

**THE GREAT MENTAL
MODELS:
PHYSICS, CHEMISTRY
AND BIOLOGY (VOL. 2)**
by Shane Parrish

Summary & Worksheet

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The Book In Three Or More Sentences:

A noble project aiming to bring more awareness to important thinking concepts. In volume 2 of The Great Mental Models series, Shane Parish is exploring 24 fundamental mental models from physics, chemistry, and biology. Full of stories and great illustrations, this second book will upgrade your mental capacity. You'll learn how to apply scientific concepts in your normal life. Fill in the gaps in your understanding of the world. And ultimately, make better decisions.

The Core Idea:

Work in accordance with the world, not against it. The mental models presented in this volume will show you how the world works so you can go with the flow of things instead of swimming against the tides of nature's laws. The physics, chemistry, and biology concepts inside this book explore foundational models that can be applied beyond laboratory tests and scientific papers. The author nicely links science frameworks to social science. You'll understand both what you need to do in everyday situations and also what you need to avoid doing.

Highlights:

- *In every ecosystem, there are keystone species (or elements in a certain project) that have a disproportionately large effect on its natural environment.*
- *To stay alive, we need to continuously adapt to the ever-changing environment.*
- *We are energy minimizers – always looking for ways to cut corners and save energy.*

6 Key Lessons from The Great Mental Models Vol.2:

- *Lesson #1: People Interpret the Same Event Differently*
- *Lesson #2: Understand Thermodynamics to Understand How The World Works*
- *Lesson #3: Find The Keystone Component To Create Resilient Organization*
- *Lesson #4: Evolution is an Ongoing Process Requiring Constant Improvements*
- *Lesson #5: We're Prone To Minimize our Energy Output*
- *Lesson #6: Understand the Fundamental Scientific Concepts*

Lesson #1: People Interpret the Same Event Differently

We misjudge a situation, not because of the things that are in front of us but because we're not aware that there are other things, hidden from our sight.

The first concept explored in volume 2 is the theory of relativity.

Shane Parish shares a thought experiment conducted more than 300 years ago – by Galileo Galilei.

What the Italian physicist discovered back then is that when people move at the same speed and in the same direction, they observe the same things. However, they see completely different things when their location, speed, and/or direction are not the same.

The description of the experiment is of a scientist, standing below deck on a ship, who drops a ball from his waist level. The scientist, unable to see the movement of the ship, sees only the vertical movement of the ball. However, since the ship is also moving forward, there is also a horizontal movement that the scientist is unable to capture. Only a person who is not moving, say someone standing on the beach, can see the horizontal movement because his perspective is different.

The concept of relativity helps us understand that different perspectives unlock additional information. If the physical location of two individuals is different, they'll see different things. And even more interestingly, they will both have correct, but different interpretations of the same event.

Realizing that your perspective may be imperfect a lot of times during the day will make you more empathetic and willing to seek different

opinions and points of view. You will stop stubbornly safeguard your opinion and start accepting new viewpoints.

“While we all see our own version of events, the goal is to enlarge our perspective to be a closer representation of reality by removing some of the factors that cloud our judgment. One of the best ways to do this is by noticing and observing the details of what is going on around you.” Shane Parrish

Lesson #2: Understand Thermodynamics to Understand How The World Works

The laws of thermodynamics can help us a lot in terms of understanding how the world works on an atomic level.

Once we have the gist – that everything requires energy and nature is in constant pursuit of balance – we can move with more caution. Preserve our energy and also avoid being influenced by external forces that want to impose their views on us.

For starters, it’s useful to consider the four foundational laws of thermodynamics:

1. Energy is never lost. It can only be transferred from one object, or form, to another. For example, light to heat.
2. Entropy in the world is always increasing. To create order, we need to exhaust energy.
3. Entropy in a system approaches zero when the temperature also approaches zero.
4. The fourth law is called the zeroth law. It was formulated after the above three laws were formed. In short, it states that if two objects exchange no energy, and they are in contact with a third object, there will be no exchange of heat between the three.

Essentially, the laws of thermodynamics are about finding order in the chaotic world.

But the core laws are not the main argument in the book. The metaphorical applications of the laws explained by Shane Parrish are far more interesting for observation and consideration.

