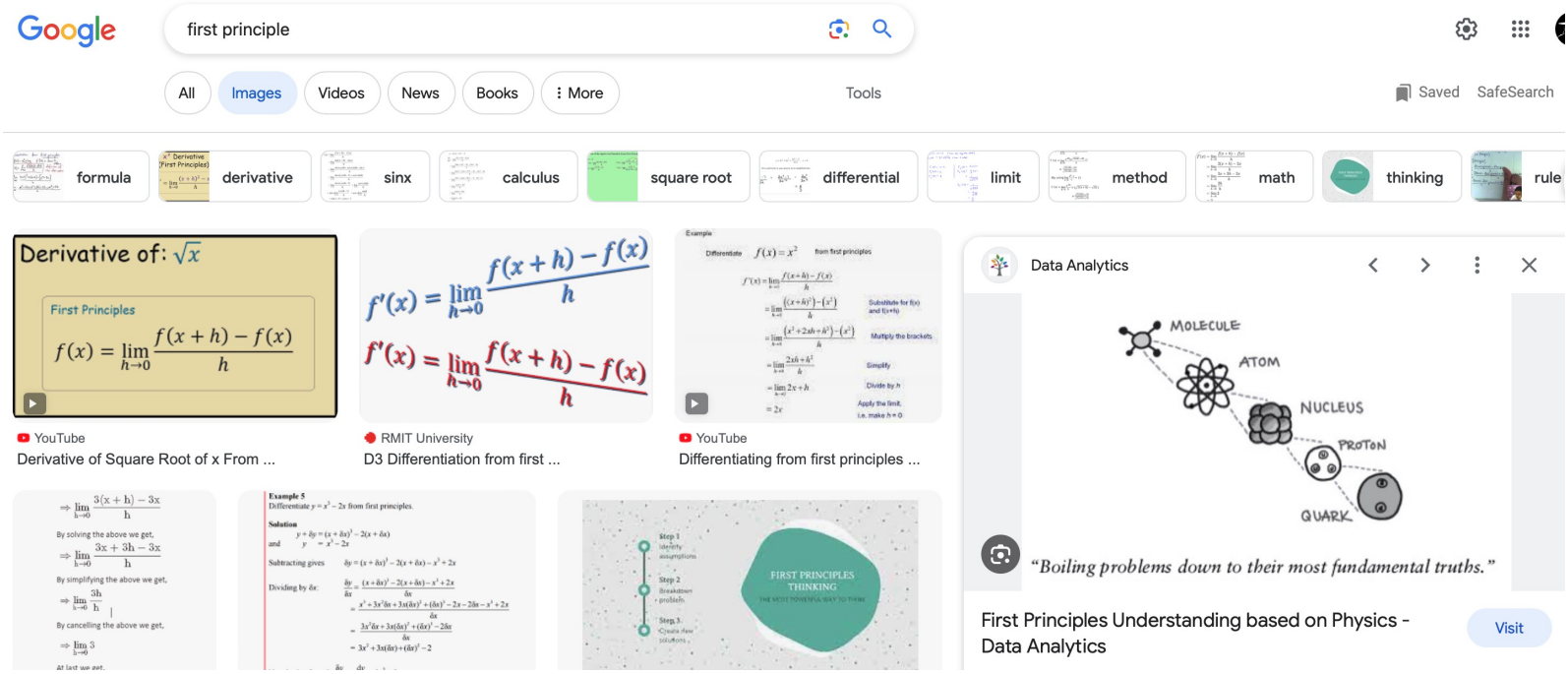


–
Go back to basics.

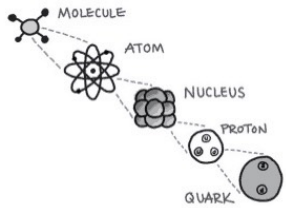
张海露 Eric🎺

今晚的课讲First Principles Thinking，想到之前写的这篇，当初只是搜了下第一性原理的基本定义就起了这样一个标题。

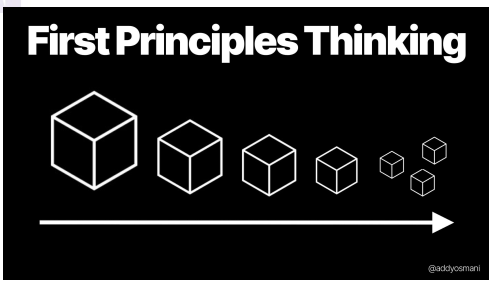
英文阅读的第一性原理

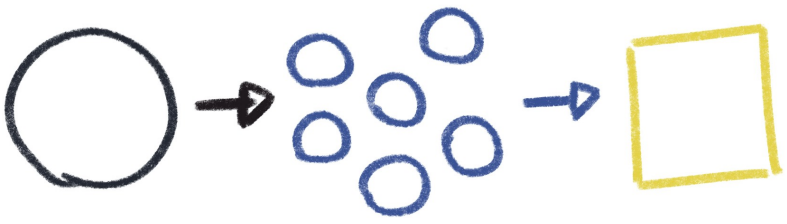


First Principles Thinking



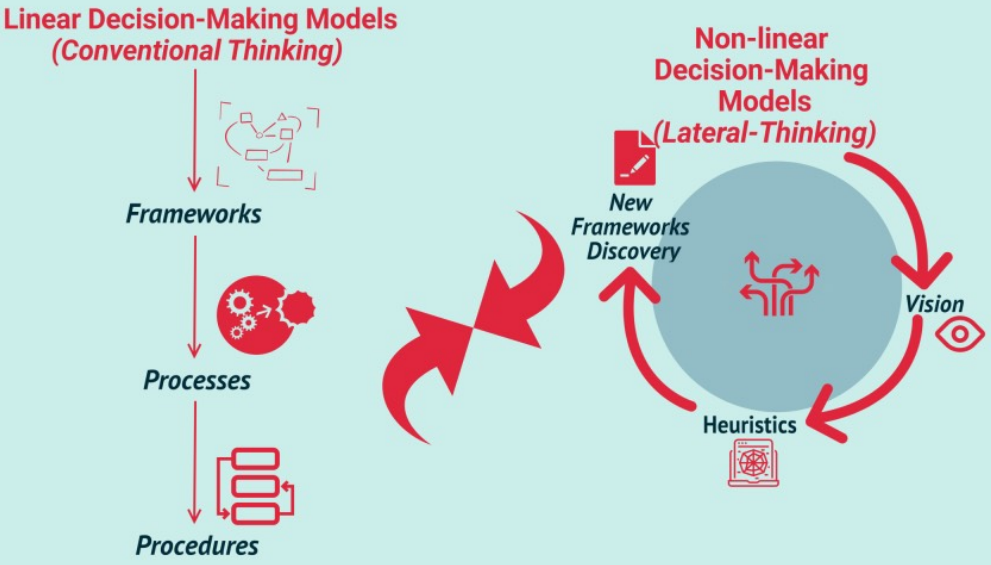
"Boiling problems down to their most fundamental truths."





What is Critical Thinking?

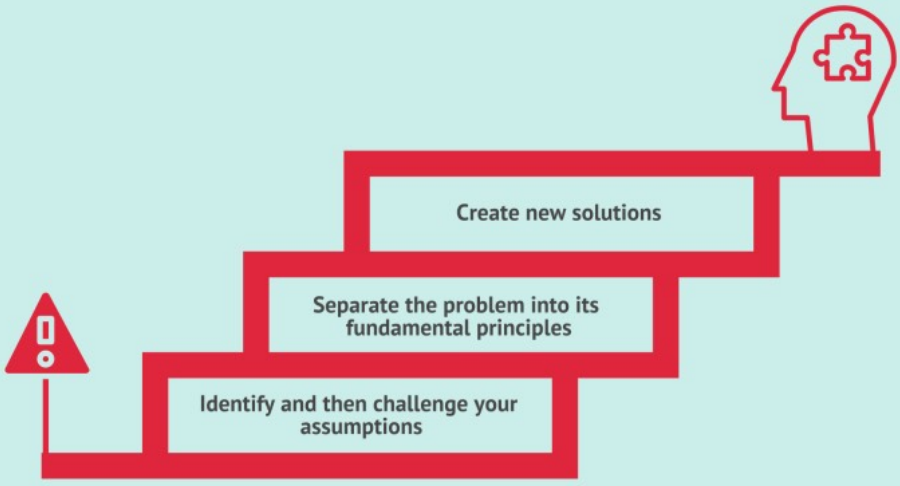
Critical thinking involves analyzing observations, facts, evidence, and arguments to form a judgment about what someone reads, hears, says, or writes.



FourWeekMBA

First-principles Thinking In A Nutshell

First-principles thinking – sometimes called reasoning from first principles – is used to reverse-engineer complex problems and encourage creativity. It involves breaking down problems into basic elements and reassembling them from the ground up. Elon Musk is among the strongest proponents of this way of thinking.

