July 21:07

cut-to-the-quick

Anita 21:07

don't get ahead of yourself/hold your horse/slow your roll
cut-to-the-quick

Alex 21:07

course correction

May 21:07

the genie never gets back in the bottle

jing 21:07

short termgain long term pain

Sicy 21:07

too many cooks spoil the broth

Sicy 21:08

When we factor it in, we realize that our safety has not really been compromised.

yuki 21:08

Sicy 21:07

· Availability Heuristic
· Representativeness Heuristic
Anchoring effect

May 21:04

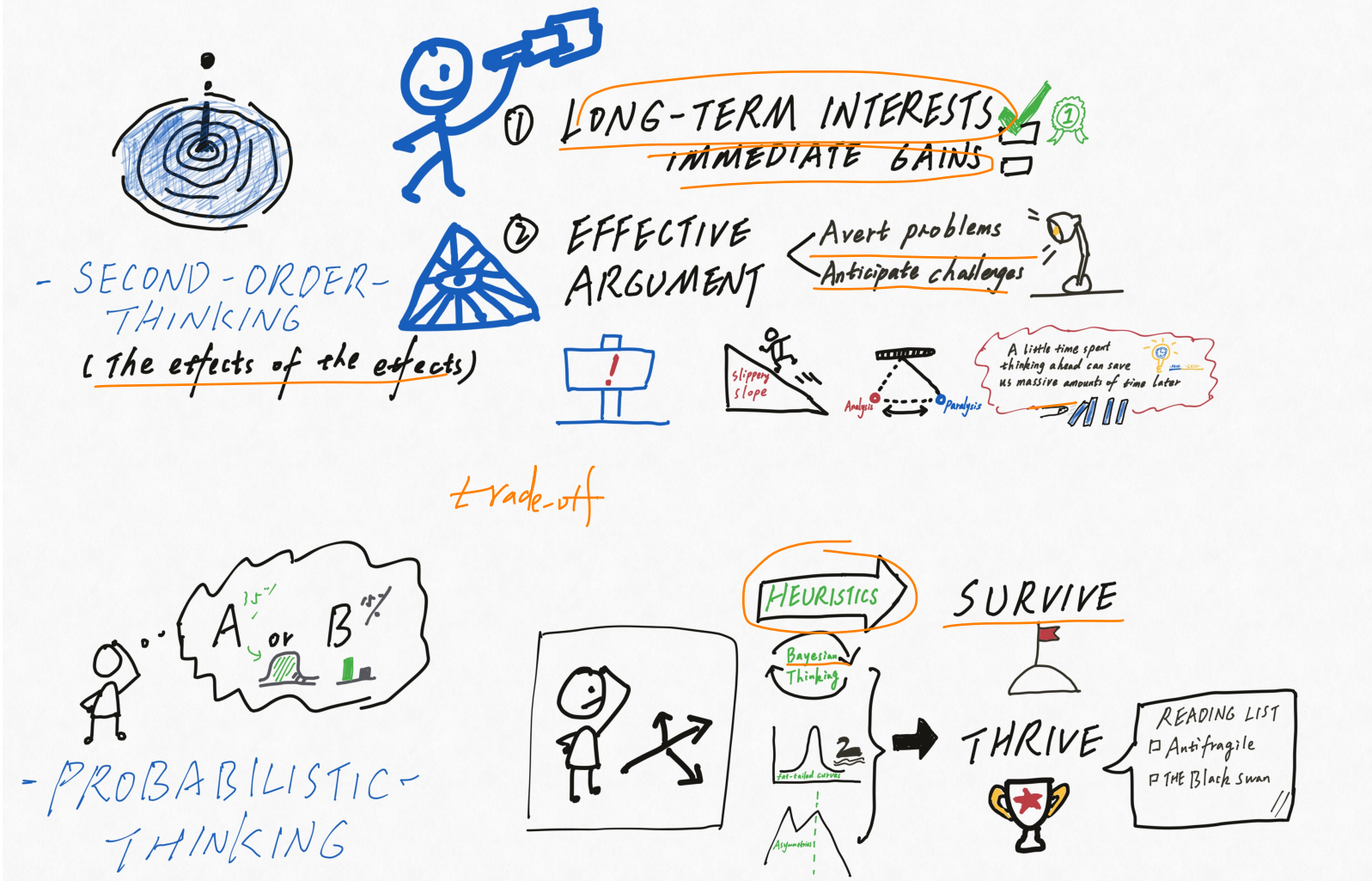
A little time spent thinking ahead can save us massive amounts of time later.

Sicy 21:04

analysis paralysis

Sicy 21:05

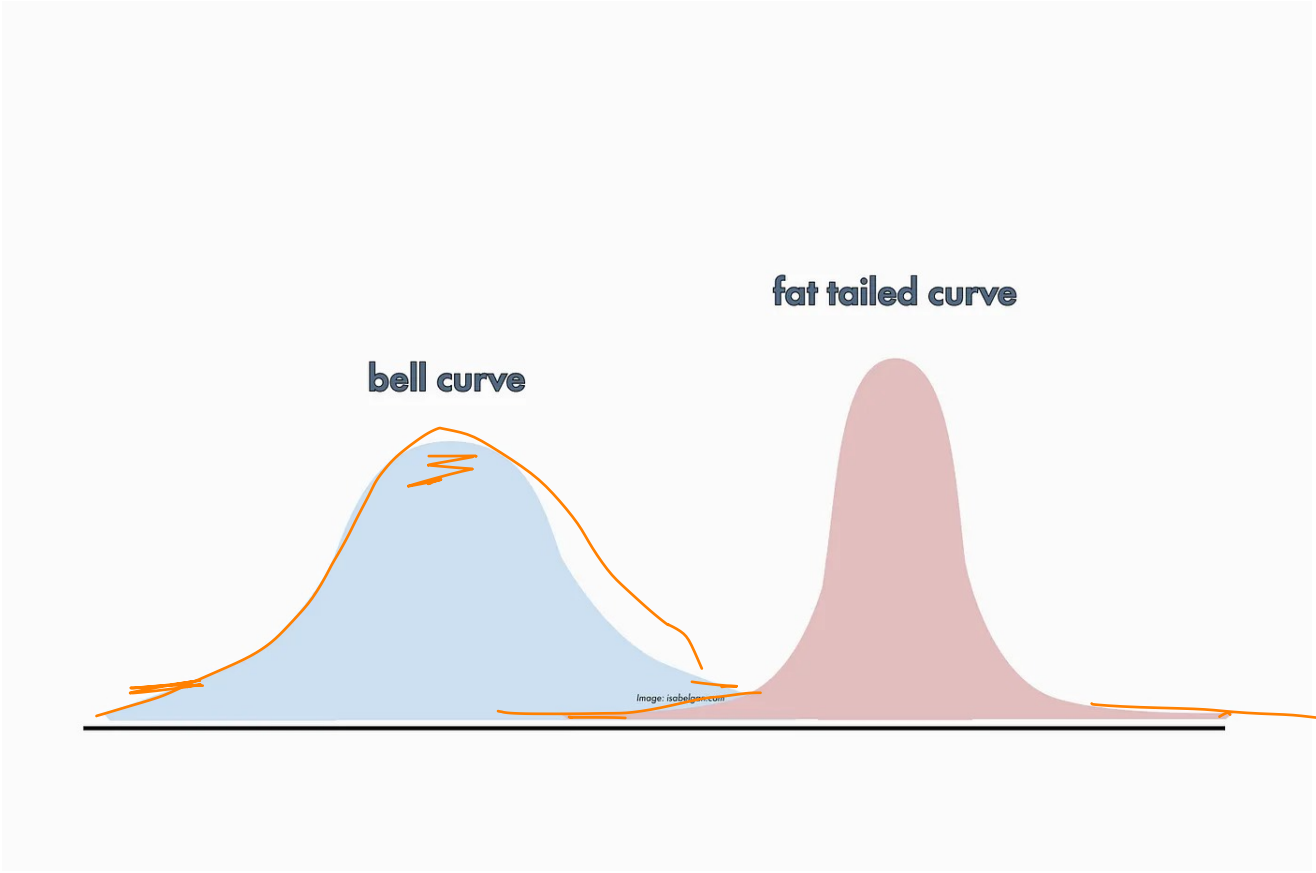
educated guess

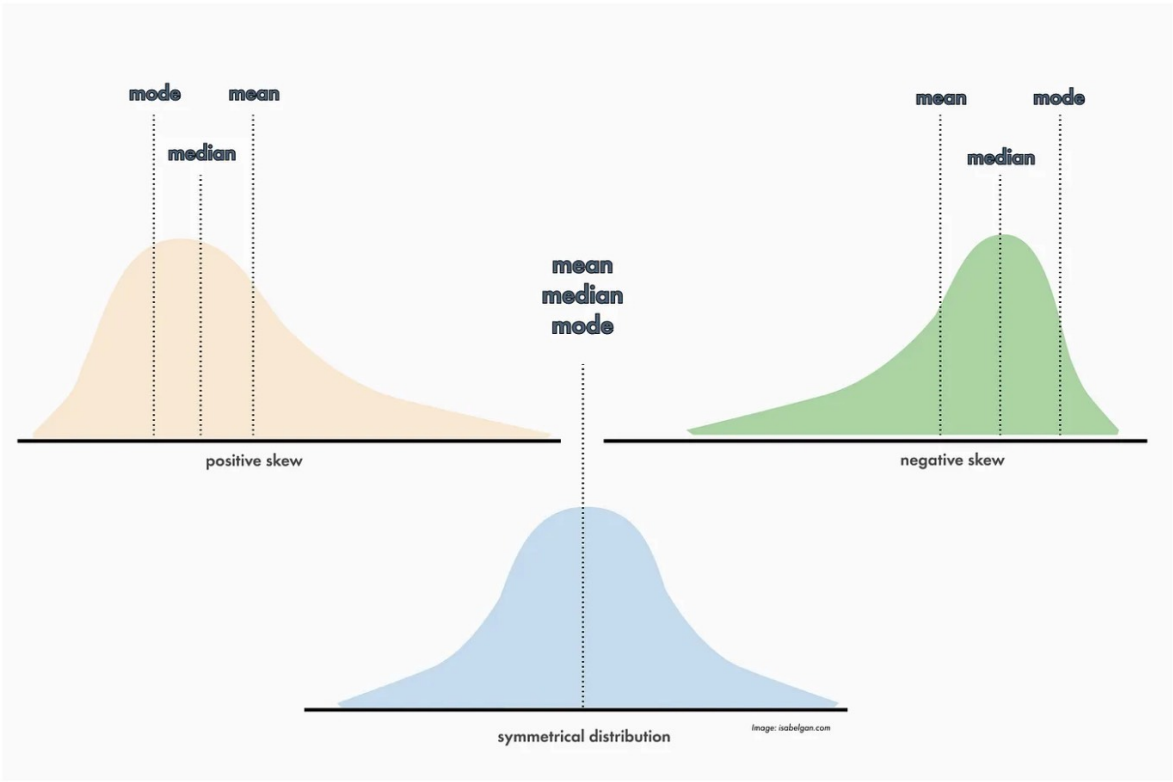


(source: scientific american)