For example, regardless of how one thing in nature is far more energy-emitting than another, eventually, the two objects (life forms) will reach a point of mutual existence – equilibrium. Trees, shrubs, animals, parasites all learn to live together in harmony.

Analogically, we can see how different people become the “same” people based on the individuals they regularly see. At some point, if you crowd yourself with the same people without allowing new connections to enter your life, a form of balance will emerge between your views and the views of others – you’ll eventually all think the same way. This means that if we don’t expose ourselves to different concepts and ideas, our mental capacity will always stay the same.

Every new piece of information causes disturbance in your system. At some point, you somehow adopt it. But if you never expose yourself to new behavior traits and new insights, you’ll never grow.

The idea here is that there is value in chaos. If there is only balance, as the author states in the book, “there is no change, no growth, no movement.”

Lesson #3: Find The Keystone Component To Create Resilient Organization

In nature, everything is connected. All species, regardless of their size, interact with each other and rely on the overall function of the rest of the species in order for the system to flourish.

With this in mind, sometimes, small changes in the ecosystem can cause a huge disturbance in the entire system. Whole species can evaporate if a single component is removed from the environment.

These strategic organisms are called keystone species. If they suddenly disappear, the change will be catastrophic for the whole population.

Sea otters are a keystone species. They live in underwater areas with a high density of kelp. And, they are responsible for eating sea urchins because they eat kelp. If there aren’t enough sea otters, the kelp in the ecosystem will be eaten by the urchins. The important thing here is that kelp balances the carbon dioxide in the ecosystem.

Such foundational species and components exist outside the realm of nature.

Your ability to recognize a keystone factor, product, or system in your organization, and even in your life is vital. Once you know what type of work is foundational, you can focus more resources on this particular thing.

But often we misjudge the keystone component. We don’t adequately comprehend the importance of small elements. We think that looks

are important, or that producing a high volume of work is the essential factor to reach the next level. Usually, though, a less obvious component is foundational, and of real importance.

Outside appearance is nice to have, but lasting resilience comes from inside strength.

In your life (ecosystem), everything plays a role. For example, if you don't regularly get enough sleep, you won't get anything done regardless of how creative you are. That is why it's important to spend time and nourish all the little components to live a healthy life.

“Nothing exists in isolation. Everything is connected. The ecosystem lens reveals that the actions of any one species have consequences for many others in the same environment.” Shane Parrish

Lesson #4: Evolution is an Ongoing Process Requiring Constant Improvements

Life is harsh. You either adapt or you die. That's how evolution works. Only the strongest survive to see another day.

This realization is hard to swallow but it also applies to our own lives and institutions.

Our surrounding environment is constantly changing and if we're unable to adapt, we'll soon perish.

That's why it's important to understand a couple of concepts related to evolution.

- **The Red Queen effect:** Staying in the same place – financially, mentally, psychologically – is lethal. You must adapt to the constant changes happening to ensure your survival. The Red Queen effect states that, “the least fit of a species dies first.”
- **Competition is in our nature:** When two species need the same resources to survive, they compete. Naturally, the stronger breed will survive and outperform the weaker one. To survive, you must either make changes or find another form of resource.
- **Exaptation in biology:** The original purpose of feathers was for attracting mates, not for flying. Flying became possible at a later stage. Birds “repurposed” this part of their body. The concept of exaptation basically means that we don't always have to reinvent the wheel. We can simply repurpose what we already have.

Or in other words, it's all about your ability to adapt to the ever-chang-

ing environment and do it fast. To find your niche, to be completely aware of your abilities so you can repurpose them adequately. And, to never stop making positive changes to your persona. Only by doing these things, you can cope with the unstableness of the whole system.

“As Darwin recognized, all life is a struggle for survival. Species that are able to fight for the resources they need to survive and reproduce are the successful ones.” Shane Parrish

Lesson #5: We're Prone To Minimize our Energy Output

All our daily functions consume energy. Even the act of obtaining more energy, requires energy – finding food and eating. Unsurprisingly, all species developed different techniques to minimize the energy output.