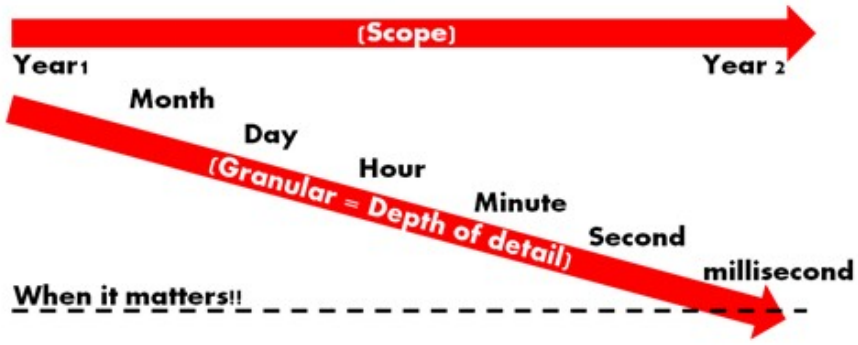


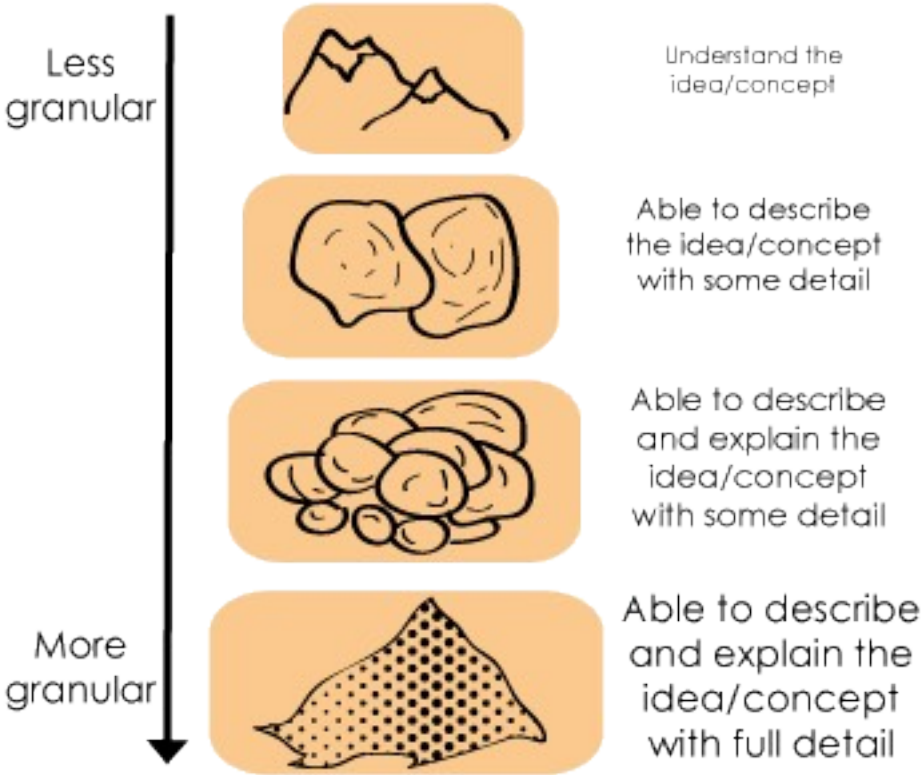
FourWeekMBA

'GRANULARITY'

The opposite of high-level thinking.
This level of thinking is only attainable by the deepest of thinkers

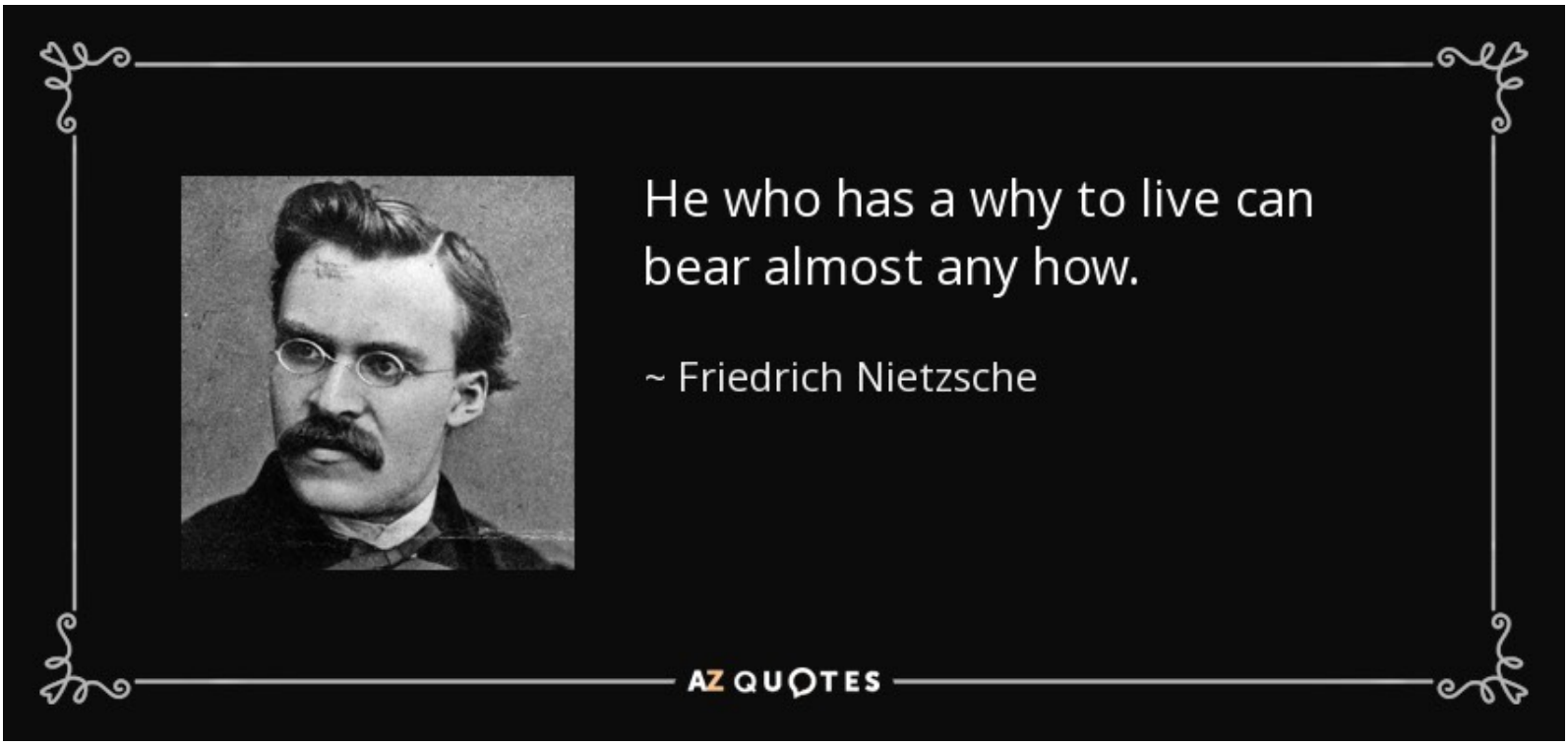
"Specific" is concerned with *scope* whereas "Granular" is concerned with *depth*, or *level* of detail.

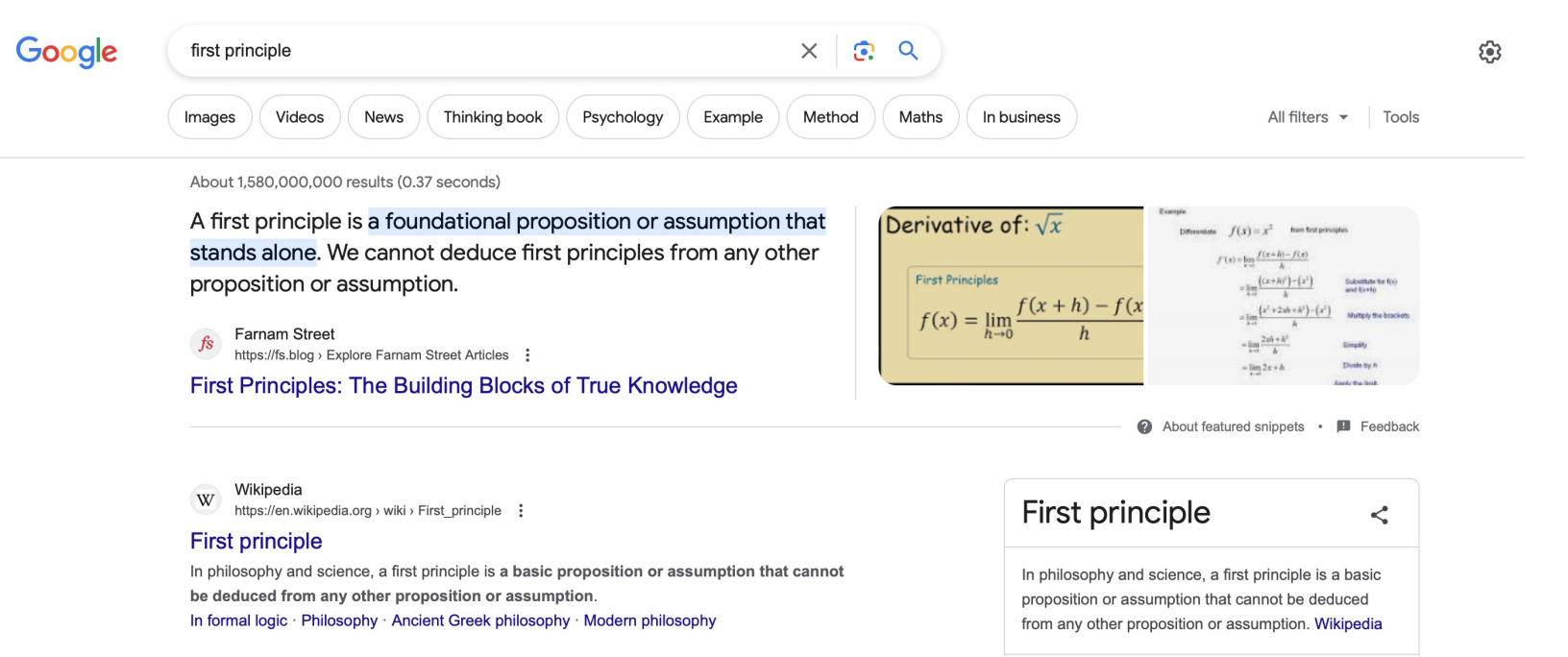




I don’t know what’s the matter with people: they don’t learn by understanding; they learn by some other way— by rote or something. Their knowledge is so fragile!

Richard Feynman [1]





Examples of First Principles in Action

So we can better understand how first-principles reasoning works, let's look at four examples.

Elon Musk and SpaceX

Perhaps no one embodies first-principles thinking more than Elon Musk. He is one of the most audacious entrepreneurs the world has ever seen. My kids (grades 3 and 2) refer to him as a real-life Tony Stark, thereby conveniently providing a good time for me to remind them that by fourth grade, Musk was reading the Encyclopedia Britannica and not Pokemon.

What's most interesting about Musk is not what he thinks but how he thinks:

own ignorance, we resort to self-defense.

I remember being in meetings and asking people why we were doing something this way or why they thought something was true. At first, there was a mild tolerance for this approach. After three "whys," though, you often find yourself on the other end of some version of "we can take this offline."

Can you imagine how that would play out with Elon Musk? Richard Feynman? Charlie Munger? Musk would build a billion-dollar business to prove you wrong, Feynman would think you're an idiot, and Munger would profit based on your inability to think through a problem.