> *Never, ever leave a number all by itself. Never believe that one number on its own can be meaningful. If you are offered one number, always ask for at least one more. Something to compare it with.* — *Hans Rosling*

All this to say, our initial belief is only as valid as the evidence. Bayesian thinking encourages us to use all relevant prior information in making decisions. Hans Rosling mentions this in his book "Factfulness" (*note: will probably be referencing this book multiple times in this series*) about utilizing **comparing** and **dividing** to avoid misjudging something's importance.




mode
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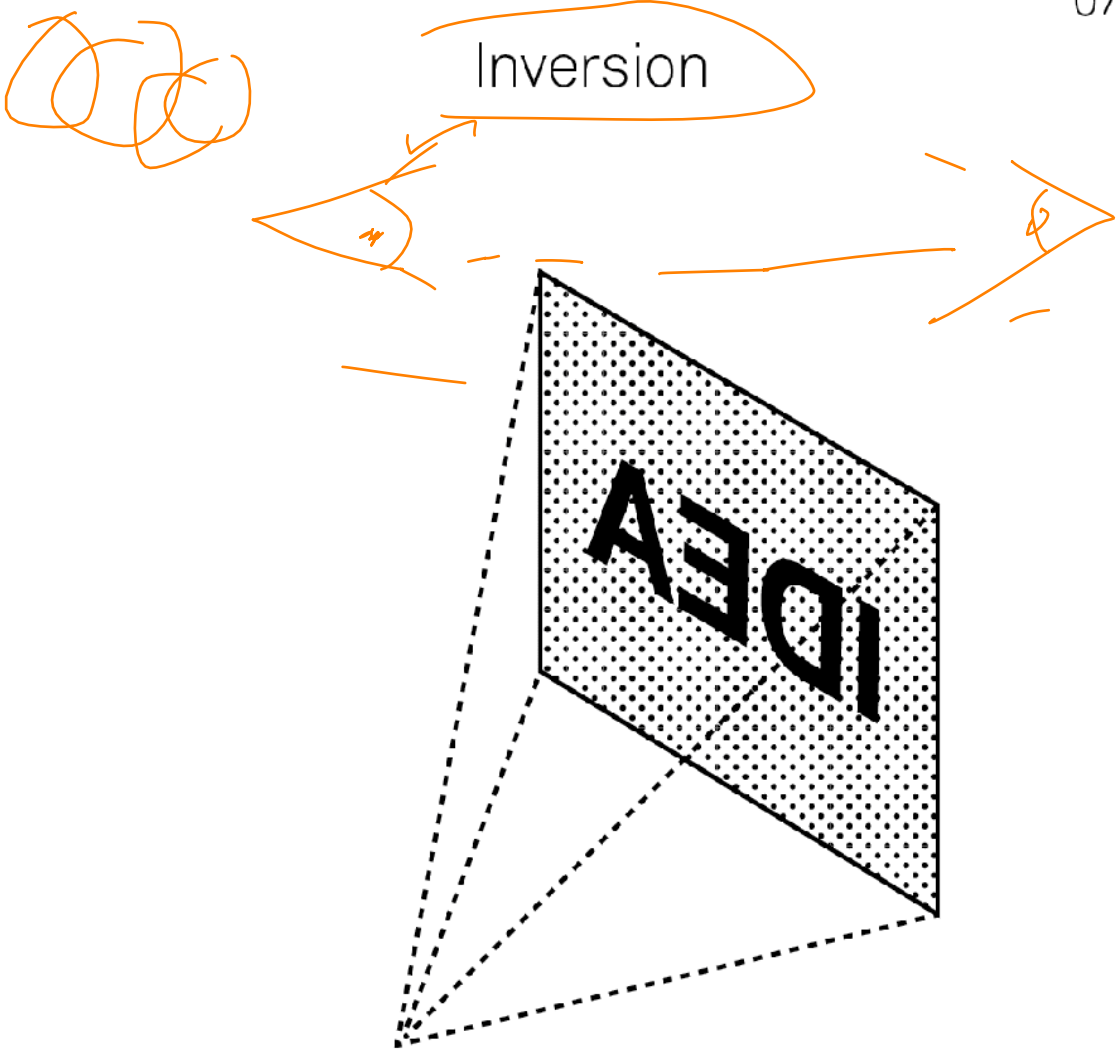
Inversion



Change your perspective.

The test of a first-rate intelligence is the ability to hold two opposing ideas in mind at the same time and still retain the ability to function. One should, for example, be able to see that things are hopeless yet be determined to make them otherwise.

F. Scott Fitzgerald [1]

The People Who Appear in this Chapter

Jacobi, Carl.
1804-1851 - German mathematician who made fundamental contributions to elliptic functions, dynamics, and number theory.

Bernays, Edward.
1891-1995 - Austrian-American. Known as “the Father of Public Relations”. Although his influence cannot be doubted, his legacy is one of brilliant but sometimes unethical strategies that consumers and citizens are still navigating today.

Bogle, John.
1929 - American investor, business magnate, and philanthropist. He is the founder and retired chief executive of The Vanguard Group.

Lewin, Kurt.
1890-1947 - German-American psychologist. Often recognized as the founder of social psychology, he was one of the first to study group dynamics and organizational development.

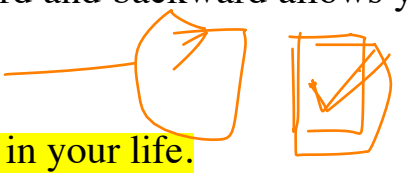
Nightingale, Florence.
1820-1910 - English social reformer, statistician, and the founder of modern nursing. By turning nursing into a profession and collecting detailed statistics on hospital conditions, she improved the lives of people all over

the world.

Inversion

Inversion is a powerful tool to improve your thinking because it helps you identify and remove obstacles to success. The root of inversion is "invert," which means to upend or turn upside down. As a thinking tool it means approaching a situation from the opposite end of the natural starting point. Most of us tend to think one way about a problem: forward. Inversion allows us to flip the problem around and think backward. Sometimes it's good to start at the beginning, but it can be more useful to start at the end.

Think of it this way: Avoiding stupidity is easier than seeking brilliance. Combining the ability to think forward and backward allows you to see reality from multiple angles.



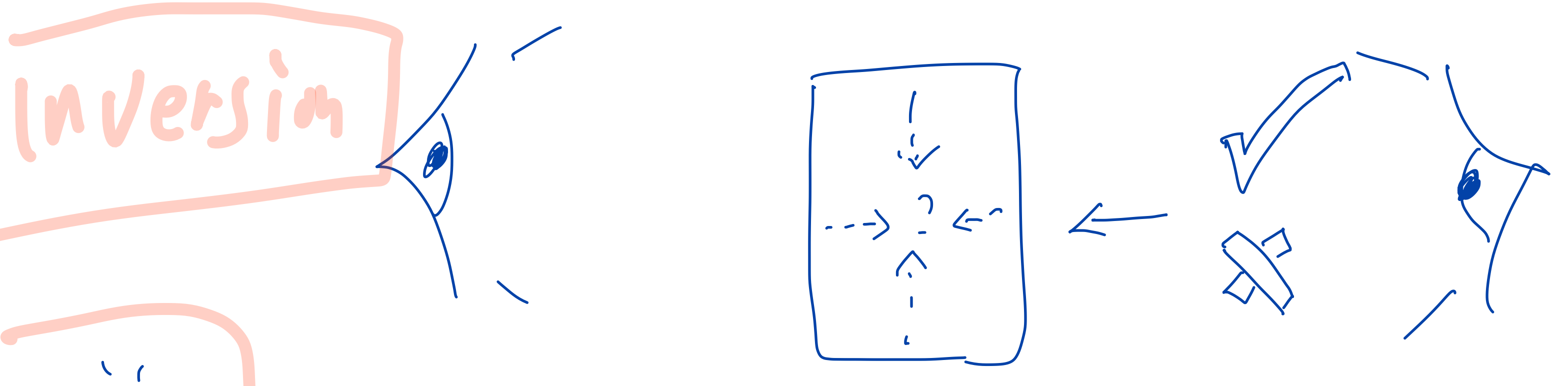
There are two approaches to applying inversion in your life.

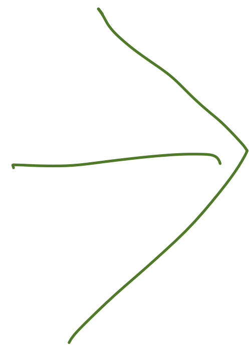
1. Start by assuming that what you're trying to prove is either true or false, then show what else would have to be true.
2. Instead of aiming directly for your goal, think deeply about what you want to *avoid* and then see what options are left over.

Set your assumptions: The 19th century German mathematician Carl Jacobi became famous for a number of reasons— including solving some ungodly difficult problems— but is perhaps best remembered for his advice to "invert, always invert." Jacobi solved a range of problems by starting with the endpoint. When faced with proving an axiom in a difficult math problem, he might instead assume a property of the axiom was correct and then try to determine the consequences of this assumption. From that point, he could work out surprising, and at times counterintuitive, insights.