Sadly, for us, humans, this trait is worsening our spot in the universe. As the world is more and more focused on fast outcomes and frenzy-like productivity, preserving energy leads to chronic laziness.

Apart from resting every time they get the chance, different animals have different systems to minimize energy output. The stable temperature of cold-blooded species saves them energy. The aerodynamic shape of sharks and their sophisticated skin structure reduce water resistance.

What do humans do?

Our bodies are also unique and have different systems to preserve energy. We have body hair that keeps us warm and our nervous system subconsciously monitors energy use and continuously re-optimizes our movements. But these methods are not enough. The largest energy consumer in humans is the brain.

To cut corners and consume less resources, the brain creates a set of heuristics. This means that, for example, we don't consider all possible moves when we play chess. Our brain focuses on the most used tactics by us in the past and ignores everything else to save energy.

The bottleneck of this tendency we all have is the unsatisfactory results it produces. The brain highlights the first solution that comes to mind and it's unwilling to imagine more options. And like we all know, the first solutions are usually not the best.

So, to avoid making the wrong collusion, apart from constantly trying to level up your thinking by reading, taking some time to think about

alternative solutions is a useful approach.

“If we want to develop our thinking and get the most out of our environments, then we have to be aware of the natural tendency to minimize energy output and correct for it where doing so creates value.” Shane Parrish

Lesson #6: Understand the Fundamental Scientific Concepts

The path to multidisciplinary thinking is a path worth pursuing.

It's a tough one though. It requires not only to understand different concepts, but also to allow yourself the opportunity to make connections between everything you learn – something not so obvious. By doing so, you'll find new relationships, discover hidden opportunities, and create a network of useful understandings in your brain about the world. Therefore, move faster in the right direction.

Below, I'll provide a short overview of all mental models mentioned in the book so you can get the essence of the content. Hence, upgrade your mental toolbox:

Physics

- **Relativity:** Your perspective is subjective. What you know is heavily influenced by your physical location, mental capacity, and current beliefs. To uncover gaps in a given situation, always consider the opinion of others. That's the only way you can see things clearly.
- **Reciprocity:** In physics, a reciprocal force is experienced whenever an object is exerting force (Newton's third law). The same correlation exists between giving and taking in our normal life. You need to give first so you can then receive.
- **Thermodynamics:** Energy is freely flowing between different objects. It cannot be destroyed nor it can be easily tamed. To reduce entropy in your world (the free flow of energy that is causing chaos) you need to exhaust energy. But since energy is scarce, it's best to place barriers between you and the outside noise to protect yourself from unwanted bad influence. Yet, this comes at a cost too – you also need to spend energy to maintain this separation.
- **Inertia:** Changes in our society are hard and sluggish because people resist accepting new ideas. Amending your views requires effort while believing what you currently hold in your mind is an idle process – effortless. To get an idea rolling, you need to get momentum.
- **Friction and viscosity:** When friction increases in an environment, movement slows down. With this in mind, the author concludes

that the successful distribution of the information does not depend on its usefulness. It depends on the environment. If a society (the environment) is keen on reading “shocking” news, instead of well-supported reports, tyrannic updates will always rule our media. And when something truthful is shared, it will be quickly forgotten because friction is high.

- **Velocity:** Velocity is not speed. Velocity is a focused movement towards a particular place. That’s why solely moving fast doesn’t guarantee success, you need to move in the right direction. Figure out where you want to go first, then focus on speed.
- **Leverage:** Our force is limited. Even if we exhaust ourselves to death, we can only produce so much. Achieving greater outputs happens only with the help of a lever. But finding where you have leverage is not enough. You also need to consider how much pressure to apply in a given situation. Often leverage is confused with manipulation. But it’s a different kind of force-usage. It’s about influencing a given situation based on your skills to get the desired outcome.

