

First Principles: The Building Blocks of True Knowledge

First-principles thinking is one of the best ways to reverse-engineer complicated problems and unleash creative possibility. Sometimes called “reasoning from first principles,” the idea is to break down complicated problems into basic elements and then reassemble them from the ground up. It’s one of the best ways to learn to think for yourself, unlock your creative potential, and move from linear to non-linear results.

This approach was used by the philosopher Aristotle and is used now by Elon Musk and Charlie Munger. It allows them to cut through the fog of shoddy reasoning and inadequate analogies to see opportunities that others miss.

“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

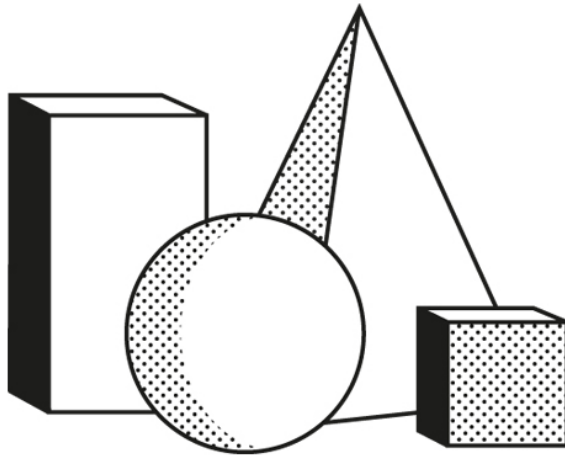
The Basics

A first principle is a foundational proposition or assumption that stands alone. We cannot deduce first principles from any other proposition or assumption.

Aristotle, writing^[1] on first principles, said:

In every systematic inquiry (methodos) where there are first principles, or causes, or elements, knowledge and science result from acquiring knowledge of these; for we think we know something just in case we acquire knowledge of the primary causes, the primary first principles, all the way to the elements.

Later he connected the idea to knowledge, defining first principles as “the first basis from which a thing is known.”^[2]



The search for first principles is not unique to philosophy. All great thinkers do it.

Reasoning by first principles removes the impurity of assumptions and conventions. What remains is the essentials. It's one of the best mental models you can use to improve your thinking because the essentials allow you to see where reasoning by analogy might lead you astray.

The Coach and the Play Stealer

My friend Mike Lombardi (a former NFL executive) and I were having dinner in L.A. one night, and he said, “Not everyone that’s a coach is really a coach. Some of them are just play stealers.”

Every play we see in the NFL was at some point created by someone who thought, “What would happen if the players did this?” and went out and tested the idea. Since then, thousands, if not millions, of plays have been created. That’s part of what coaches do. They assess what’s physically possible, along with the weaknesses of the other teams and the capabilities of their own players, and create plays that are designed to give their teams an advantage.

The coach reasons from first principles. The rules of football are the first principles: they govern what you can and can’t do. Everything is possible as long as it’s not against the rules.

The play stealer works off what’s already been done. Sure, maybe he adds a tweak here or there, but by and large he’s just copying something that someone else created.

While both the coach and the play stealer start from something that already exists, they generally have different results. These two people look the same to most of us on the sidelines or watching the game on the TV. Indeed, they look the same most of the time, but when something goes wrong, the difference shows. Both the coach and the play stealer call successful plays and unsuccessful plays. Only the coach, however, can determine why a play was successful or unsuccessful and figure out how to adjust it. The coach, unlike the play stealer, understands what the play was designed to accomplish and where it went wrong, so he can easily course-correct. The play stealer has no idea what’s going on. He doesn’t understand the difference between something that didn’t work and something that played into the other team’s strengths.

Musk would identify the play stealer as the person who reasons by analogy, and the coach as someone who reasons by first principles. When you run a team, you want a coach in charge and not a play stealer. (If you’re a sports fan, you need only look at the difference between the Cleveland Browns and the New England Patriots.)

We’re all somewhere on the spectrum between coach and play stealer. We reason by first principles, by analogy, or a blend of the two.

Another way to think about this distinction comes from another friend, Tim Urban. He says^[3] it’s like the difference between the cook and the chef. While these terms are often used interchangeably, there is an important nuance. The chef is a trailblazer, the person

who invents recipes. He knows the raw ingredients and how to combine them. The cook, who reasons by analogy, uses a recipe. He creates something, perhaps with slight variations, that's already been created.