— *Sidebar: The Most Successful Detective of All Time*

Jacobi was not the first mathematician to use inversion. In fact,





英语口语

? First Principles Thinking

口语

课程
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inversion is a staple of mathematical, philosophical, and scientific inquiry. We can look around today and appreciate that we can't see atoms and quarks, but we know they exist because we can make predictions about their behavior and test those predictions.

Or we can go back 2,300 years and look at the work of the Greek Hippasus, a follower of Pythagoras.[2] (Yes, the one with the Theorem.) His attempts to derive the square root of 2, and his original direct approach to solving the problem (essentially, dividing larger and larger whole numbers into each other) were both fruitless and time consuming. He hit an impasse, realizing that he'd never be able to definitely solve the problem by thinking forward. In his increasing frustration, Hippasus decided to take the reverse route, thinking about what the square root of 2 might *imply*, and working backwards from there. If he couldn't find it the way he had expected to, he'd start by proving what the number *couldn't* be. His quest forever changed what we understood about mathematics, and led to the discovery of the first irrational number.

Mathematics is not the only area where using inversion can produce surprising and non-intuitive results. In the 1920s the American Tobacco Company wanted to sell more of their Lucky Strike cigarettes to women. Men were smoking, but women weren't. There were pervasive taboos against women smoking— it was seen as a man's activity. Women therefore presented an untapped market that had the potential of providing huge revenue. The head of the company thought that they needed to convince women that smoking would make them thinner, riding on the slimness trend that had already begun, so he hired Edward Bernays, who came up with a truly revolutionary marketing campaign.[3,4]

In the style of the inversion approach described above, Bernays did not ask, "How do I sell more cigarettes to women?" Instead, he wondered, if women bought and smoked cigarettes, what else would have to be true? What would have to change in the world to make smoking desirable to

women and socially acceptable? Then— a step farther— once he knew what needed to change, how would he achieve that?

The Most Successful Detective of All Time

The first great detective to capture the public imagination was Sherlock Holmes. He solved cases in ways that were unfathomable to others, yet seemed obvious in retrospect. He gave the appearance of being a magician, but really he was an excellent observer. He was also a master of inversion.

In his third case, "A Scandal in Bohemia,"[5] Holmes is hired by a king to recover a compromising photograph in which the king appears with an American opera singer, Irene Adler. The king is fearful that Adler will use the picture of the two of them to prevent his upcoming marriage or to blackmail him in the future. He does not want to live under this threat, and so hires Sherlock Holmes to retrieve the picture from Adler.

Presented with this task, what does Holmes do? What would you do? Does he study Adler for months to determine where, based on her personality, she is likely to hide the picture? Does he break into her house and perform a systematic exploration of every nook and cranny? No. Instead, he inverts the problem.

If it is true that Adler has this compromising picture of the king and is planning to blackmail him, what would also be true? Likely that she would greatly value the photo as it will bring her money, and that it would be hidden in an accessible location so she could retrieve it in a hurry. We tend to keep our most prized possessions where we can easily grab them in case of emergency.

So Holmes contrives a scenario in which he is able to be in her house while Watson creates an illusion of a fire on the street outside.

Believing the threat, Adler takes the photo out of its hiding place before escaping. In one instant Holmes both confirms the existence of the photo and now knows its whereabouts. By starting with the logical outcome of his assumptions and seeking to validate those, he advances his case with significantly more efficiency and accuracy than if he had searched first for proof of the assumptions themselves.

–

Bernays never believed his own propaganda on smoking, for years pressuring his wife to quit.

To tackle the idea of smoking as a slimming aid, he mounted a large anti-sweets campaign. After dinner, it was about cigarettes, not dessert. Cigarettes were slimming, while desserts would ruin one's figure. But Bernays's real stroke of genius lay not just in coming out with adverts to convince women to stay slim by smoking cigarettes; "instead, he sought nothing less than to reshape American society and culture."[6] He solicited journalists and photographers to promote the virtues of being slim. He sought testimonials from doctors about the health value of smoking after a meal. He combined this approach with

> *…altering the very environment, striving to create a world in which the cigarette was ubiquitous. He mounted a campaign to persuade hotels and restaurants to add cigarettes to dessert-list menus, and he provided such magazines as* House and Garden *with feature articles that included menus designed to preserve readers 'from the dangers of overeating'…. The idea was not only to influence opinion but to remold life itself. Bernays approached designers, architects, and cabinetmakers in an effort to persuade them to design kitchen cabinets that included special compartments for cigarettes, and he spoke to the manufacturers of kitchen containers to add cigarette tins to their traditional lines of labeled containers for coffee, tea, sugar, and flour.*[7]

The result was a complete shift in the consumption habits of American women. It wasn't just about selling the cigarette, it was reorganizing society to make cigarettes an inescapable part of the American woman's daily experience.

Bernays's efforts to make smoking in public socially acceptable had equally startling results. He linked cigarette smoking with women's emancipation. To smoke was to be free. Cigarettes were marketed as "torches of freedom." He orchestrated public events, including an infamous parade on Easter Sunday in 1929 which featured women smoking as they

walked in the parade. He left no detail unattended, so public perception of smoking was changed almost overnight. He both normalized it and made it desirable in one swoop.

Although the campaign utilized more principles than just inversion, it was the original decision to invert the approach that provided the framework from which the campaign was created and executed. Bernays didn't focus on how to sell more cigarettes to women within the existing social structure. Sales would have undoubtedly been a lot more limited. Instead he thought about what the world would look like if women smoked often and anywhere, and then set about trying to make that world a reality. Once he did that, selling cigarettes to women was comparatively easy.

This inversion approach became a staple of Bernays's work. He used the descriptor "appeals of indirection", and each time when "hired to sell a product or service, he instead sold whole new ways of behaving, which appeared obscure but over time reaped huge rewards for his clients and redefined the very texture of American life."[8]

What are you trying to avoid? Instead of thinking through the achievement of a positive outcome, we could ask ourselves how we might achieve a terrible outcome, and let that guide our decision-making. Index funds are a great example of stock market inversion promoted and brought to bear by Vanguard's John Bogle.[9] Instead of asking how to beat the market, as so many before him, Bogle recognized the difficulty of the task. Everyone is trying to beat the market. No one is doing it with any consistency, and in the process real people are losing actual money. So he inverted the approach. The question then became, how can we help investors minimize losses to fees and poor money manager selection? The results were one of the greatest ideas— index funds— and one of the greatest powerhouse firms in the history of finance.

The index fund operates on the idea that accruing wealth has a lot to

do with minimizing loss. Think about your personal finances. Often we focus on positive goals, such as "I want to be rich," and use this to guide our approach. We make investing and career choices based on our desire to accumulate wealth. We chase after magical solutions, like attempting to outsmart the stock market. These inevitably get us nowhere, and we have usually taken some terrible risks in the process which actually leave us worse off.

Instead, we can try inverting the goal. It becomes, not getting rich, but avoiding being poor. Instead of trying to divine the decisions that will bring wealth, we first try to eliminate those behaviors that are guaranteed to erode it. There are some pretty obvious ones. Spending more than we make, paying high interest rates on debt so that we can't tackle paying back the principal, and not starting to save as early as we can to take advantage of the power of compounding, are all concrete financial behaviors that cost us money. We can more readily secure wealth by using inversion to make sure we are not doing the worst things that prevent the accumulation of wealth.
— *Sidebar: Inversion Leads to Innovation*

One of the theoretical foundations for this type of thinking comes from psychologist Kurt Lewin.[10] In the 1930s he came up with the idea of force field analysis, which essentially recognizes that in any situation where change is desired, successful management of that change requires applied inversion. Here is a brief explanation of his process:

1. Identify the problem
2. Define your objective
3. Identify the forces that support change towards your objective
4. Identify the forces that impede change towards the objective
5. Strategize a solution! This may involve both augmenting or adding to the forces in step 3, and reducing or eliminating the forces in step 4.

Even if we are quite logical, most of us stop after step 3. Once we figure out our objective, we focus on the things we need to put in place to make it happen, the new training or education, the messaging and marketing. But Lewin theorized that it can be just as powerful to remove obstacles to change.

The inversion happens between steps 3 and 4. Whatever angle you choose to approach your problem from, you need to then follow with consideration of the opposite angle. Think about not only what you could do to solve a problem, but what you could do to make it worse— and then avoid doing that, or eliminate the conditions that perpetuate it.

«He wins his battles by making no mistakes.»

Sun Tzu [11]

This inversion approach was used by Florence Nightingale to help significantly reduce the mortality rate of British soldiers in military hospitals in the late 19th century. She is often remembered as the founder of modern nursing, but she was also an excellent statistician and was the first woman elected to the Royal Statistical Society in 1858.

During the first winter of the Crimean War, 1854–55, the British Army endured a death rate of 23%. The next winter that rate had dropped to 2.5%.[12] The main reason for the change was a much better understanding of what was actually killing the soldiers, an understanding that rested on the detailed statistics that Florence Nightingale started to collect. She demonstrated that the leading cause of death by far was poor sanitation. In her famous polar-area chart, a completely new way of presenting data at the time, she captured a visual representation of the statistics that made them easy to understand. Improve the sanitary conditions in the hospitals, she explained, and many soldiers' lives will be saved.