> *"Science is a way of thinking much more than it is a body of knowledge."*
>
> *— Carl Sagannone*

Examples of First Principles in Action

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What's most interesting about Musk is not what he thinks but how he thinks:

> *I think people's thinking process is too bound by convention or analogy to prior experiences. It's rare that people try to think of something on a first principles basis. They'll say, "We'll do that because it's always*

> *been done that way." Or they'll not do it because "Well, nobody's ever done that, so it must not be good. But that's just a ridiculous way to think. You have to build up the reasoning from the ground up—"from the first principles" is the phrase that's used in physics. You look at the fundamentals and construct your reasoning from that, and then you see if you have a conclusion that works or doesn't work, and it may or may not be different from what people have done in the past.*[4]

His approach to understanding reality is to start with what is true — not with his intuition. The problem is that we don't know as much as we think we do, so our intuition isn't very good. We trick ourselves into thinking we know what's possible and what's not. The way Musk thinks is much different.

→ Musk starts out with something he wants to achieve, like building a rocket. Then he starts

with the first principles of the problem. Running through how Musk would think, Larry Page said in an

interview, “What are the physics of it? How much time will it take? How much will it cost? How much cheaper can I make it? There’s this level of engineering and physics that you need to make judgments about what’s possible and interesting. Elon is unusual in that he knows that, and he also knows business and organization and leadership and governmental issues.”[5]

Rockets are absurdly expensive, which is a problem because Musk wants to send people to Mars. And to send people to Mars, you need cheaper rockets. So he asked himself, “What is a rocket made of? Aerospace-grade aluminum alloys, plus some titanium, copper, and carbon fiber. And … what is the value of those materials on the commodity market? It turned out that the materials cost of a rocket was around two

percent of the typical price."[6]

Why, then, is it so expensive to get a rocket into space? Musk, a notorious self-learner with degrees in both economics and physics, literally taught himself rocket science. He figured that the only reason getting a rocket into space is so expensive is that people are stuck in a mindset that doesn't hold up to first principles. With that, Musk decided to create SpaceX and see if he could build rockets himself from the ground up.

In an interview with Kevin Rose, Musk summarized his approach:

> *I think it's important to reason from first principles rather than by analogy. So the normal way we conduct our lives is, we reason by analogy. We are doing this because it's like something else that was done, or it is like what other people are doing... with slight iterations on a theme. And it's ... mentally easier to reason by analogy*

> *rather than from first principles. First principles is kind of a physics way of looking at the world, and what that really means is, you … boil things down to the most fundamental truths and say, "okay, what are we sure is true?" … and then reason up from there. That takes a lot more mental energy.*[7]

Musk then gave an example of how Space X uses first principles to innovate at low prices:

> *Somebody could say — and in fact people do — that battery packs are really expensive and that's just the way they will always be because that's the way they have been in the past. … Well, no, that's pretty dumb… Because if you applied that reasoning to anything new, then you wouldn't be able to ever get to that new thing…. you can't say, … "oh, nobody wants a car because horses are great, and we're used to them and they can eat grass and there's lots of grass all over the place and … there's no gasoline that*

> *people can buy....”*

He then gives a fascinating example about battery packs:

> *... they would say, “historically, it costs $600 per kilowatt-hour. And so it’s not going to be much better than that in the future. ... So the first principles would be, ... what are the material constituents of the batteries? What is the spot market value of the material constituents? ... It’s got cobalt, nickel, aluminum, carbon, and some polymers for separation, and a steel can. So break that down on a material basis; if we bought that on a London Metal Exchange, what would each of these things cost? Oh, jeez, it’s ... $80 per kilowatt-hour. So, clearly, you just need to think of clever ways to take those materials and combine them into the shape of a battery cell, and you can have batteries that are much, much cheaper than anyone realizes.*

First Principles Thinking

First principles thinking is one of the best ways to reverse-engineer complicated situations and unleash creative possibility. Sometimes called reasoning from first principles, it's a tool to help clarify complicated problems by separating the underlying ideas or facts from any assumptions based on them. What remain are the essentials. If you know the first principles of something, you can build the rest of your knowledge around them to produce something new.

The idea of building knowledge from first principles has a long tradition in philosophy. In the Western canon it goes back to Plato and Socrates, with significant contributions from Aristotle and Descartes. Essentially, they were looking for the foundational knowledge that would not change and that we could build everything else on, from our ethical systems to our social structures.

First principles thinking doesn't have to be quite so grand. When we do it, we aren't necessarily looking for absolute truths. Millennia of epistemological inquiry have shown us that these are hard to come by, and the scientific method has demonstrated that knowledge can only be built when we are actively trying to falsify it (*see* Supporting Idea: Falsifiability). Rather, first principles thinking identifies the elements that are, in the context of any given situation, non-reducible.

First principles do not provide a checklist of things that will always be true; our knowledge of first principles changes as we understand more. They are the foundation on which we must build, and thus will be different in every situation, but the more we know, the more we can challenge. For example, if we are considering how to improve the energy efficiency of a refrigerator, then the laws of thermodynamics can be taken as first principles. However, a theoretical chemist or physicist might want to explore entropy, and thus further break the second law into its underlying

how about: : If you strictly follow the 'authentic recipe,' you will constantly hit walls because the original ingredients found in China are hard to come by elsewhere.

If you stick to the "authentic recipe" too closely, you'll be banging your head against the wall because those original Chinese ingredients are like rare unicorns outside of China.

rephrase my original sentence and include the phrase "come by"

If you rigidly follow the 'authentic recipe,' you'll be hitting walls left and right because it's hard to come by all the original ingredients found in China.

again

If you stubbornly insist on strictly following the 'authentic recipe,' get ready to hit walls left, right, and center because finding those original Chinese ingredients is like trying to catch a shooting star - incredibly hard to come by.

principles and the assumptions that were made because of them. First principles are the boundaries that we have to work within in any given situation— so when it comes to thermodynamics an appliance maker might have different first principles than a physicist.

Techniques for establishing first principles

If we never learn to take something apart, test our assumptions about it, and reconstruct it, we end up bound by what other people tell us— trapped in the way things have always been done. When the environment changes, we just continue as if things were the same, making costly mistakes along the way.

Some of us are naturally skeptical of what we're told. Maybe it doesn't match up to our experiences. Maybe it's something that used to be true but isn't true anymore. And maybe we just think very differently about something. When it comes down to it, everything that is not a law of nature is just a shared belief. Money is a shared belief. So is a border. So are bitcoin. So is love. The list goes on.

If we want to identify the principles in a situation to cut through the dogma and the shared belief, there are two techniques we can use: Socratic questioning and the Five Whys.

Socratic questioning can be used to establish first principles through stringent analysis. This is a disciplined questioning process, used to establish truths, reveal underlying assumptions, and separate knowledge from ignorance. The key distinction between Socratic questioning and ordinary discussions is that the former seeks to draw out first principles in a systematic manner. Socratic questioning generally follows this process:

1. Clarifying your thinking and explaining the origins of your ideas. (Why do I think this? What exactly do I think?)
2. Challenging assumptions. (How do I know this is true? What if I thought the opposite?)

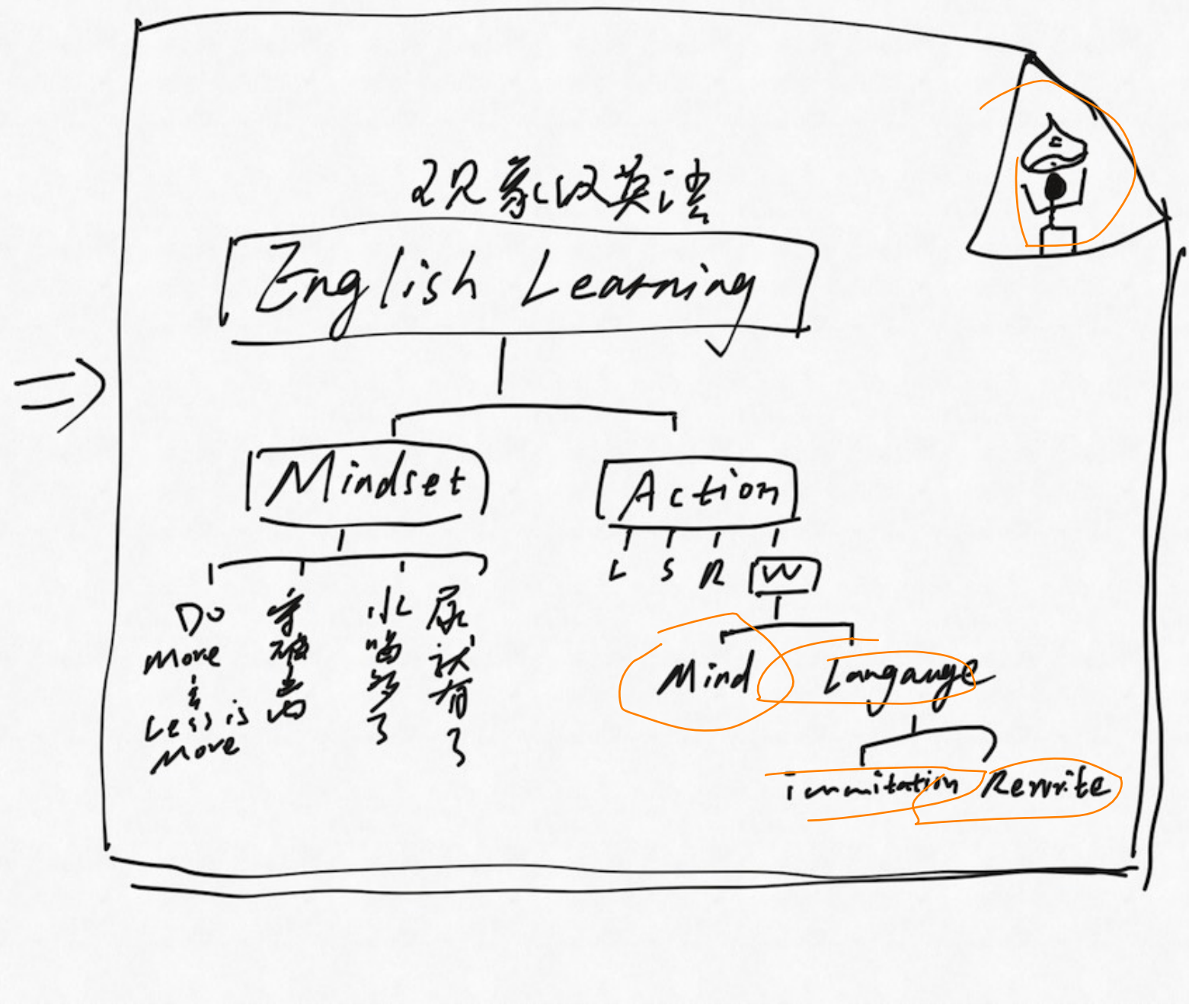
3. Looking for evidence. (How can I back this up? What are the sources?)
4. Considering alternative perspectives. (What might others think? How do I know I am correct?)
5. Examining consequences and implications. (What if I am wrong? What are the consequences if I am?)
6. Questioning the original questions. (Why did I think that? Was I correct? What conclusions can I draw from the reasoning process?)