The difference between reasoning by first principles and reasoning by analogy is like the difference between being a chef and being a cook. If the cook lost the recipe, he'd be screwed. The chef, on the other hand, understands the flavor profiles and combinations at such a fundamental level that he doesn't even use a recipe. He has real knowledge as opposed to know-how.

Authority

So much of what we believe is based on some authority figure telling us that something is true. As children, we learn to stop questioning when we're told "Because I said so." (More on this later.) As adults, we learn to stop questioning when people say "Because that's how it works." The implicit message is "understanding be damned — shut up and stop bothering me." It's not intentional or personal. OK, sometimes it's personal, but most of the time, it's not.

If you outright reject dogma, you often become a problem: a student who is always pestering the teacher. A kid who is always asking questions and never allowing you to cook dinner in peace. An employee who is always slowing things down by asking why.

When you can't change your mind, though, you die. Sears was once thought indestructible before Wal-Mart took over. Sears failed to see the world change. Adapting to change is an incredibly hard thing to do when it comes into conflict with the very thing that caused so much success. As Upton Sinclair aptly pointed out, "It is difficult to get a man to understand something, when his salary depends on his not understanding it." Wal-Mart failed to see the world change and is now under assault from Amazon.

If we never learn to take something apart, test the assumptions, and reconstruct it, we end up trapped in 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.

First-principles reasoning cuts through dogma and removes the blinders. We can see the world as it is and see what is possible.

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 bitcoins. The list goes on.

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.

"To understand is to know what to do."

— WITTGENSTEIN

Techniques for Establishing First Principles

There are many ways to establish first principles. Let's take a look at a few of them.

Socratic Questioning

Socratic questioning can be used to establish first principles through stringent analysis. This a disciplined questioning process, used to establish truths, reveal underlying assumptions, and separate knowledge from ignorance. The key distinction between Socratic questioning and normal 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?)

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

“Because I Said So” or “The Five Whys”

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 hate.

“Why?”

“Why?”

“Why?”

Here’s an example that has played out numerous times at my house:

“It’s time to brush our teeth and get ready for bed.”

“Why?”

“Because we need to take care of our bodies, and that means we need sleep.”

“Why do we need sleep?”

“Because we’d die if we never slept.”

“Why would that make us die?”

“I don’t know; let’s go look it up.”

Kids are just trying to understand why adults are saying something or why they want them to do something.

The first time your kid plays this game, it’s cute, but for most teachers and parents, it eventually becomes annoying. Then the answer becomes what my mom used to tell me: “Because I said so!” (Love you, Mom.)

Of course, I’m not always that patient with the kids. For example, I get testy when we’re late for school, or we’ve been travelling for 12 hours, or I’m trying to fit too much into the time we have. Still, I try never to say “Because I said so.”

People hate the “because I said so” response for two reasons, both of which play out in the corporate world as well. The first reason we hate the game is that we feel like it slows us down. We know what we want to accomplish, and that response creates unnecessary drag. The second reason we hate this game is that after one or two questions, we are often lost. We actually don’t know why. Confronted with our 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](https://fs.blog/intellectual-giants/richard-feynman/) (<https://fs.blog/intellectual-giants/richard-feynman/>)? [Charlie Munger](https://fs.blog/intellectual-giants/charlie-munger/) (<https://fs.blog/intellectual-giants/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 SAGAN

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:

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 (<https://fs.blog/2016/02/joseph-tussman/>) 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.

After studying the psychology of virality, Jonah Peretti founded BuzzFeed in 2006. The site quickly grew to be one of the most popular on the internet, with hundreds of employees and substantial revenue.

Peretti figured out early on the first principle of a successful website: wide distribution. Rather than publishing articles people should read, BuzzFeed focuses on publishing those that people want to read. This means aiming to garner maximum social shares to put distribution in the hands of readers.

Peretti recognized the first principles of online popularity and used them to take a new approach to journalism. He also ignored SEO, saying, “Instead of making content robots like, it was more satisfying to make content humans want to share.”^[8] Unfortunately for us, we share a lot of cat videos.

A common aphorism in the field of viral marketing is, “content might be king, but distribution is queen, and she wears the pants” (or “and she has the dragons”; pick your metaphor). BuzzFeed’s distribution-based approach is based on obsessive measurement, using A/B testing and analytics.

Jon Steinberg, president of BuzzFeed, explains the first principles of virality:

Keep it short. Ensure [that] the story has a human aspect. Give people the chance to engage. And let them react. People mustn’t feel awkward sharing it. It must feel authentic. Images and lists work. The headline must be persuasive and direct.