Inversion Leads to Innovation

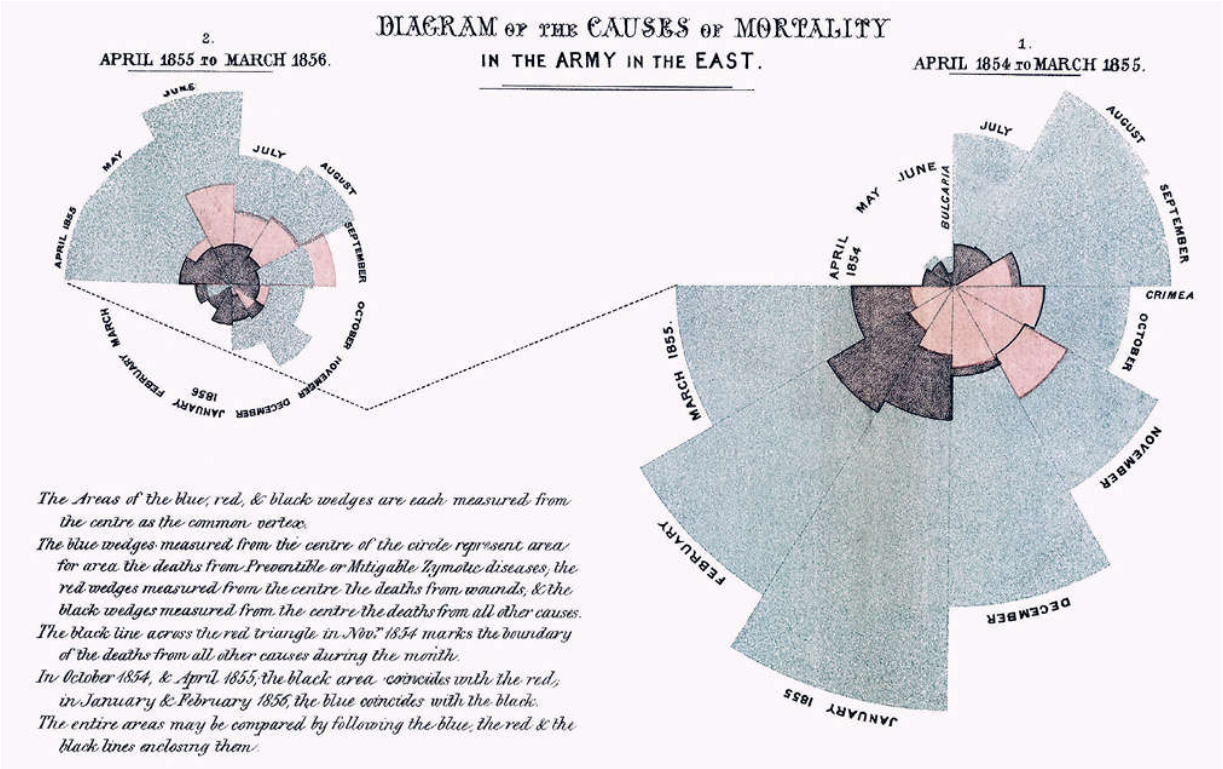
Using inversion to identify your end goal and work backward from there can lead to innovation. If you had to make a guess on who invented closed circuit television (CCTV) in the United States, whom would you choose? A large institution like the Department of Defense? A telecom company? Some techie in a police department? You probably wouldn't name the late Marie Van Brittan Brown, who, along with her husband Albert Brown, filed the first patent for a closed circuit monitoring system in 1966. She was a nurse, living in the Jamaica neighborhood of Queens, New York, and as such worked irregular hours. When she was home alone, she felt unsafe. In an interesting example of inversion, she decided to do something about it.

In the same situation, most of us would work forward, thinking of safety-oriented additions we can make to our existing set-up, like more locks, or having a friend stay over. Van Brittan Brown, however, went a step further, asking what would need to change in order for her to feel safer. She identified that it was her inability to see and communicate with persons outside her door that made her feel the most vulnerable when home alone. Working backward, her thinking may have gone something like this: what can I do to change that situation? What would have to be in place? Van Brittan Brown followed this through, and CCTV was born.

Van Brittan Brown and her husband designed a camera system that would move between four holes in the door, feeding the images to a TV monitor set up in the home. The images would allow her to get a complete view of who was at the door, and additional technology allowed for communication with the person outside without the door being opened. Further, they developed a feature that would allow her

to either let the person in, or sound an alarm to notify a neighbor or watchman.

To be fair, we will likely never know the thought process that led Van Brittan Brown to develop and patent this technology, but her story demonstrates that working backward from a goal can spur the innovation to reach it.



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Nightingale's use of statistics helped to identify the real problem of army hospital deaths.

Nightingale's use of statistics helped to identify the real problem of army hospital deaths. She was able to demonstrate not only what the army could do to improve outcomes, but, just as important, what they had to

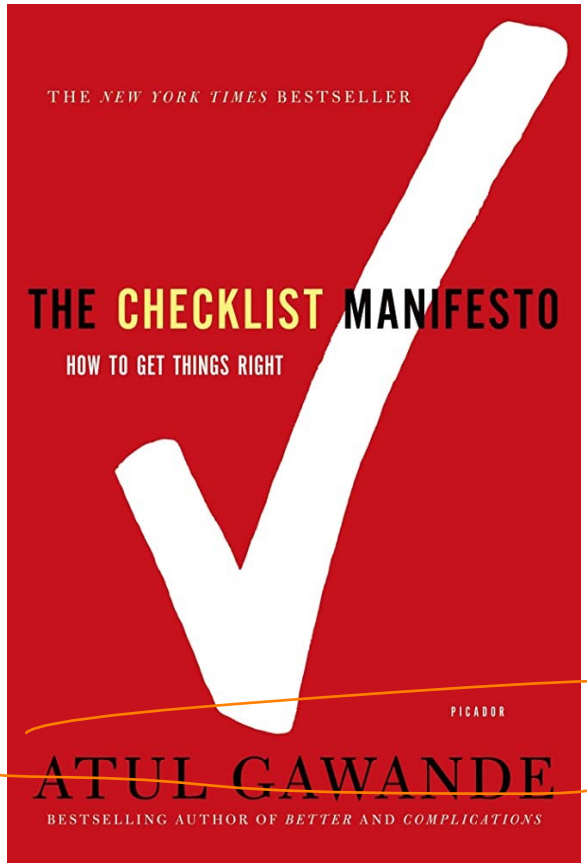
avoid doing to stop making things worse. She reflected on the knowledge that could be derived from statistics and, in another instance of inversion thinking, she advocated for their use as a means of prevention.[13] It became not so much "how do we fix this problem," but "how do we stop it from happening in the first place." She took the knowledge and experience she gained in the Crimea and began gathering statistics not just for British Army field hospitals, but for domestic ones as well. She demonstrated that unsanitary conditions in military hospitals were a real problem causing many preventable deaths.[14]

Nightingale's advocacy for statistics ultimately went much further than British military hospitals. But her use of statistics to improve sanitary conditions can be seen as an example of applied inversion. She used them to advocate for both solving problems and the invert, preventing them.

> «Hence to fight and conquer in all your battles is not supreme excellence; supreme excellence consists in breaking the enemy's resistance without fighting.»
>
> Sun Tzu[15]

Conclusion

Inversion shows us that we don't always need to be geniuses, nor do we need to limit its application to mathematical and scientific proofs. Simply invert, always invert, when you are stuck. If you take the results of your inversion seriously, you might make a great deal of progress on solving your problems.



HUMAN FALLIBILITY → AVOIDABLE MISTAKES

READINGGRAPHICS
Ideas Come Alive

The amount & complexity of knowledge has **exceeded our individual capacity** to remember/apply them correctly and consistently.

We lack certain skills, knowledge or experience

We fail to apply our skills & knowledge correctly

Training and specialization can help but aren't enough

We forget or lose focus when distracted or overwhelmed

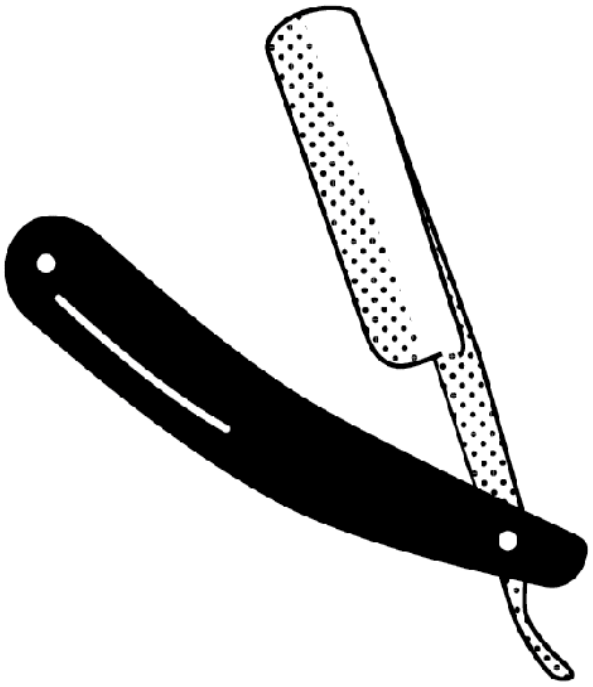
We decide to skip steps or take shortcuts

New York Time Bestseller

"In a complex environment, experts are up against two main difficulties. The first is the fallibility of human memory and attention, especially when it comes to mundane, routine matters that are easily overlooked under the strain of more pressing events...A further difficulty, just as insidious, is that people can lull themselves into skipping steps even when they remember them."

– Atul Gawande

Occam's Razor



–
Keep it simple.

Anybody can make the simple complicated. Creativity is making the complicated simple.

Charles Mingus [1]

The People Who Appear in this Chapter

William of Ockham.
1285-1347 - English philosopher and theologian. He is considered to be one of the major figures of medieval thought, and contributed to many branches of philosophy, like logic and ethics, as well as theology.

Hume, David.
1711-1776 - Scottish philosopher, historian and economist. Best known today for his influential system of philosophical empiricism, skepticism and naturalism, resting on the idea that all human knowledge is founded solely in experience.

Sagan, Carl.
1934-1996 - American astronomer, astrophysicist, and great communicator of science. He assembled the first physical messages sent into space. He also narrated and co-wrote *Cosmos: A Personal Voyage*, the most widely watched series in the history of American Public television.

Rubin, Vera.
1928-2016 - American astronomer. She received multiple honors for her achievements in astronomy, and spent her life advocating for and mentoring women in science.

Occam's Razor

Simpler explanations are more likely to be true than complicated ones. This is the essence of Occam's Razor, a classic principle of logic and problem-solving. Instead of wasting your time trying to disprove complex scenarios, you can make decisions more confidently by basing them on the explanation that has the fewest moving parts.