Chemistry

- **Activation energy:** Everything requires energy. To get from one state to another, you need enough power to go all the way. Activation energy is the source that ignites a reaction in a component and steers it in a new direction. But making a lasting change and seeing something get done doesn’t happen by a single stroke of a match, you also need to consider how much energy you will need to get all the way from point A to point B. As the author writes, “Creating lasting change is harder than creating change.”
- **Catalysts:** Catalysts are ingredients that accelerate change in chemical reactions. An additional positive quality is their reusability – you can use them in other reactions. That’s why they are so useful. Similar attributes are present in modern inventions by man. The printing press transformed the way information is produced and later distributed. It was a catalyst that basically accelerates knowledge.
- **Alloying:** The process of combining different components to produce new material is called alloying. That’s how we invented steel. In our everyday life, the concept of alloying can be used in various ways. You can join forces with other people to get more done. Also, you can mix different ideas so you can eventually form a new kind of object, better than the sum of its parts.

Biology

- **Natural selection and extinction:** Being flexible, that is, your ability to adapt your behavior depending on the situation, is key to longevity. If we fail to respond to the changing environment, we’ll perish. This is true both in the animal world and in ours.

- **Adaptation rate and the Red Queen effect:** You don't necessarily have to be the best in the world to survive, you can focus on being the best in your surrounding environment. The Red Queen effect is a principle that states that the least fit species die first. If you stop adapting, you stop your progress and therefore you prevent yourself from existing.
- **Ecosystem:** Everything is connected. Nothing exists in isolation and every living creature in some way affects the souls near it. If you uncover the keystone individual, or component in your micro-environment, you can make the right judgments.
- **Niches:** Species that can be categorized as generalists are more rigid when there are disturbances in the system. They have access to a variety of skills that allow them to quickly change their strategy. In contrast, specialists can suffer greatly when conditions change. They have pretentious food preferences and their skills are valuable only under special conditions. And while being a generalist seems like the best approach, specialists don't have to compete with everyone. Their unique attributes allow them to rule a small territory.
- **Self-preservation:** When exposed to a life-threatening situation, we either fight, run or we freeze. The self-preservation instinct plays a big role in our daily lives. We avoid hard tasks not only because they are difficult but also because our brains convince us to neglect them. For the brain, actions that don't bring immediate results are not prioritized. We need to force ourselves to do them.
- **Replication:** We're alive thanks to our ability to reproduce – the process of cell replication. But when there is no diversity between two subjects that reproduce (for example between family members), the outcome is catastrophic. That's because, as Shane Parrish concludes in the book, “the more you copy something, the more it weakens.” You need genetic diversity to create a thriving new individual. You also need to combine unusual ideas to create something genuine.
- **Cooperation:** Big projects require joint efforts. This can be easily observed in all human achievements – buildings, roads, societies, etc. But in order for cooperation between a group of people to flourish, first cooperation between the actual members – between the individuals – should be established.
- **Hierarchical organization:** Rank-based structures exist and can be observed in different breeds across the animal world. The main responsibilities of the leader on the top can be boiled down to these three: 1) assisting in finding food for everyone, 2) protection from other animals, 3) enforcing norms to ensure a flourishing society. The interesting thing about hierarchical organizations is that even if there isn't a defined hierarchy – boss, manager, etc. – people always form some sort of mutual agreement about who should lead.
- **Incentives:** We camouflage our incentives with socially accepted desires to look nobler in the eyes of others. The other common trait is that we prioritize short-term rewards over long-term proj-

ects. To solve the last problem, consider what Sun Tzu said years ago, “a good leader leads his men into battle like a man climbing to a height and kicking away the ladder.”

- **Tendency to minimize energy output:** All living creatures are designed to preserve energy. Saving energy means higher chances for survival. In our modern world though, our ambition to minimize energy output leads to laziness. Storing energy while also moving in the desired direction can happen when you reduce friction in your environment and also increase your base level of knowledge.

“There are several ways of achieving the same goal, people will eventually gravitate to the least demanding course of action. In the economy of action, effort is a cost, and the acquisition of skill is driven by the balance of benefits and costs. Laziness is built deep into our nature.” Shane Parrish

Actionable Notes:

- **Practice perspective-taking:** Your ability to consider a situation from a different point of view is a powerful mental skill. There are two components involved to master this feature. First, there is the physical perspective. Or in other words, your view is based on your physical location. If you change your location, you will see different things. If you’re unable to move to a different place, you can at least try to imagine what can be seen from this other place. The second one is called conceptual perspective. Although you can’t actually feel what others are feeling, you can imagine how what they are experiencing is influencing their emotions.
- **Put up walls:** The world is naturally moving towards equilibrium. When two objects with different temperatures interact with each other, they eventually become the same temperature. The application related to this in your daily life here is twofold: First, you should expose yourself more frequently to sources with “higher temperature.” Interact with people smarter than you so you can increase your base level of smartness. Secondly, you should put up walls to protect yourself from low-quality information. Our ancestors knew that building walls wasn’t going to protect them from armies or the outside population. But the walls they have built for years gave them something else in return: the ability to control what enters and leaves the state.
- **Incentives direct our behavior:** Our desire to earn money, so we can survive is what keeps us on a job we don’t like. If the incentive to have a meaningful purpose is stronger, though, we will most likely take a different path. We need to understand our values first to ensure we have the right incentives. But there is more. We also need to recognize what drives others – especially the ones around us. Our default actions are aimed at getting rewards and avoiding

punishments. But a lot of times worthy rewards require some sort of punishment to be reached.

- **Let curiosity drive you:** A way to get closer to where you want can be accelerated by learning from the experience of other people. Gathering knowledge from various sources will prepare you for the pitfalls you'll eventually encounter. You start to see what needs to be avoided and also what causes successful results. But the best part is that you accumulate a library of ideas. When curiosity drives your behavior, you get interested in different fields. The various concept you obtain then give you the opportunity to understand the world on a deeper level. Once this is done, you can then combine these different ideas, melt them together in a unique way to form a special new "material."
- **Create for the sake of creating:** How do you approach new projects? First, most probably, you establish a goal that will give you direction, and secondly, your ambition, probably, is to build something unique. But original creations rarely happen when you start creating, hoping to invent a new flying machine right off the bat. As the author writes, "Having to know the benefit of everything before you begin leads to missed opportunities." Spend time creating without a clear agenda. Test. Explore. Break things. You never know where this work will lead you.

Commentary and My Personal Takeaway

There is a good reason why the ideas from physics, chemistry, and biology discussed in this book are worth learning. We exist, in this very moment, thanks to thousands of years of evolution.

The energy circling around and the substances that flow in our bodies and in the bodies of everyone else are what make the world works. And by understanding these forces, you'll uncover truths about our surroundings that are essential for a happy life.

By backing up the scientific concepts mentioned in the subtitle of the book with real-world stories and practical steps, Shane Parrish gives us more ways to understand and apply ideas and concepts that are foundational for the life we live in. In other words, by learning the most common scientific laws that move the world, you'll make better decisions *in* the world.

The short chapters and the supporting stories mentioned make this book a must-have addition to your library. The Great Mental Models Vol. 2 is designed to be frequently used and referred to when you're dealing with baffling situations in your real life.

Key takeaway:

When in trouble, look at nature. Nothing in nature is created without a reason. Everything has a purpose. By observing how animals solve problems – search for food, fly, even move – we can learn to approach our own problems in a new, better way.

Notable Quotes:

“Life is an iterative and compounding game. In the words of Peter Kaufman, it pays to “go positive and go first.” Also, remember that people make mistakes. Assuming there is no maliciousness, it pays to forgive.” Shane Parrish

“Better go the right direction slowly than the wrong direction with speed.” Shane Parrish

*“External stability is important for overall success. Even if you can’t control the external factors, you must pay attention to them.”
Shane Parrish*

What to read next:

- [The Great Mental Models](#) (Vol. 1) by Shane Parrish [Summary]
- [Super Thinking: The Big Book of Mental Models](#) by Gabriel Weinberg [Summary]
- [How to Take Smart Notes](#) by Sönke Ahrens [Summary]

INTERACTIVE SHEET FOR NOTE-TAKING

Reading alone won't help you understand the actionable notes. You need to engage with the content. Answer the question below (just type inside the boxes) to outline your future steps:

- 1. Always consider the perspective of others. Try to imagine what they feel and see.*
- 2. What can you do to block the negative outside influence?*
- 3. What can you do to expose yourself more to "high temperature" people?*
- 4. What are your real incentives?*
- 5. Schedule time to create for the sake of creating (without a clear agenda):*

Don't forget to save your changes.