Derek Sivers and CD Baby

When Sivers founded his company CD Baby, he reduced the concept down to first principles. Sivers asked, What does a successful business need? His answer was happy customers.

Instead of focusing on garnering investors or having large offices, fancy systems, or huge numbers of staff, Sivers focused on making each of his customers happy. An example of this is his famous order confirmation email, part of which reads:

Your CD has been gently taken from our CD Baby shelves with sterilized contamination-free gloves and placed onto a satin pillow. A team of 50 employees inspected your CD and polished it to make sure it was in the best possible condition before mailing. Our packing specialist from Japan lit a candle and a hush fell over the crowd as he put your CD into the finest gold-lined box money can buy.

By ignoring unnecessary details that cause many businesses to expend large amounts of money and time, Siverson was able to rapidly grow the company to \$4 million in monthly revenue. In *Anything You Want*

([https://www.amazon.com/gp/product/1591848261/ref=as_li_qf_asin_il_tl?](https://www.amazon.com/gp/product/1591848261/ref=as_li_qf_asin_il_tl?ie=UTF8&tag=farnamstreet-20&creative=9325&linkCode=as2&creativeASIN=1591848261&linkId=1256e603a17e40ab2bcc0cd0f58b23a4)

[ie=UTF8&tag=farnamstreet-](https://www.amazon.com/gp/product/1591848261/ref=as_li_qf_asin_il_tl?ie=UTF8&tag=farnamstreet-20&creative=9325&linkCode=as2&creativeASIN=1591848261&linkId=1256e603a17e40ab2bcc0cd0f58b23a4)

[20&creative=9325&linkCode=as2&creativeASIN=1591848261&linkId=1256e603a17e40ab2bcc0cd0f58b23a4](https://www.amazon.com/gp/product/1591848261/ref=as_li_qf_asin_il_tl?ie=UTF8&tag=farnamstreet-20&creative=9325&linkCode=as2&creativeASIN=1591848261&linkId=1256e603a17e40ab2bcc0cd0f58b23a4)), Siverson wrote:

Having no funding was a huge advantage for me.

A year after I started CD Baby, the dot-com boom happened.

Anyone with a little hot air and a vague plan was given millions of dollars by investors. It was ridiculous. ...

Even years later, the desks were just planks of wood on cinder blocks from the hardware store. I made the office computers myself from parts. My well-funded friends would spend \$100,000 to buy something I made myself for \$1,000. They did it saying, "We need the very best," but it didn't improve anything for their customers. ...

It's counterintuitive, but the way to grow your business is to focus entirely on your existing customers. Just thrill them, and they'll tell everyone.

To survive as a business, you need to treat your customers well. And yet so few of us master this principle.

Employing First Principles in Your Daily Life

Most of us have no problem thinking about what we want to achieve in life, at least when we're young. We're full of big dreams, big ideas, and boundless energy. The problem is that we let others tell us what's possible, not only when it comes to our dreams but also when it comes to how we go after them. And when we let other people tell us what's possible or what the best way to do something is, we outsource our thinking to someone else.

The real power of first-principles thinking is moving away from incremental improvement and into possibility. Letting others think for us means that we're using their analogies, their conventions, and their possibilities. It means we've inherited a world that conforms to what they think. This is incremental thinking.

When we take what already exists and improve on it, we are in the shadow of others. It's only when we step back, ask ourselves what's possible, and cut through the flawed analogies that we see what is possible. Analogies are beneficial; they make complex problems easier to communicate and increase understanding. Using them, however, is not without a cost. They limit our beliefs about what's possible and allow people to argue without ever exposing our (faulty) thinking. Analogies move us to see the problem in the same way that someone else sees the problem.

The gulf between what people currently see because their thinking is framed by someone else and what is physically possible is filled by the people who use first principles to think through problems.

First-principles thinking clears the clutter of what we've told ourselves and allows us to rebuild from the ground up. Sure, it's a lot of work, but that's why so few people are willing to do it. It's also why the rewards for filling the chasm between possible and incremental improvement tend to be non-linear.

Let's take a look at a few of the limiting beliefs that we tell ourselves.