We all jump to overly complex explanations about something. Husband late getting home? What if he's been in a car accident? Son grew a centimeter less than he did last year? What if there is something wrong with him? Your toe hurts? What if you have bone cancer? Although it is possible that any of these worst case scenarios could be true, without any other correlating factors, it is significantly more likely that your husband got caught up at work, you mismeasured your son, and your shoe is too tight.

We often spend lots of time coming up with very complicated narratives to explain what we see around us. From the behavior of people on the street to physical phenomena, we get caught up in assuming vast icebergs of meaning beyond the tips that we observe. This is a common human tendency, and it serves us well in some situations, such as creating art. However, complexity takes work to unravel, manage, and understand. Occam's Razor is a great tool for avoiding unnecessary complexity by helping you identify and commit to the simplest explanation possible.

Named after the medieval logician William of Ockham, Occam's Razor is a general rule by which we select among competing explanations. Ockham wrote that "a plurality is not to be posited without necessity"—essentially that we should prefer the simplest explanation with the fewest moving parts.[2,3] They are easier to falsify, easier to understand, and generally more likely to be correct. Occam's Razor is not an iron law but a tendency and a mind-frame you can choose to use: If all else is equal, that is if two competing models both have equal explanatory power, it's more

likely that the simple solution suffices.

Of course, it's unlikely that Ockham himself derived the idea. It had been in use since antiquity. Nor was Ockham the last to note the value of simplicity. The principle was stated in another useful way by the 18th-century Scottish philosopher David Hume, in his famous *Enquiry Concerning Human Understanding*. Writing about the truth or untruth of miracles, Hume stated that we should default to skepticism about them.[4]

Why? It wasn't simply that Hume was a buzzkill. He had a specific, Occam-like reason for being cautious about miracles. By definition, a miracle is something which has happened outside of our normal understanding of the way nature works. If the miracle was not outside of our common experience, we wouldn't consider its occurrence miraculous. If there was a simple explanation for the occurrence based on mostly common knowledge, we likely wouldn't pay much attention to it at all.

Therefore, the most simple explanation for a miracle is that the miracle-witnesser is not describing the event correctly, or the miracle represents a more common phenomenon that we currently don't properly understand. As scientist and writer Carl Sagan explains in *The Demon Haunted World*,

> *A multitude of aspects of the natural world that were considered miraculous only a few generations ago are now thoroughly understood in terms of physics and chemistry. At least some of the mysteries of today will be comprehensively solved by our descendants. The fact that we cannot now produce a detailed understanding of, say, altered states of consciousness in terms of brain chemistry no more implies the existence of a 'spirit world' than a sunflower following the Sun in its course across the sky was evidence of a literal miracle before we knew about phototropism and plant hormones.*[5]

The simpler explanation for a miracle is that there are principles of

nature being exploited that we do not understand. This is Hume's and Sagan's point.

Dark what?

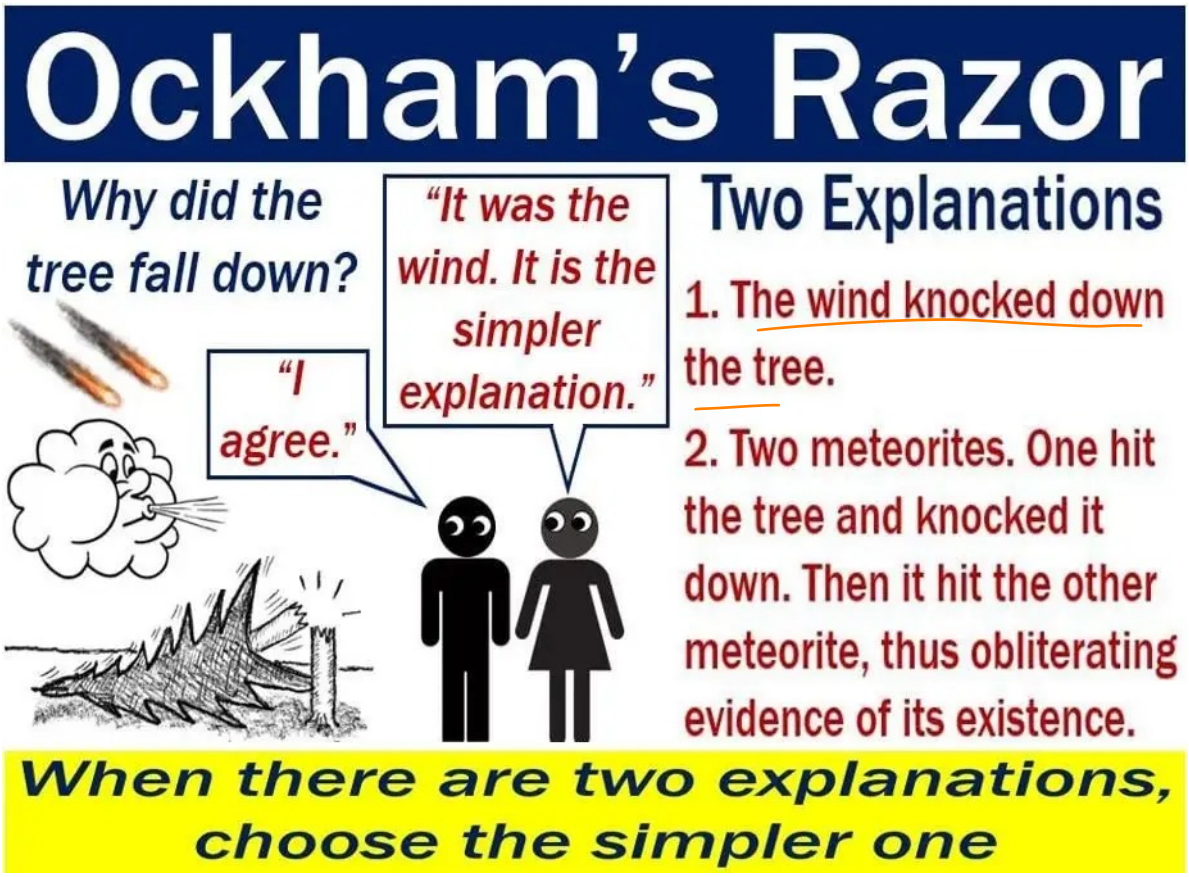
In the mid-1970s astronomer Vera Rubin had a very interesting problem. She had a bunch of data about the behavior of galaxies piling up that wasn't explained by contemporary theories.[6,7,8]

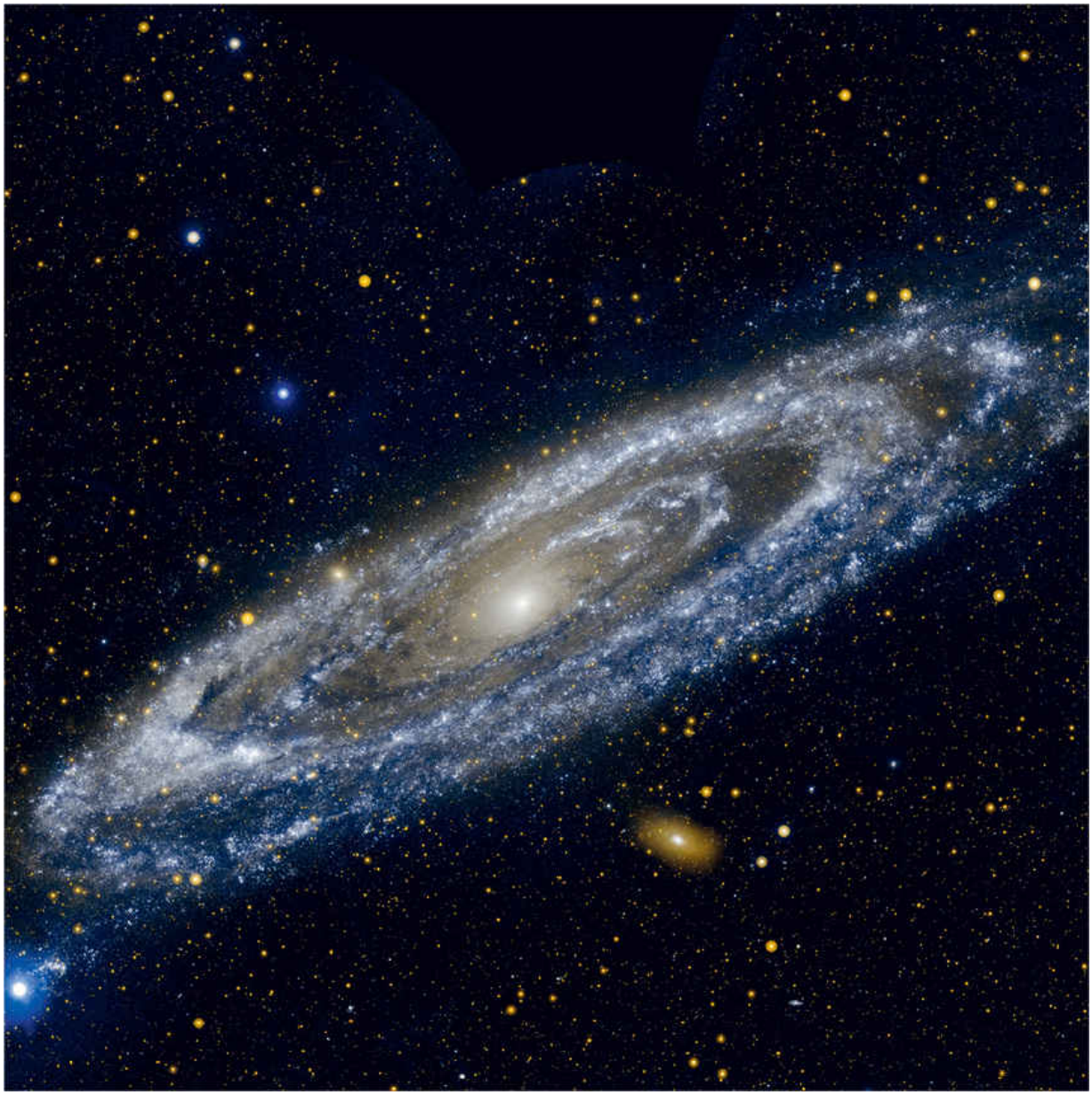
Rubin had been observing the behavior of the Andromeda Galaxy, and had noticed something very strange. As explained in an article on Astronomy.com, "the vast spiral seemed to be rotating all wrong. The stuff at the edges was moving just as fast as the stuff near the center, apparently violating Newton's Laws of Motion (which also govern how the planets move around our Sun)." This didn't make any sense. Gravity should exert less pull on distant objects, which should move slower. But Rubin was observing something entirely different.