Socratic questioning stops you from relying on your gut and limits strong emotional responses. This process helps you build something that lasts.

The Five Whys is a method rooted in the behavior of children. Children instinctively think in first principles. Just like us, they want to understand what's happening in the world. To do so, they intuitively break through the fog with a game some parents have come to dread, but which is exceptionally useful for identifying first principles: repeatedly asking "why?"

The goal of the Five Whys is to land on a "what" or "how". It is not about introspection, such as "Why do I feel like this?" Rather, it is about systematically delving further into a statement or concept so that you can separate reliable knowledge from assumption. If your "whys" result in a statement of falsifiable fact, you have hit a first principle. If they end up with a "because I said so" or "it just is", you know you have landed on an assumption that may be based on popular opinion, cultural myth, or dogma. These are not first principles.

There is no doubt that both of these methods slow us down in the short term. We have to pause, think, and research. They seem to get in the way of what we want to accomplish. And after we do them a couple of times we realize that after one or two questions, we are often lost. We actually don't know how to answer most of the questions. But when we are confronted with our own ignorance, we can't just give up or resort to self-


2只象以英语
English Learning
Mindset
Action
L S R W
Do More is Less is More
Mind
Langauge
Imitation
Rewrite

defense. If we do, we will never identify the first principles we have to work with, and will instead make mistakes that will slow us down in the long term.

> «Science is much more than a body of knowledge. It is a way of thinking.»
>
> Carl Sagan [2]

First principles thinking as a way to blow past inaccurate assumptions

The discovery that a bacterium, not stress, actually caused the majority of stomach ulcers is a great example of what can be accomplished when we push past assumptions to get at first principles. Since the discovery of bacteria, scientists thought that bacteria could not grow in the stomach on account of the acidity. If you had surveyed both doctors and medical research scientists in the 60s or 70s, they likely would have postulated this as a first principle. When a patient came in complaining of stomach pain, no one ever looked for a bacterial cause.

It turned out, however, that a sterile stomach was not a first principle. It was an assumption. As Kevin Ashton writes in his book on creativity, discovery, and invention, "the dogma of the sterile stomach said that bacteria could not live in the gut." [3] Because this dogma was taken as truth, for a long time no one ever looked for reasons that it could be false.

That changed for good with the discovery of the *H. pylori* bacteria and its role in stomach ulcers. When pathologist Robin Warren started seeing bacteria in samples from patients' stomachs, he realized that stomachs were not, in fact, sterile. He started collaborating with Barry Marshall, a gastroenterologist, and together they started seeing bacteria in loads of stomachs. If the sterile stomach wasn't a first principle, then, when it came to stomachs, what was?

Marshall, in an interview with *Discover*, recounts that Warren gave him a list of 20 patients identified as possibly having cancer, but when he had looked he had found the same bacteria in all of them instead. He said, "Why don't you look at their case records and see if they've got anything wrong with them." Since they now knew stomachs weren't sterile, they could question all the associated dogma about stomach disease and use some Socratic-type questioning to work to identify the first principles at play. They spent years challenging their related assumptions, clarifying their thinking, and looking for evidence.[4]

Their story ultimately has a happy ending— Marshall and Warren were awarded the Nobel Prize in 2005, and now stomach ulcers are regularly treated effectively with antibiotics, improving and saving the lives of millions of people. But many practitioners and scientists rejected their findings for decades. The dogma of the sterile stomach was so entrenched as a first principle, that it was hard to admit that it rested on some incorrect assumptions which ultimately ended with the explanation, "because that's just the way it is". Even though, as Ashton notes, "*H. pylori* has now been found in medical literature dating back to 1875," it was Warren and Marshall who were able to show that "because I said so" wasn't enough to count the sterile stomach as a first principle.

Incremental innovation and paradigm shifts

To improve something, we need to understand why it is successful or not. Otherwise, we are just copying thoughts or behaviors without understanding why they worked. First principles thinking helps us avoid the problem of relying on someone else's tactics without understanding the rationale behind them. Even incremental improvement is harder to achieve if we can't identify the first principles.

Temple Grandin is famous for a couple of reasons. One, she is autistic, and was one of the first people to publicly disclose this fact and

give insight into the inner workings of one type of autistic mind. Second, she is a scientist who has developed many techniques to improve the welfare of animals in the livestock industry.

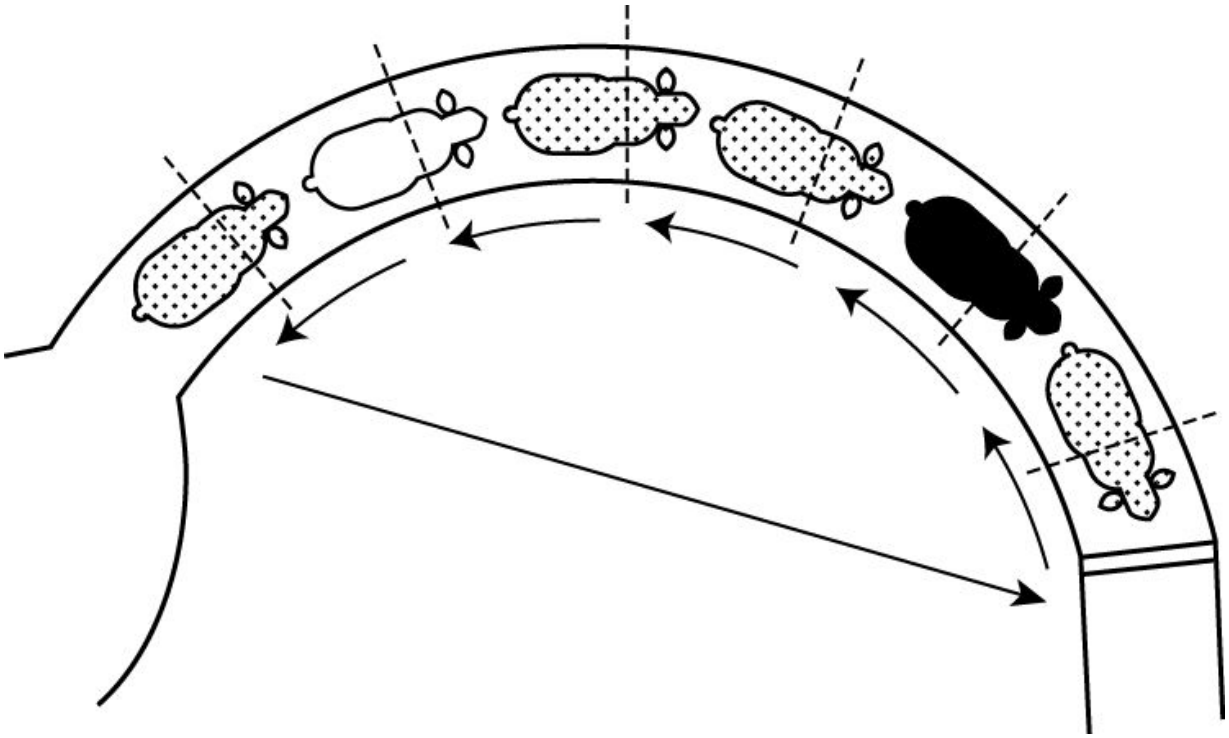
One of the approaches she pioneered was the curved cattle chute. Previous to her experiments, cattle were put in a straight chute. Curved chutes, on the other hand, "are more efficient for handling cattle because they take advantage of the natural behavior of cattle. Cattle move through curved races more easily because they have a natural tendency to go back to where they came from."[5] Of course, science doesn't stop with one innovation, and animal scientists continue to study the best way to treat livestock animals.

Stockmanship Journal presented research that questioned the efficiency of Grandin's curved chute. It demonstrated that sometimes the much more simple straight chute would achieve the same effect in terms of cattle movement. The journal sought out Grandin's response, and it is invaluable for teaching us the necessity of first principles thinking.

Grandin explains that curved chutes are not a first principle. She designed them as a tactic to address the first principle of animal handling that she identified in her research— essentially that reducing stress to the animals is the single most important aspect and affects everything from conception rates to weight to immune systems. When designing a livestock environment, a straight chute could work as long as it is part of a system that reduces stress to the animals. You can change the tactics if you know the principles.[6]

Sometimes we don't want to fine-tune what is already there. We are skeptical, or curious, and are not interested in accepting what already exists as our starting point. So when we start with the idea that the way things are might not be the way they have to be, we put ourselves in the right frame of mind to identify first principles. The real power of first principles thinking is moving away from random change and into choices that have a real

possibility of success.



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Curved cattle chutes improve animal welfare by working with the natural behavior of the animals.

Starting in the 1970s, scientists began to ask: what are the first principles of meat? The answers generally include taste, texture, smell, and use in cooking. Do you know what is not a first principle of meat? Once being a part of an animal. Perhaps most important to consumers is the taste. Less important is whether it was actually once part of a cow.

Researchers then looked at why meat tastes like meat. Part of the answer is a chemical reaction between sugars and amino acids during cooking, known as the Maillard reaction. This is what gives meat its flavor and smell. By replicating this exact reaction, scientists expect to be able to replicate the first principles of meat: taste and scent. In doing so they will

largely eliminate the need to raise animals for consumption.

Instead of looking for ways to improve existing constructs, like mitigating the environmental impacts of the livestock industry, around 30 laboratories worldwide are now developing the means to grow artificial meat. This lab-grown meat is close to having the constituent parts of meat. One food researcher described the product this way:

> *There is really a bite to it, there is quite some flavor with the browning. I know there is no fat in it so I didn't really know how juicy it would be, but there is … some intense taste; it's close to meat, it's not that juicy, but the consistency is perfect.… This is meat to me…it's really something to bite on and I think the look is quite similar.*[7]

This quote illustrates how artificial meat combines the core properties of meat to form a viable replacement, thereby addressing some significant environmental and ethical concerns.