“I don't have a good memory.” ^[10]

People have far better memories than they think they do. Saying you don't have a good memory is just a convenient excuse to let you forget. Taking a first-principles approach means asking how much information we can physically store in our minds. The answer is

“a lot more than you think.” Now that we know it’s possible to put more into our brains, we can reframe the problem into finding the most optimal way to store information in our brains.

“There is too much information out there.”

A lot of professional investors read Farnam Street. When I meet these people and ask how they consume information, they usually fall into one of two categories. The differences between the two apply to all of us. The first type of investor says there is too much information to consume. They spend their days reading every press release, article, and blogger commenting on a position they hold. They wonder what they are missing. The second type of investor realizes that reading everything is unsustainable and stressful and makes them prone to overvaluing information they’ve spent a great amount of time consuming. These investors, instead, seek to understand the variables that will affect their investments. While there might be hundreds, there are usually three to five variables that will really move the needle. The investors don’t have to read everything; they just pay attention to these variables.

“All the good ideas are taken.”

A common way that people limit what’s possible is to tell themselves that all the good ideas are taken. Yet, people have been saying this for hundreds of years — literally — and companies keep starting and competing with different ideas, variations, and strategies.

“We need to move first.”

I’ve heard this in boardrooms for years. The answer isn’t as black and white as this statement. The iPhone wasn’t first, it was better. Microsoft wasn’t the first to sell operating systems; it just had a better business model. There is a lot of evidence showing that first movers in business are more likely to fail than latecomers. Yet this myth about the need to move first continues to exist.

Sometimes the early bird gets the worm and sometimes the first mouse gets killed. You have to break each situation down into its component parts and see what’s possible. That is the work of first-principles thinking.

“I can’t do that; it’s never been done before.”

People like Elon Musk are constantly doing things that have never been done before. This type of thinking is analogous to looking back at history and building, say, floodwalls, based on the worst flood that has happened before. A better bet is to look at what could happen and plan for that.

“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

Conclusion

The thoughts of others imprison us if we're not thinking for ourselves.

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.

Reasoning by first principles is useful when you are (1) doing something for the first time, (2) dealing with complexity, and (3) trying to understand a situation that you're having problems with. In all of these areas, your thinking gets better when you stop making assumptions and you stop letting others frame the problem for you.

Analogies can't replace understanding. While it's easier on your brain to reason by analogy, you're more likely to come up with better answers when you reason by first principles. This is what makes it one of the best sources of creative thinking. Thinking in first principles allows you to adapt to a changing environment, deal with reality, and seize opportunities that others can't see.

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.^[11] 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 ourselves. Thinking through first principles is a way of taking off the blinders. Most things suddenly seem more possible.

“I think most people can learn a lot more than they think they can,” says Musk. “They sell themselves short without trying. One bit of advice: it is important to view knowledge as sort of a semantic tree — make sure you understand the fundamental principles, i.e., the

trunk and big branches, before you get into the leaves/details or there is nothing for them to hang on to.”

End Notes

^[1] Aristotle, Physics 184a10–21

^[2] Aristotle, Metaphysics 1013a14-15

^[3] <https://waitbutwhy.com/2015/11/the-cook-and-the-chef-musks-secret-sauce.html>

^[4] Elon Musk, quoted by Tim Urban in “The Cook and the Chef: Musk’s Secret Sauce,” Wait But Why <https://waitbutwhy.com/2015/11/the-cook-and-the-chef-musks-secret-sauce.html>

^[5] Vance, Ashlee. *Elon Musk: Tesla, SpaceX, and the Quest for a Fantastic Future* (p. 354)

^[6] <https://www.wired.com/2012/10/ff-elon-musk-qa/all/>

^[7] https://www.youtube.com/watch?v=L-s_3b5fRd8

^[8] David Rowan, “How BuzzFeed mastered social sharing to become a media giant for a new era,” Wired.com. 2 January 2014. <https://www.wired.co.uk/article/buzzfeed>

^[9] <https://www.quora.com/What-does-Elon-Musk-mean-when-he-said-I-think-it%E2%80%99s-important-to-reason-from-first-principles-rather-than-by-analogy/answer/Bruce-Achterberg>

^[10] <https://www.scientificamerican.com/article/new-estimate-boosts-the-human-brain-s-memory-capacity-10-fold/>

^[11] Breakpoint and Beyond: Mastering the Future Today, George Land

^[12]

https://www.reddit.com/r/IAMa/comments/2rgsan/i_am_elon_musk_ceocto_of_a_rocket_company_ama/cnfre0a/

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