One possible explanation was something that had been theorized as far back as 1933, by Swiss astrophysicist Fritz Zwicky, who coined the phrase "dark matter" to describe a mass we couldn't see, but which was influencing the behavior of the orbits in the galaxies. Dark matter became the simplest explanation for the observed phenomenon, and Vera Rubin has been credited with providing the first evidence of its existence. What is particularly interesting is that to this day no one has ever actually discovered dark matter.

Why are more complicated explanations less likely to be true? Let's work it out mathematically. Take two competing explanations, each of which seem to equally explain a given phenomenon. If one of them requires the interaction of three variables and the other the interaction of thirty variables, all of which *must* have occurred to arrive at the stated conclusion, which of these is more likely to be in error? If each variable has a 99% chance of being correct, the first explanation is only 3% likely to be wrong.

The second, more complex explanation, is about nine times as likely to be wrong, or 26%. The simpler explanation is more robust in the face of uncertainty.





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It was Rubin's observations of the Andromeda galaxy that led to her to collect the first evidence in support of the theory of dark matter— a substance that does not emit energy or light.

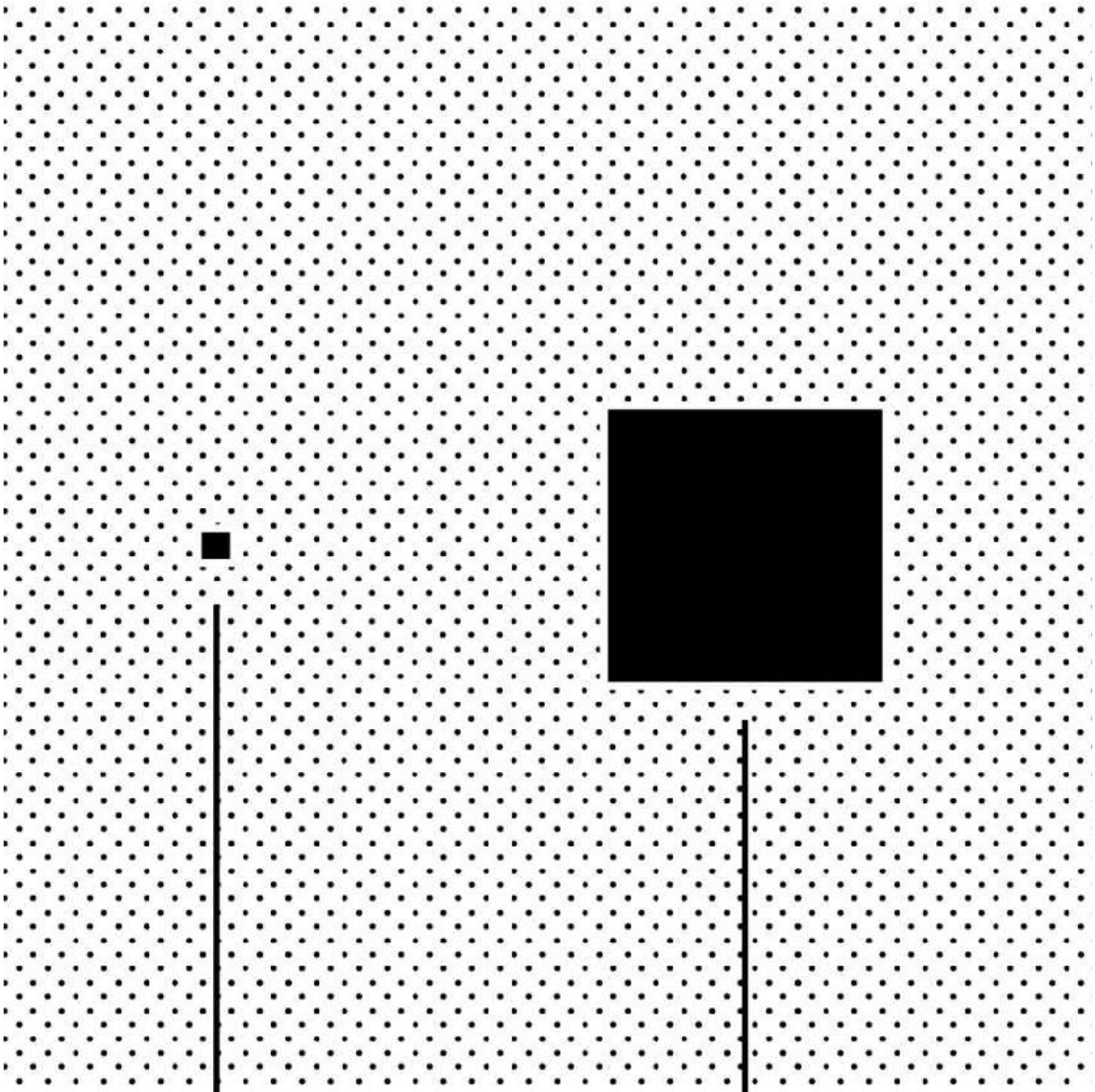
Dark matter is an excellent theory with a lot of explanatory power. As Lisa Randall explains in *Dark Matter and the Dinosaurs*, measurements

of dark matter so far fit in exactly with what we understand about the Universe. Although we can't see it, we can make predictions based on our understanding of it, and test those predictions. She writes, "It would be even more mysterious to me if the matter we can see with our eyes is all the matter that exists."[9] Dark matter is currently the simplest explanation for certain phenomena we observe in the Universe. The great thing about science, however, is that it continually seeks to validate its assumptions.

Sagan wrote that "extraordinary claims require extraordinary proof."[10] He dedicated much ink to a rational investigation of extraordinary claims. He felt most, or nearly all, were susceptible to simpler and more parsimonious explanations. UFOs, paranormal activity, telepathy, and a hundred other seemingly mystifying occurrences could be better explained with a few simple real world variables. And as Hume suggested, if they couldn't, it was a lot more likely that we needed to update our understanding of the world than that a miracle had occurred.

And so, dark matter remains, right now, the simplest explanation for the peculiar behavior of galaxies. Scientists, however, continue to try to conclusively discover dark matter and thus try to determine if our understanding of the world is correct. If dark matter eventually becomes too complicated an explanation, it could be that the data describes something we don't yet understand about the universe. We can then apply Occam's Razor to update to what is the simplest, and thus easiest to verify, explanation. Vera Rubin herself, after noting that scientists always felt like they were ten years away from discovering dark matter without ever closing the gap, was described in an interview as thinking, "The longer that dark matter went undetected, … the more likely she thought the solution to the mystery would be a modification to our understanding of gravity."[11] This claim, demanding a total overhaul of our established theories of gravity, would correspondingly require extraordinary proof!

99% chance of being correct



3%
wrong

26%
wrong

Explanation 1

Explanation 2

Simplicity can increase efficiency

With limited time and resources, it is not possible to track down every theory with a plausible explanation of a complex, uncertain event. Without the filter of Occam's Razor, we are stuck chasing down dead ends. We waste time, resources, and energy.

The great thing about simplicity is that it can be so powerful. Sometimes unnecessary complexity just papers over the systemic flaws that will eventually choke us. Opting for the simple helps us make decisions based on how things really are. Here are two short examples of those who got waylaid chasing down complicated solutions when simple ones were most effective.

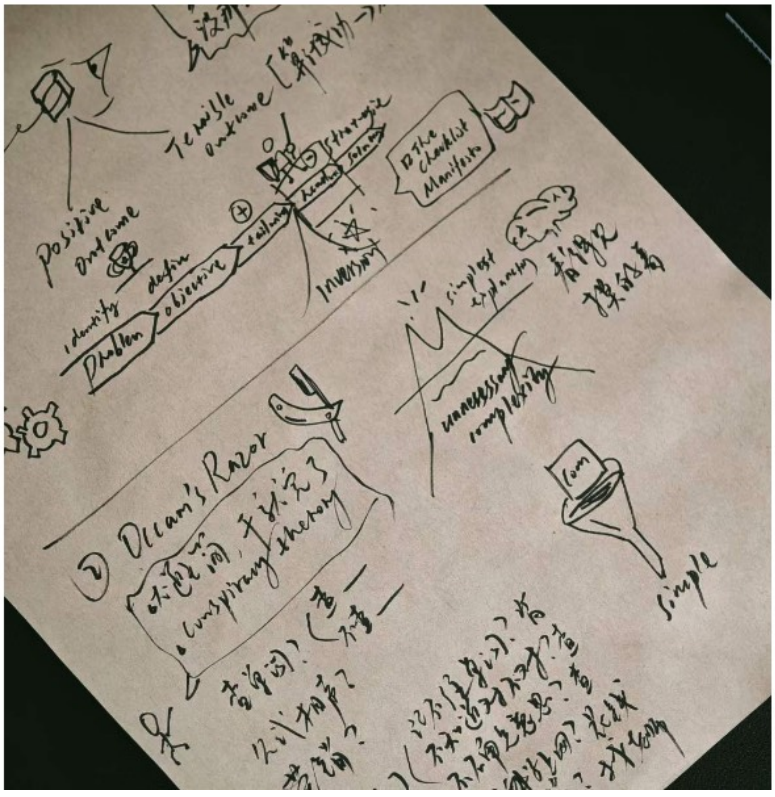
The ten-acre Ivanhoe Reservoir in Los Angeles provides drinking water for over 600,000 people. Its nearly 60 million gallons of water are disinfected with chlorine, as is common practice.[12] Ground water often contains elevated levels of a chemical called bromide. When chlorine and bromide mix, then are exposed to sunlight, they create a dangerous carcinogen called bromate.