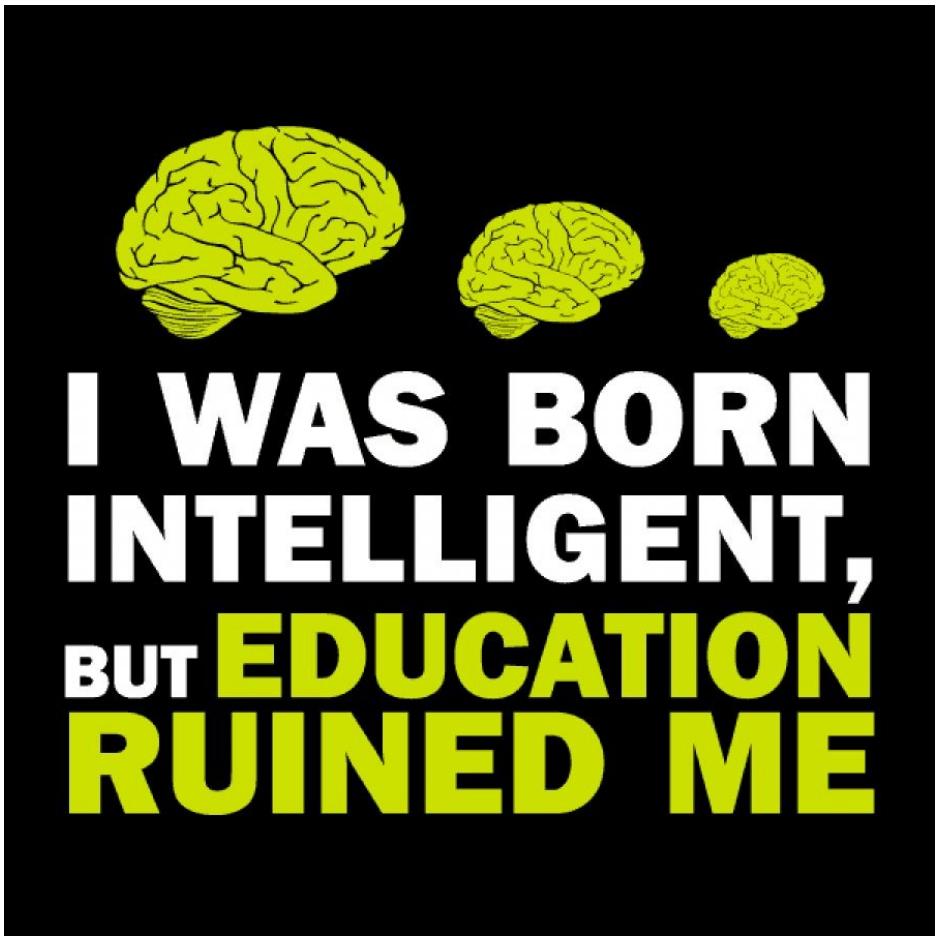
«As to methods, there may be a million and then some, but principles are few. The man who grasps principles can successfully select his own methods. The man who tries methods, ignoring principles, is sure to have trouble.»

Harrington Emerson[8]

Conclusion

Reasoning from first principles allows us to step outside of history and conventional wisdom and see what is possible. When you really understand the principles at work, you can decide if the existing methods make sense. Often they don't.

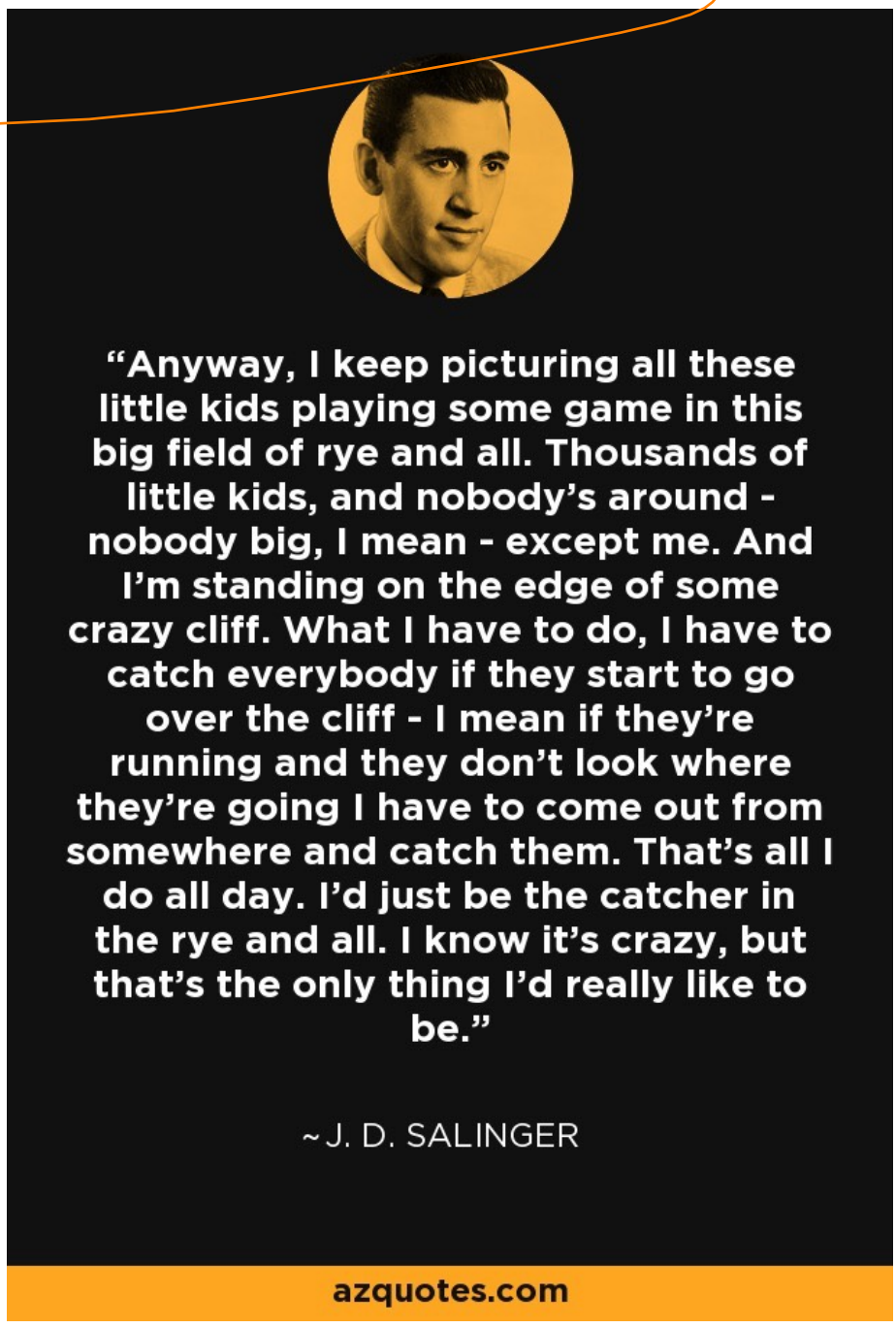
Many people mistakenly believe that creativity is something that only some of us are born with, and either we have it or we don't. Fortunately, there seems to be ample evidence that this isn't true. We're all born rather creative, but during our formative years, it can be beaten out of us by busy parents and teachers. As adults, we rely on convention and what we're told because that's easier than breaking things down into first principles and thinking for yourself. Thinking through first principles is a way of taking off the blinders. Most things suddenly seem more possible.

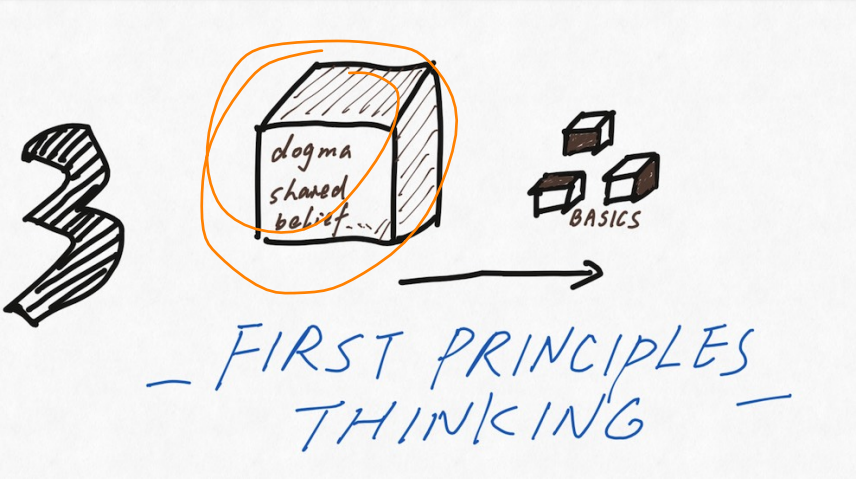


un-
learn

一切学习的最终目的是提升自学能力。
英语是工具，幸福是目的。
英语是一件小事，更重要的是认识自己。
学语言的本质是你选择想成为什么样的人。
读书，顺便学英语。
Start with why.

Principles Vs. Tactics

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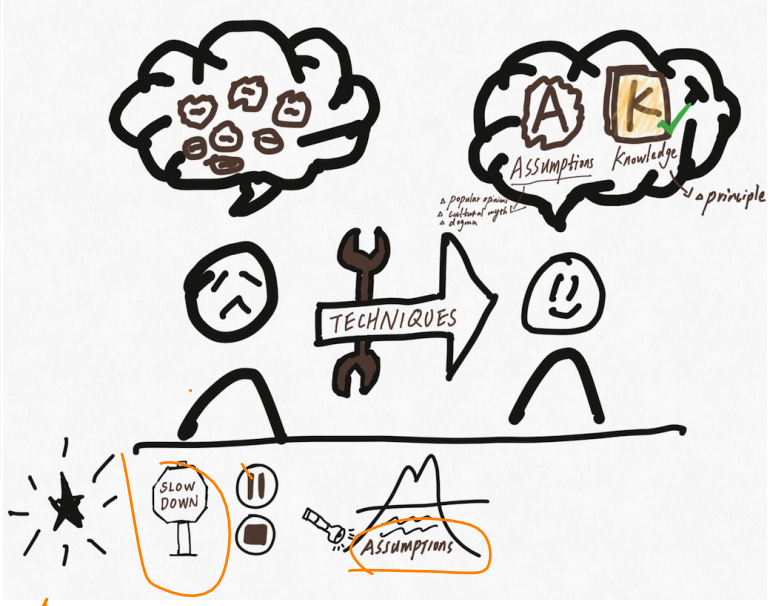
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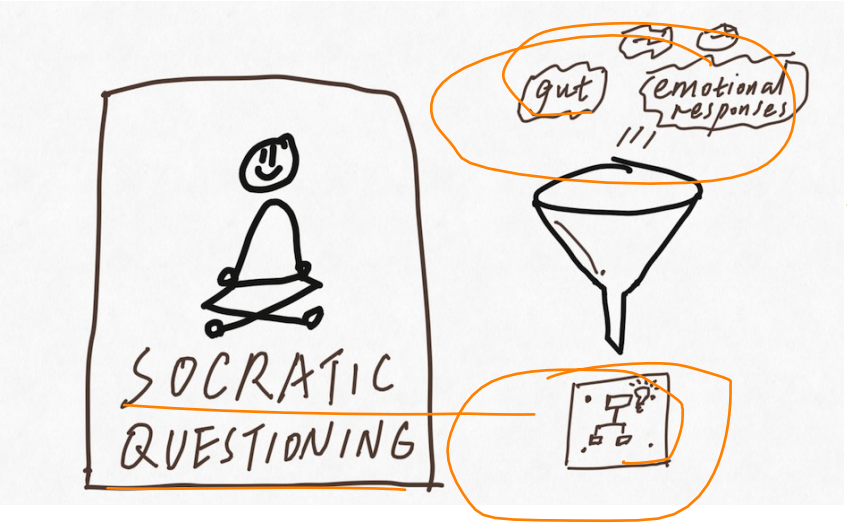
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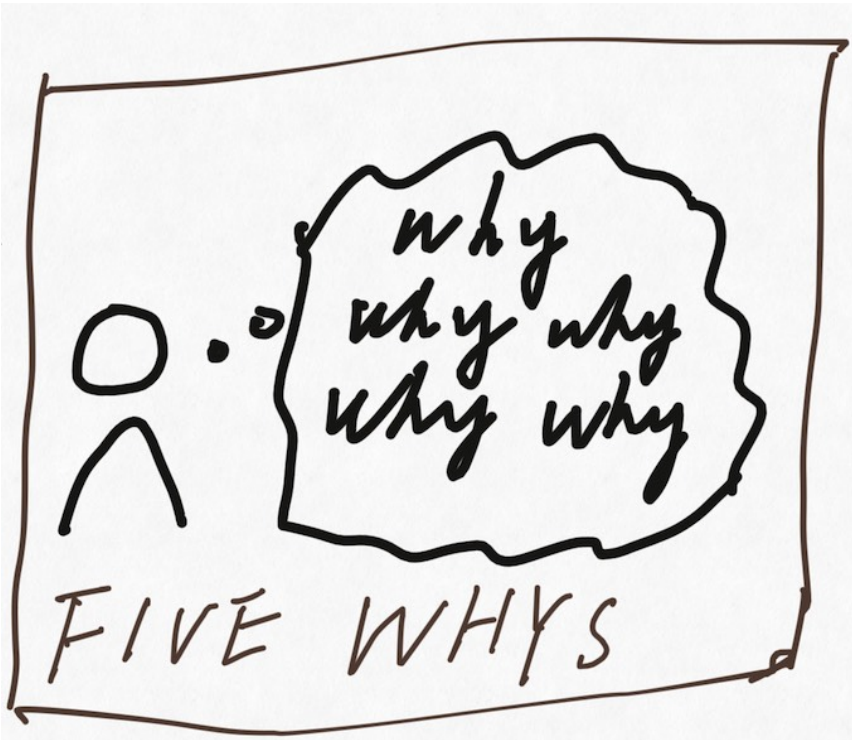
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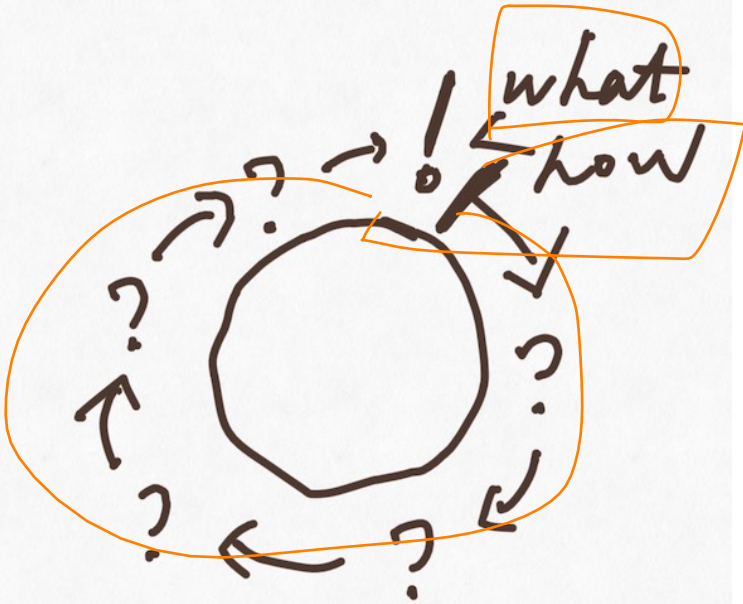
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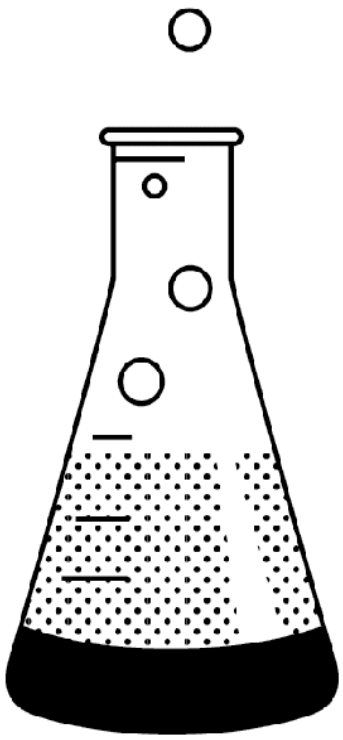
Thought Experiment



–
Imagine the possibilities.

Creativity is intelligence having fun.

Anonymous

The People Who Appear in this Chapter

Rawls, John.
1921-2002 - American moral and political philosopher. His work theorized "Justice and fairness" and remains integral to discussions of political philosophy.

Thought Experiment

Thought experiments can be defined as "devices of the imagination used to investigate the nature of things."[1] Many disciplines, such as philosophy and physics, make use of thought experiments to examine what can be known. In doing so, they can open up new avenues for inquiry and exploration. Thought experiments are powerful because they help us learn from our mistakes and avoid future ones. They let us take on the impossible, evaluate the potential consequences of our actions, and re-examine history to make better decisions. They can help us both figure out what we really want, and the best way to get there.

Betting on basketball

Suppose I asked you to tell me who would win in a game of basketball: The NBA champion LeBron James or the filmmaker Woody Allen? How much would you bet that your answer was correct?

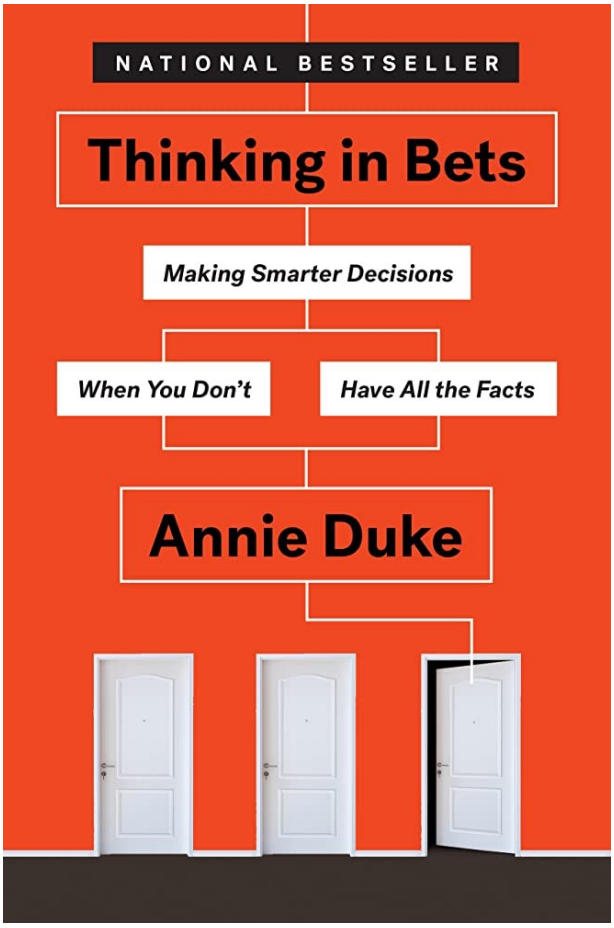
I think you'd get me an answer pretty quickly, and I hope you'd bet all you had.

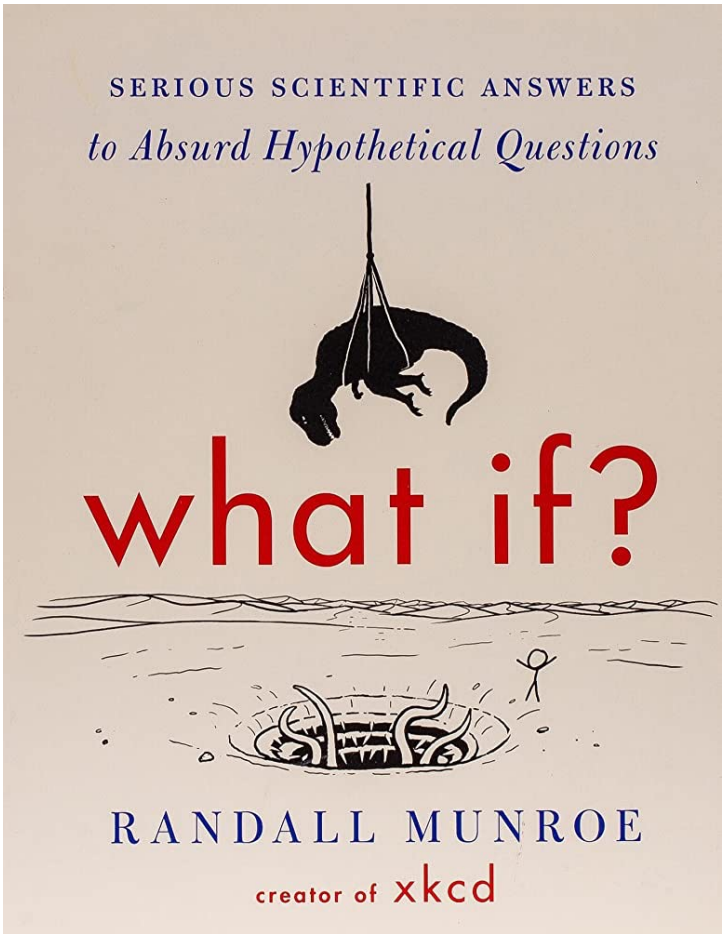
Next, suppose I asked you to tell me who'd win in a game of basketball: The NBA champion LeBron James or the NBA champion Kevin Durant? How much would you bet that your answer was correct?