In order to avoid poisoning the water supply, the L.A. Department of Water and Power (DWP) needed a way to shade the water's surface. Brainstorming sessions had yielded only two infeasible solutions, building either a ten-acre tarp or a huge retractable dome over the reservoir. Then a DWP biologist suggested using "bird balls," the floating balls that airports use to keep birds from congregating near runways. They require no construction, no parts, no labor, no maintenance, and cost US$0.40 each. Three million UV-deflecting black balls were then deployed in Ivanhoe and other LA reservoirs, a simple solution to a potentially serious problem.

张海露 Eric🎺

边备课，边用刚刚写字纸北面随手写了个笔记。我发现我在英语学习上一直在践行 这些 mental models，比如今天要讲的奥卡姆剃刀，英语学习的很多问题并不复杂，是商家营销号们故意把它变得神秘和复杂。比如背单词，你不需要去了解什么记忆方法什么曲线，背东西的基本是重复，那你增加重复的量就完了，我当初刚开始学英语不知道怎么学，就天天背单词，就这一件事情就让我考过了四六级。类似的都可以这样简单粗暴的解决，比如不会自学？花钱找老师；不知道自己写的对不对就不写，写自己确定的；不知道一个词啥意思就去查，词典上查不到就去搜。我们需要深入思考，也需要看到最明显最能执行最少副作用的解决方案。

Show Less



Occam's Razor in the Medical Field

Occam's Razor can be quite powerful in the medical field, for both doctors and patients. Let's suppose that a patient shows up at a doctor's office with horrible flu-like symptoms. Are they more likely to have the flu or have contracted Ebola?

This is a problem best solved by a concept we explored in the chapter on Probabilistic Thinking, called Bayesian Updating. It's a way of using general background knowledge in solving specific problems with new information. We know that generally the flu is far more common than Ebola, so when a good doctor encounters a patient with what looks like the flu, the simplest explanation is almost certainly the correct one. A diagnosis of Ebola means a call to the Center for Disease Control and a quarantine— an expensive and panic-inducing mistake if the patient just has the flu. Thus, medical students are taught to heed the saying, "When you hear hoofbeats, think horses, not zebras."

And for patients, Occam's Razor is a good counter to hypochondria. Based on the same principles, you factor in the current state of your health to an evaluation of your current symptoms. Knowing that the simplest explanation is most likely to be true can help us avoid unnecessary panic and stress.

In another life-and-death situation, in 1989 Bengal tigers killed about 60 villagers from India's Ganges delta.[13] No weapons seemed to work against them, including lacing dummies with live wires to shock the tigers away from human populations.

Then a student at the Science Club of Calcutta noticed that tigers

only attacked when they thought they were unseen, and recalled that the patterns decorating some species of butterflies, beetles, and caterpillars look like big eyes, ostensibly to trick predators into thinking their prey was also watching them. The result: a human face mask, worn on the back of head. Remarkably, no one wearing a mask was attacked by a tiger for the next three years; anyone killed by tigers during that time had either refused to wear the mask, or had taken it off while working. — *Sidebar: Occam's Razor in the Medical Field*

A few caveats

One important counter to Occam's Razor is the difficult truth that some things are simply not that simple. The regular recurrence of fraudulent human organizations like pyramid schemes and Ponzi schemes is not a miracle, but neither is it obvious. No simple explanation suffices, exactly. They are a result of a complex set of behaviors, some happening almost by accident or luck, and some carefully designed with the intent to deceive. It isn't a bit easy to spot the development of a fraud. If it was, they'd be stamped out early. Yet, to this day, frauds frequently grow to epic proportions before they are discovered.

Alternatively, consider the achievement of human flight. It, too, might seem like a miracle to our 17th century friar, but it isn't— it's a natural consequence of applied physics. Still, it took a long time for humans to figure out because it's not simple at all. In fact, the invention of powered human flight is highly counterintuitive, requiring an understanding of airflow, lift, drag, and combustion, among other difficult concepts. Only a precise combination of the right factors will do. You can't just know enough to get the aircraft off the ground, you need to keep it in the air!

The Razor in Leadership

When Louis Gerstner took over IBM in the early 1990s, during one of the worst periods of struggle in its history, many business pundits called for a statement of his vision. What rabbit would Gerstner pull out of his hat to save Big Blue?

It seemed a logical enough demand— wouldn't a technology company that had fallen behind need a grand vision of brilliant technological leadership to regain its place among the leaders of American innovation? As Gerstner put it, "The IBM organization, so full of brilliant, insightful people, would have loved to receive a bold recipe for success— the more sophisticated, the more complicated the recipe, the better everyone would have liked it."

Smartly, Gerstner realized that the simple approach was most likely to be the effective one. His famous reply was that "the last thing IBM needs right now is a vision." What IBM actually needed to do was to serve its customers, compete for business in the here and now, and focus on businesses that were already profitable. It needed simple, tough-minded business execution.

By the end of the 1990s, Gerstner had provided exactly that, bringing IBM back from the brink without any brilliant visions or massive technological overhauls.

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Gerstner, Louis V.
Who Says Elephants Can't Dance? Leading a Great Enterprise Through Dramatic Change.
New York: HarperCollins, 2003.

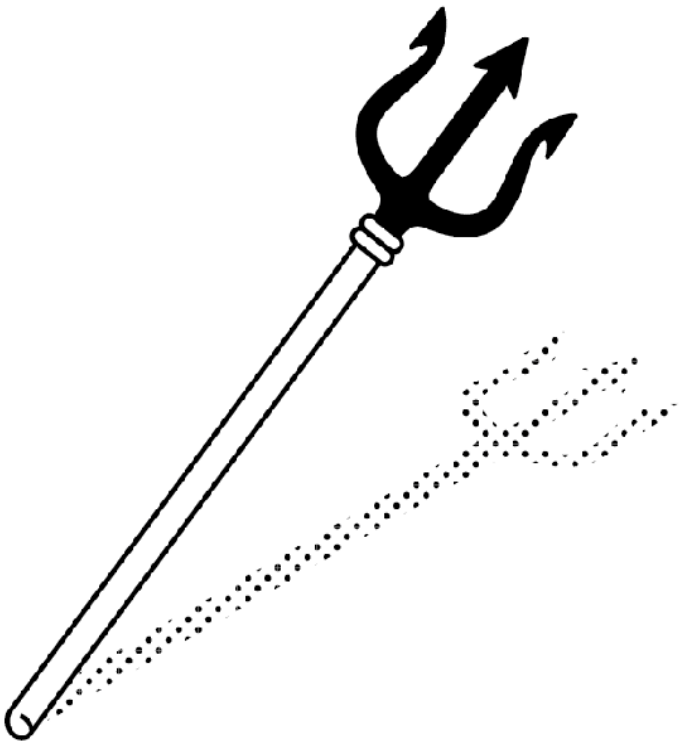
Simple as we wish things were, irreducible complexity, like simplicity, is a part of our reality. Therefore, we can't use this Razor to create artificial simplicity. If something cannot be broken down any further, we must deal with it as it is.

How do you know something is as simple as it can be? Think of computer code. Code can sometimes be excessively complex. In trying to simplify it, we would still have to make sure it can perform the functions we need it to. This is one way to understand simplicity. An explanation can be simplified only to the extent that it can still provide an accurate understanding.

Conclusion

Of course, focusing on simplicity when all others are focused on complexity is a hallmark of genius, and it's easier said than done. But always remembering that a simpler explanation is more likely to be correct than a complicated one goes a long way towards helping us conserve our most precious resources of time and energy. — *Sidebar: The Razor in Leadership*

Hanlon's Razor



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Don't assume the worst.

I need to listen well so that I hear what is not said.

Thuli Madonsela[1]

The People Who Appear in this Chapter

Honorius.
384-423 - Western Roman Emperor for 30 years. His reign was chaotic and messy, and saw Rome being sacked for the first time in almost 800 years.

Stilicho.
359-408 - High ranking general in the Roman army. Half Vandal, his regency for Honorius marked the high point of Germanic advancement in the service of Rome.

Arkhipov, Vasili.
1926-1998 - Russian. Retired as a Vice-Admiral in the Soviet Navy.
In 1961 he was deputy commander of K-19. The events on board inspired the Harrison Ford movie, *K-19: The Widowmaker.*

Hanlon's Razor

Hard to trace in its origin, Hanlon's Razor states that we should not attribute to malice that which is more easily explained by stupidity. In a complex world, using this model helps us avoid paranoia and ideology. By not generally assuming that bad results are the fault of a bad actor, we look for options instead of missing opportunities. This model reminds us that people do make mistakes. It demands that we ask if there is another reasonable explanation for the events that have occurred. The explanation most likely to be right is the one that contains the least amount of intent.

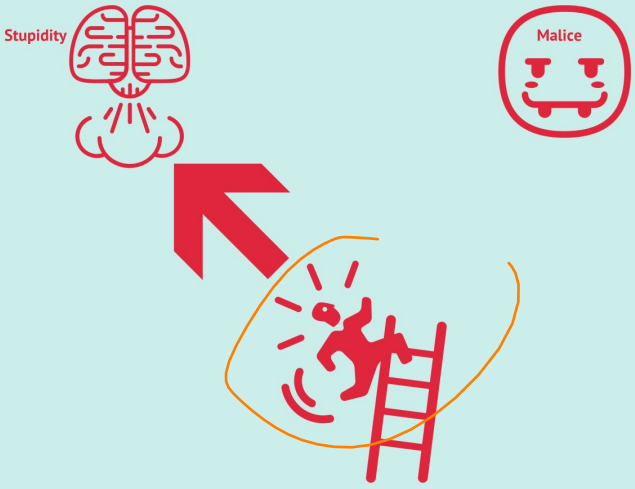
Assuming the worst intent crops up all over our lives. Consider road rage, a growing problem in a world that is becoming short on patience and time. When someone cuts you off, to assume malice is to assume the other person has done a lot of risky work. In order for someone to deliberately get in your way they have to notice you, gauge the speed of your car, consider where you are headed, and swerve in at exactly the right time to cause you to slam on the brakes, yet not cause an accident. That is some effort. The simpler and thus more likely explanation is that they didn't see you. It was a mistake. There was no intent. So why would you assume the former? Why do our minds make these kinds of connections when the logic says otherwise?