A little harder, right? Would you bet anywhere near all you had on being right?

Let's think this through. You attempted to solve both of the questions in the same way— you imagined the contests. Perhaps more importantly, you *didn't* attempt to solve either of them by calling up Messrs. James, Allen, and Durant and inviting them over for an afternoon of basketball. You simply simulated them in your mind.

In the first case, your knowledge of James (young, tall, athletic, and skilled), Allen (old, small, frail, and funny), and the game of basketball


NATIONAL BESTSELLER
Thinking in Bets
Making Smarter Decisions
When You Don't
Have All the Facts
Annie Duke


SERIOUS SCIENTIFIC ANSWERS
to Absurd Hypothetical Questions
what if?
RANDALL MUNROE
creator of xkcd

gave you a clear mental image. The disparity between the players' abilities makes the question (and the bet) a total no-brainer.

In the second case, your knowledge of LeBron and Durant may well be extensive, but that doesn't make it an easy bet. They're both professional basketball players who are quite similar in size and ability, and both of them are likely to go down as among the best ever to play the game. It's doubtful that one is *much* better than the other in a one-on-one match. The only way to answer for sure would be to see them play. And even then, a one-off contest is not going to be definitive.

A better way to answer the "who would win" question is through a remarkable ability of the human brain— the ability to conduct a detailed thought experiment. Its chief value is that it lets us do things in our heads we cannot do in real life, and so explore situations from more angles than we can physically examine and test for.

Thought experiments are more than daydreaming. They require the same rigor as a traditional experiment in order to be useful. Much like the scientific method, a thought experiment generally has the following steps:

1. Ask a question
2. Conduct background research
3. Construct hypothesis
4. Test with (thought) experiments
5. Analyze outcomes and draw conclusions
6. Compare to hypothesis and adjust accordingly (new question, etc.)

In the James/Allen experiment above, we started with a question: Who would win in a game of basketball? If you didn't already know who those people were, finding out would have been a necessary piece of background research. Then you came out with your hypothesis (James all the way!), and you thought it through.

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Who would win in a game of one-on-one?

One of the real powers of the thought experiment is that there is no limit to the number of times you can change a variable to see if it influences the outcome. In order to place that bet, you would want to estimate in how many possible basketball games does Woody Allen beat LeBron James. Out of 100,000 game scenarios, Allen probably only wins in the few where LeBron starts the game by having a deadly heart attack. Experimenting to discover the full spectrum of possible outcomes gives you a better appreciation for what you can influence and what you can reasonably expect to happen.

Let's now explore few areas in which thought experiments are tremendously useful.

1. Imagining physical impossibilities
2. Re-imagining history
3. Intuiting the non-intuitive

Imagining physical impossibilities: Albert Einstein was a great user of the thought experiment because it is a way to logically carry out a test in one's own head that would be very difficult or impossible to perform in real life. With this tool, we can solve problems with intuition and logic that cannot be demonstrated physically.

One of his notable thought experiments involved an elevator.[2] Imagine you were in a closed elevator, feet glued to the floor. Absent any other information, would you be able to know whether the elevator was in outer space with a string pulling the elevator upwards at an accelerating rate, or sitting on Earth, being pulled down by gravity? By running the thought experiment, Einstein concluded that you would not.

This led to the formulation of Einstein's second major theory, the general theory of relativity— his universal theory of gravity. Einstein's hypothesis was that the force you felt from acceleration and the force you

felt from gravity didn't just *feel* the same— they were the same! Gravity must work similarly to the accelerating elevator. We can't build elevators in space, but can still define some of the properties they would have if we could. This gives us enough information to test the hypothesis. Eventually, Einstein worked it all out mathematically and in great detail, but it started with a simple thought experiment, impossible to actually perform.

This type of thought experiment need not only apply to physics and is actually reflected in some of our common expressions. When we say "if money were no object" or "if you had all the time in the world," we are asking someone to conduct a thought experiment because actually removing that variable (money or time) is physically impossible. In reality, money is always an object, and we never have all the time in the world. But the act of detailing out the choices we would make in these alternate realities that have otherwise similar properties to our current one, doing the thought experiment, is what leads to insights regarding what we value in life and where to focus our energies. — *Sidebar: The Trolley Experiment*

Re-imagining history: A familiar use of the thought experiment is to re-imagine history. This one we all use, all the time. What if I hadn't been stuck at the airport bar where I met my future business partner? Would World War I have started if Gavrilo Princip hadn't shot the Archduke of Austria in Sarajevo? If Cleopatra hadn't found a way to meet Caesar, would she still have been able to take the throne of Egypt?

These approaches are called the *historical counter-factual and semi-factual*. If Y happened instead of X, what would the outcome have been? Would the outcome have been the same?

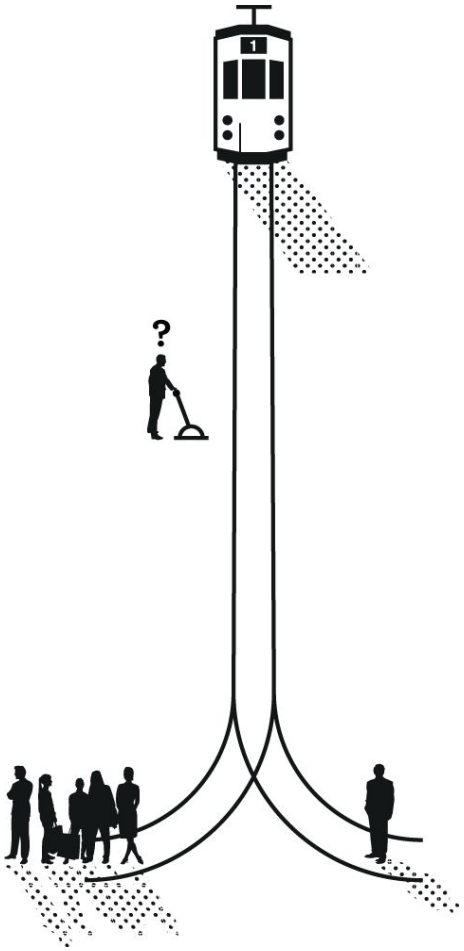
As popular— and generally useful— as counter- and semi-factuals are, they are also the areas of thought experiment with which we need to use the most caution. Why? Because history is what we call a chaotic system. A small change in the beginning conditions can cause a *very* different outcome down the line. This is where the rigor of the scientific

method is indispensable if we want to draw conclusions that are actually useful.

The Trolley Experiment

Thought experiments are often used to explore ethical and moral issues. When you are dealing with questions of life and death it is obviously not recommended to kill a bunch of people in order to determine the most ethical course of action. This then is where a thought experiment is also extremely valuable.

One of the most famous of this type is the trolley experiment. It goes like this: say you are the driver of a trolley that is out of control. You apply the brakes and nothing happens. Ahead of you are five people who will die should your trolley continue on the track. At the last moment you notice a spur that has one person on it. What do you do? Do you continue on and kill the five, or do you divert and kill the one?



This experiment was first proposed in modern form by Philippa Foot in her paper "The Problem of Abortion and the Doctrine of the Double Effect,"[3] and further considered extensively by Judith Jarvis Thomson in "The Trolley Problem."[4] In both cases the value of the thought experiment is clear. The authors were able to explore situations that would be physically impossible to reproduce without causing serious harm, and in so doing significantly advanced certain questions of morality. Moreover, the trolley problem remains relevant to this day as technological advances often ask us to define when it is acceptable, and even desirable, to sacrifice one to save many (and lest you think this is always the case, Thomson conducts another great thought experiment considering a doctor killing one patient to save

five through organ donation).

To understand it, let's think about another chaotic system we're all familiar with, the weather. Why is it that we can predict the movement of the stars but we can't predict the weather more than a few weeks out, and even that is not altogether reliable?

It's because weather is highly chaotic. Any infinitesimally small error in our calculations today will change the result down the line, as rapid feedback loops occur throughout time. Since our measurement tools are not infinitely accurate, and never will be, we are stuck with the unpredictability of chaotic systems.

And compared to human systems, one could say weather is pretty reliable stuff. As anyone who's seen *Back to the Future* knows, a small change in the past could have a massive, unpredictable effect on the future. Thus, running historical counter-factuals is an easy way to accidentally mislead yourself. We simply don't know what else would have occurred had Cleopatra not met Caesar or had you not been stuck at that airport. The potential outcomes are too chaotic.

But we can use thought experiments to *explore* unrealized outcomes — to re-run a process as many times as we like to see what could have occurred, and learn more about the limits we have to work with.

The truth is, the events that have happened in history are but one realization of the historical process— one possible outcome among a large variety of possible outcomes. They're like a deck of cards that has been dealt out only one time. All the things that didn't happen, but could have if some little thing went another way, are invisible to us. That is, until we use our brains to generate these theoretical worlds via thought experiments.

If we can also factor in the approximate probability of these occurrences, relative to the scope of possible ones, we can learn what the most likely outcomes are. Sometimes it is easy to imagine ten different

ways a situation could have played out differently, but more of a stretch to change the variables and still end up with the same thing.

So let's try it. First, we have to ask a question. What if Serbian Gavrilo Princip hadn't shot Austrian Archduke Franz Ferdinand? That single act has often been credited with launching World War I, so it is a question worth asking. If we conclude the assassination started a chain reaction for which war was the inevitable result, it would certainly tell us a lot about certain causal relationships in politics, diplomacy, and possibly human psychology.

Then we need to do our background research: What do we need to know to be able to answer this question? So we look into it— treaties, conflicts, alliances, interests, personalities— enough to be able to formulate an hypothesis.