The famous Linda problem, demonstrated by the psychologists Daniel Kahneman[2] and Amos Tversky in a 1982 paper, is an illuminating example of how our minds work and why we need Hanlon's Razor. It went like this:

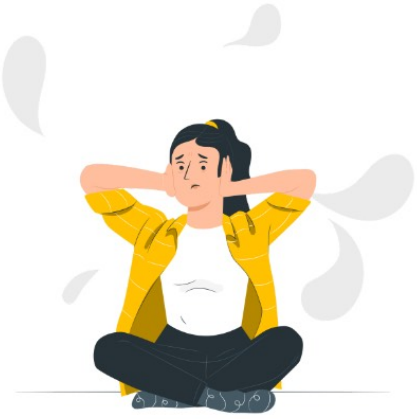
> *Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.*

Hanlon's Razor

"Never attribute to malice that which is adequately explained by stupidity."



FourWeekMBA

SITUATION	FLAWED THINKING	HANLON'S RAZOR
		
MY MANAGER HAS NOT INVITED ME TO SPRINT PLANNING MEETING!	~~MY MANAGER DOES NOT LIKE ME~~ ~~HE FEELS I AM INCOMPETENT~~ ~~HE IS TRYING TO INSULT ME~~ ~~HE IS SEEKING REVENGE AGAINST ME~~	HE MAY HAVE FORGOTTEN TO ADD ME.

Which is more probable?

1. Linda is a bank teller.
2. Linda is a bank teller and is active in the feminist movement.

The majority of respondents chose option 2. Why? The wording used to describe her suggests Linda is feminist. But Linda could only be a bank teller, or a feminist *and* a bank teller. So naturally the majority of students concluded she was both. They didn't know anything about what she did, but because they were led to believe she had to be a feminist they couldn't reject that option, even though the math of statistics makes it more likely that a single condition is true instead of multiple conditions. In other words, every feminist bank teller is a bank teller, but not every bank teller is a feminist.

Thus, Kahneman and Tversky showed that students would, with enough vivid wording, assume it more likely that a liberal-leaning woman was both a feminist *and* a bank teller rather than simply a bank teller. They called it the "Fallacy of Conjunction."

With this experiment, and a host of others, Kahneman and Tversky exposed a sort of tic in our mental machinery: we're deeply affected by vivid, available evidence, to such a degree that we're willing to make judgments that violate simple logic. We over-conclude based on the available information. We have no trouble packaging in unrelated factors if they happen to occur in proximity to what we already believe.

The Linda problem was later criticized as the psychologists setting their test subjects up for failure. If it was stated in a different way, subjects did not always make the error. But this of course was their point. If we present the evidence in a certain light, the brain malfunctions. It doesn't weigh out the variables in a rational way.

What does this have to do with Hanlon's Razor? The connection is this:

When we see something we don't like happen and which seems wrong, we assume it's intentional. But it's more likely that it's completely unintentional. Assuming someone is doing wrong and doing it purposefully is like assuming Linda is more likely to be a bank teller *and* a feminist. Most people doing wrong are not bad people trying to be malicious.

With such vividness, and the associated emotional response, comes a sort of malfunctioning in our minds when we're trying to diagnose the causes of a bad situation. That's why we need Hanlon's Razor as an important remedy. Failing to prioritize stupidity over malice causes things like paranoia. Always assuming malice puts you at the center of everyone else's world. This is an incredibly self-centered approach to life. In reality, for every act of malice, there is almost certainly far more ignorance, stupidity, and laziness.

> «One is tempted to define man as a rational animal who always loses his temper when he is called upon to act in accordance with the dictates of reason.»
>
> Oscar Wilde[3]

The end of an empire

In 408 AD, Honorius was the Emperor of the Western Roman Empire. He assumed malicious intentions on the part of his best General, Stilicho, and had him executed. According to some historians, this execution may have been a key factor in the collapse of the Empire.[4,5]

Why? Stilicho was an exceptional military general who won many campaigns for Rome. He was also very loyal to the Empire. He was not, however, perfect. Like all people, he made some decisions with negative outcomes. One of these was persuading the Roman Senate to accede to the demands of Alaric, leader of the Visigoths. Alaric had attacked the Empire

multiple times and was no favorite in Rome. They didn't want to give in to his threats and wanted to fight him.

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Rome didn't fall in a day. It was a decades-long crumble that saw a disbursement of power in Europe and a steady dismantling of the Roman infrastructure.

Stilicho counseled against this. Perhaps he had a relationship with Alaric and thought he could convince him to join forces and push back against the other invaders Rome was dealing with. Regardless of his reasoning, this action of Stilicho's compromised his reputation.

Honorius was thus persuaded of the undesirability of having Stilicho around. Instead of defending him, or giving him the benefit of the doubt on the Alaric issue, Honorius assumed malicious intent behind Stilicho's

actions— that he wanted the throne and so was making decisions to shore up his power. Honorius ordered the general's arrest and likely supported his execution.

Without Stilicho to influence the relationship with the Goths, the Empire became a military disaster. Alaric sacked Rome two years later, the first barbarian to capture the city in nearly eight centuries. Rome was thus compromised, a huge contributing factor to the collapse of the Western Roman Empire.

Hanlon's Razor, when practiced diligently as a counter to confirmation bias, empowers us, and gives us far more realistic and effective options for remedying bad situations. When we assume someone is out to get us, our very natural instinct is to take actions to defend ourselves. It's harder to take advantage of, or even see, opportunities while in this defensive mode because our priority is saving ourselves— which tends to reduce our vision to dealing with the perceived threat instead of examining the bigger picture.

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By not assuming the worst, Vasili Arkhipov single-handedly avoided nuclear war with the Americans.

The man who saved the world

On October 27, 1962, Vasili Arkhipov stayed calm, didn't assume malice, and saved the world. Seriously.

This was the height of the Cuban missile crisis. Tensions were high between the United States and the Soviet Union. The world felt on the verge of nuclear war, a catastrophic outcome for all.

American destroyers and Soviet subs were in a standoff in the waters off Cuba. Although they were technically in International waters, the Americans had informed the Soviets that they would be dropping blank depth charges to force the Soviet submarines to surface. The problem was, Soviet HQ had failed to pass this information along, so the subs in the area were ignorant of the planned American action.[6]

Arkhipov was an officer aboard Soviet sub B-59— a sub that, unbeknownst to the Americans, was carrying a nuclear weapon. When the depth charges began to detonate above them, the Soviets on board B-59 assumed the worst. Convinced that war had broken out, the captain of the sub wanted to arm and deploy the nuclear-tipped torpedo.

This would have been an unprecedented disaster. It would have significantly changed the world as we know it, with both the geopolitical and nuclear fallout affecting us for decades. Luckily for us, the launch of the torpedo required all three senior officers on board to agree, and Arkhipov didn't. Instead of assuming malice, he stayed calm and insisted on surfacing to contact Moscow.

Although the explosions around the submarine could have been malicious, Arkhipov realized that to assume so would put the lives of billions in peril. Far better to suppose mistakes and ignorance, and base the decision not to launch on that. In doing so, he saved the world.

They surfaced and returned to Moscow. Arkhipov wasn't hailed as a hero until the record was declassified 40 years later, when documents revealed just how close the world had come to nuclear war.

The Devil Fallacy

Robert Heinlein's character Doc Graves describes the Devil Fallacy in the 1941 sci-fi story "Logic of Empire", as he explains the theory to another character:

"I would say you've fallen into the commonest fallacy of all in dealing with social and economic subjects— the 'devil' theory. You have attributed conditions to villainy that simply result from stupidity…. You think bankers are scoundrels. They are not. Nor are company officials, nor patrons, nor the governing classes back on earth. Men are constrained by necessity and build up rationalizations to account for their acts."

Hanlon's Razor is a great tool for overcoming this fallacy, one we all fall into at one time or another.

As useful as it can be, it is, however, important not to overthink this model. Hanlon's Razor is meant to help us perceive stupidity or error, and their inadvertent consequences. It says that of all possible motives behind an action, the ones that require the least amount of energy to execute (such as ignorance or laziness) are more likely to occur than one that requires active malice.

Conclusion

Ultimately, Hanlon's Razor demonstrates that there are fewer true villains than you might suppose— what people are is human, and like you, all humans make mistakes and fall into traps of laziness, bad thinking, and bad incentives. Our lives are easier, better, and more effective when we recognize this truth and act accordingly. — *Sidebar: The Devil Fallacy*

Acknowledgements

I'm forever indebted to Charlie Munger, Peter Kaufman, Warren Buffett, and Peter Bevelin, who, to varying degrees, started me down the path of multidisciplinary thinking. I owe them a huge debt of gratitude. While I've sought wisdom from the world, it's a journey that one starts and never completes.

When I first started learning about multidisciplinary thinking there was no source of collected wisdom— no place where I could find the big ideas from multiple disciplines in one place. This book, and indeed, this series, is meant to bring some of the big invariant ideas into the world to help us better understand the world we live in and how it interconnects. These pages are filled with ideas from many great minds. It's only fair to point out that any idea you found in this book comes from someone else.

This book would not be here without the work and talents of Rhiannon Beaubien, Morgwn Rimel, Marcia Mihotich, and Garvin Hirt.

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I also want to thank my kids, William and Mackenzie, who, without knowing it, have provided me with a renewed sense of curiosity and understanding. This book is for you.

I hope you pull this book off your shelf whenever you're stuck or need inspiration in understanding our world. It's designed to be a reference book of big ideas but also a book that pulls you in aesthetically through the intersection of design and content.