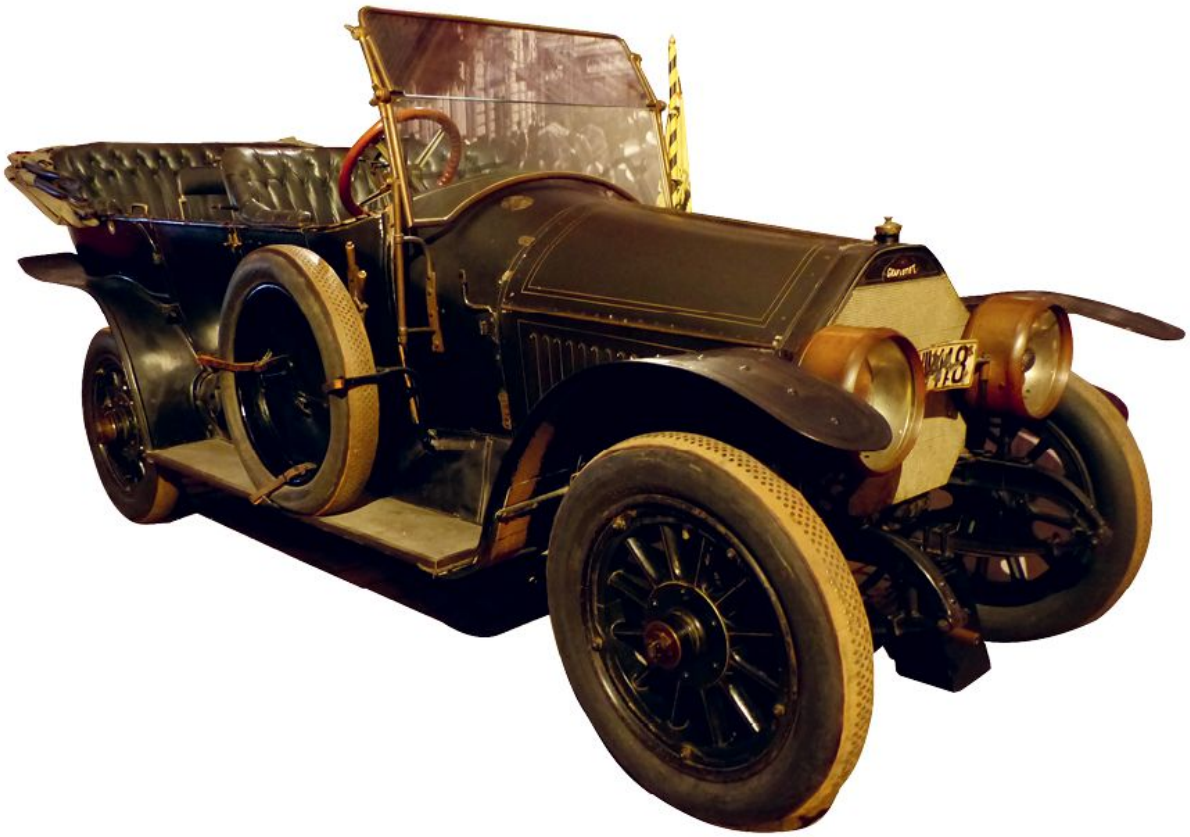
An immediate response to the assassination was on June 30, 1914, two days later. Austria changed its policy toward Serbia. Shortly after that Germany offered full military support to Austria, and less than two months later the world was at war. Thus, a next step in our thought experiment might be to refine the question. Something like, how did Princip's assassination of the Archduke influence Austrian policy toward Serbia?

Our hypothesis could be one of the following:

1. The assassination had no effect on the policy
2. The assassination had partial effect on the policy
3. The assassination had total effect on the policy

To test any one of these, we run the experiment in our heads. We sit back and think about what the world looked like in Sarajevo on June 28, 1914. The Archduke and his wife being chauffeured in their car, Gavrilo Princip cleaning his gun somewhere. Now we imagine Princip gets stomach cramps from some bad food the night before. The Archduke's car makes it to its destination while Princip is curled up in bed. The Archduke gives a speech,

emphasizing peace. One of Princip's gang tries to assassinate the Archduke, but fails. How does Austria react? Is it demonstrably different from what they actually did?



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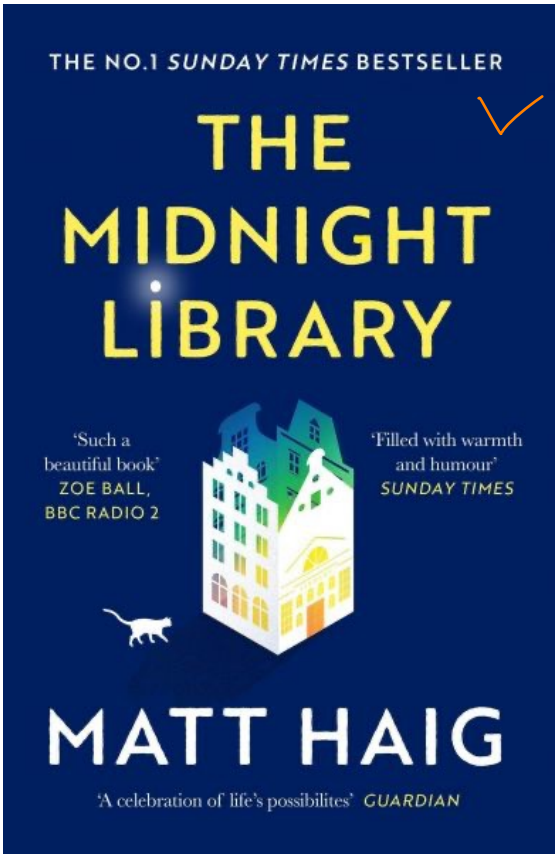
What we think of as an inevitable occurrence could have played out in many ways: Earlier on the day of the assassination, Archduke Ferdinand and his wife Sophie survived a grenade being detonated by their car. It was on the way to visit those injured, an unplanned change of schedule, that Princip got his opportunity.

Princip wasn't a lone wolf, and there was a lot of unrest in Serbia towards Austria. How could the situation be changed to lead to different

Austrian policy? Given the climate at the time, is our hypothetical situation realistic? Meaning, can you construct an historically accurate scenario in which no events come to pass that prompt Austria's policy change? How many Serbians would have to get the stomach flu?

One of the goals of a thought experiment like this is to understand the situation enough to identify the decisions and actions that had impact. This process doesn't provide definitive answers, such as whether the assassination did, or did not, cause World War I. What you are trying to get to is a rough idea of how much it may have contributed to starting the war. The more scenarios you can imagine where war comes to pass without the assassination, the weaker the case for it being the critical cause. Thus, by exploring the realistic relationships between events you can better understand the most likely effects of any one decision. — *Sidebar: Reduce the Role of Chance*

Intuiting the non-intuitive: One of the uses of thought experiments is to improve our ability to intuit the non-intuitive. In other words, a thought experiment allows us to verify if our natural intuition is correct by running experiments in our deliberate, conscious minds that make a point clear.



Reduce the Role of Chance

Let's try a real world example. Suppose you were to buy $100,000 of stock in Google, with 50% paid for in cash and 50% borrowed from the brokerage firm. (They call it a margin loan.)

A few years later, the stock price has doubled: That means your $100,000 is worth $200,000. Since you still owe the brokerage $50,000, your own $50,000 is now worth $150,000— you've tripled your money! You consider yourself a financial genius.

Before we land on that conclusion, though, let's run our Theoretical World Generator a bunch of times in our head. What else could have happened, but didn't?

Google could have gone down 50% before it went up 100%— nearly all stocks on the exchange have had this happen to them at some time or another. In fact, Google could have gone down 90%! The whole New York Stock Exchange did just that between 1929 and 1932.

What if something like that had happened? The brokerage would have called in your margin loan: Game over, thanks for playing. You would have been worth zero.

Now, return to the beginning of the chapter again. If you're going to buy Google on margin, is your bet that Google won't go down 50% more similar to the LeBron/Allen thought experiment, or the LeBron/Durant thought experiment? Running through the scenario 100,000 times, how many times do you go broke and how many times do you triple your dough?

should be fair. But what exactly does this mean? We can use this thought experiment to test the likely outcomes of different rules and structures to come up with an aggregate of "most fair."

We need not be constructing the legislation of entire nations for this type of thinking to be useful. Think, for example, of a company's human resources policies on hiring, office etiquette, or parental leave. What kind of policies would you design or support if you didn't know what your role in the company was? Or even anything about who you were?

Conclusion

Thought experiments tell you about the limits of what you know and the limits of what you should attempt. In order to improve our decision-making and increase our chances of success, we must be willing to probe all of the possibilities we can think of. Thought experiments are not daydreams. They require both rigor and work. But the more you use them, the more you understand actual cause and effect, and the more knowledge you have of what can really be accomplished.

Supporting Idea:

Necessity and Sufficiency

We often make the mistake of assuming that having some necessary conditions in place means that we have all of the sufficient conditions in place for our desired event or effect to occur. The gap between the two is the difference between becoming a published author and becoming J.K. Rowling. Certainly you have to know how to write well to become either, but it isn't sufficient to become a Rowling. This is somewhat obvious to most. What's not obvious is that the gap between what is necessary to succeed and what is sufficient is often luck, chance, or some other factor beyond your direct control.

Assume you wanted to make it into the Fortune 500. Capital is necessary, but not sufficient. Hard work is necessary, but not sufficient. Intelligence is necessary, but not sufficient. Billionaire

success takes all of those things and more, plus a lot of luck. That's a big reason that there's no recipe.

Winning a military battle is a great example of necessity and sufficiency. It is necessary to prepare for the battle by evaluating the strength and tactics of your enemy, and by developing your own plan. You need to address logistics such as supplies, and have a comprehensive strategy that allows flexibility to respond to the unexpected. These things, however, are not enough to win the battle. Without them you definitely won't be successful, but on their own they are not sufficient for success.

This concept is demonstrated in sport as well. To be successful at a professional level in any sport depends on some necessary conditions. You must be physically capable of meeting the demands of that sport, and have the time and means to train. Meeting these conditions, however, is not sufficient to guarantee a successful outcome. Many hard-working, talented athletes are unable to break into the professional ranks.

In mathematics they call these sets. The set of conditions necessary to become successful is a part of the set that is sufficient to become successful. But the sufficient set itself is far larger than the necessary set. Without that distinction, it's too easy for us to be misled by the wrong stories.

THOUGHT EXPERIMENT

- THINGING IN BETS
- THOUGHT EXPERIMENTS