Ashby's Law of Requisite Variety

The Story of Requisite Variety for Reflective Practitioners

It is a real pity that the idea of Requisite Variety is almost unknown. From my perspective, it is astonishing that almost no one with a degree in business has heard about it, not to talk about many Agile or Lean folks. It is insofar unbelievable, as the whole concept of Requisite Variety offers fundamental insights about systems and how "goal achievement" can be understood. Actually, it should be part of every human being's repertoire that is involved in an organization (so basically everyone). The whole idea of Requisite Variety could be compared to the insights of the Laws of Motion from Isaac Newton. Therefore I dare to claim that the knowledge of Ashby's Law of Requisite Variety is for a business person of the same importance as Newton's insights about Gravity for a physics researcher. I still do not understand why this relatively simple concept is not part of every business or economics school in the world – from Harvard to Frankfurt?!

First things first, therefore, let us start with an examination, what variety means. After this introduction, I'll dive into the concept of Requisite Variety.

What does the term variety mean?

The shortest possible definition: Variety measures the **number of possible system states**. This description might sound simple, but its impact is powerful: The term offers a **measure for complexity**. It allows us to use the concept of probabilities (stochastic systems) to deal with "high variety systems", also known as **complex systems**. Furthermore, it allows us to distinguish **simple**, **complicated** and **chaotic systems** since humans usually have only a "feeling" for the above-mentioned problem domains. The term variety enables a "qualitative-quantitative" approach to understand these problem domains and deal with real-life situations.

Let's make the concept more tangible with some examples from the gaming world.

Examples for Variety and

Problem Domains according to Cynefin Framework

Simple: A regular dice is maybe the most accessible example for the domain of simple problems. Since the dice has six sides, the total number of possible system states is six. This is a deterministic system – all system states are predefined and will not change (as long as it is a dice with six sides).

Complicated: This problem domain might consist of hundreds of thousands of possible system states. One could experience it in situations when experts tackle, for instance, an engineering problem. Let's imagine there are ten experts, and each of them has two different ideas that are different from the other ideas. You end up with 1024 possible states (2^{10}).

Complex: The Game of chess is another example of complexity. Allegedly the amount of possible positions on the board equals about 10^{50}. Quite a lot if you consider that the estimated amount of atoms in the observable universe is about 10^{90}. But the Game of Go is the real blast because it has a variety of $2{,}08*10^{170}$ possible token positions. Side note: This fact might illustrate why the achievements of Alpha Go are interesting – to say the least.

Chaotic: This domain is, IMHO, an exceptional case. In a technical sense, chaotic behavior is entirely unpredictable, nor can it be explained in the retrospective. Chaos means a "real" random function with no pattern at all. Therefore, the variety of this domain can not be measured at all – everything is just "happening." Of course, this statement has only a metaphorical quality. An example could be a situation where a player is playing a game where she/he knows absolutely nothing about the rules, the goal, and so on.

Hopefully, this explanation helped clarify a useful meaning of variety and how the number of possible system states helps identify problem domains in the game context. Now it is time to have a look at Ashby's Law of Requisite Variety and its insights regarding control (= goal achievement).

Requisite Variety and Ashby's Law

Ross Ashby is the creator of the basic cybernetic theory of control. His work is often reduced to the following phrase:

"Only variety absorbs variety."

This statement means that any viable system, which can cope with a changing environment, contains a matching variety (=possible system states) in relation to the environment. In short: The complexity of a viable system (or business) must match (up to a certain extent) the domain's complexity.

Now we encounter Ashby's term of Requisite Variety. Which variety is necessary/mandatory to cope with the dynamics of the "outside"? Do we need "endless" variety? The answer is no. A system needs, based on its selections of the incoming variety, just a matching variety. Why? Because the number of possible states of the environment is always higher than the variety of embedded systems. This insight implies that an embedded system needs to **dampen the incoming variety** since it is impossible to cope with ALL possible states. Boundaries are needed. **We can not fulfill all demands of all customers**, so we are forced to make decisions. In praxis, this means one has to prioritize, which is a wonderful way to reduce variety. From this insight, we can deduct that any viable system can maintain its viability by successfully reducing the incoming variety (= complexity) of the environment. Only THIS kind of information enters the system, which ensures that it contributes to the ability to exist in the environment. A viable system seeks the **Requisite Variety** in a given situation. Not more, not less.

The following formula nails it down:

Variety formula: V(C) >= V(S)

The variety of the Controller (C) must be equal or higher than the variety of the Situation (S, Environment). In pragmatic business terms: The internal variety of a productive working system must match the external variety of the environment (situation). Therefore, it is not only mandatory to reduce the incoming variety, but also to increase the internal variety to reach the Requisite Variety. Typically this means you need sufficient resources, capabilities, and time to solve customer problems in a given situation.

Let’s have a look at this abstract concept and apply it to a simple real-world problem (which turns out not to be so simple at all).

The problem solving/goal achievement example

Imagine you have an electrical circuit that you have not build by yourself. You look at it, and you observe six elements:

- Light Bulb
- Battery
- Switch
- Three wires to connect the elements above

The circuit is working fine, as shown in the following illustration:

Suddenly the light turns off. You try to turn the switch off and on again, but the bulb stays dark.

Scenario 1: You want to find the error and first check the light bulb. In this scenario, you see the burned wire and replace the bulb. You check the function, and yes – it’s working. You found the error.

Now let’s look at what happened in the context of Ashby’s Law of Requisite Variety. The variety of the situation (system or problem states) equaled 1. The variety of the controller (you) was at least the same as the situation. The condition of Ashby’s Law has been met: You as a controller had at least the same variety as the situation, and therefore you gained control (V(C) >= V(S)). Let’s move on to the second scenario.

Scenario 2: Now, you still have the same circuit, but this time you already checked the bulb, and it was not broken. So you continue your investigation and measure the voltage of the battery. It is too low. You replace it, and of course, this time, the bulb is working.

Again we see that the variety of the controller matched the variety of the situation. There were two sources of error, and you found the problem and solved it.

Scenario 3: Now, we repeat the same steps as in the last scenario, and it turns out that a connection at the switch was poorly soldered. You fix it, and the problem is solved.

Again you find out that Ashby's Law shows that the theory of "absorbing variety" did its job. 3=3.

Scenario 4: Lastly, something unexpected happens. Even though you have checked the three aforementioned problem sources, the error persists. The dramaturgic clue – no matter how much you search, you can't find the source of the problem. The reason is fairly simple but dramatic. In this scenario, a piece of information is missing: It is NOT included in your **mental model** that this circuit contains a fuse. You are not aware that there are more elements in the circuit (for whatever reason). Therefore you cannot solve the problem. Your variety is lower as the variety of the situation.

So finally, Ashby's equation does not match. Now the variety of the situation is greater than the variety of the controller. In other words: We can not gain control (= achieving a goal) if our mental models do not fit the problem situation. Therefore a counter-intuitive insight arises: In times of complexity, we have to find the optimal variety, which often implies enhancing the variety in the system to cope with a dynamic situation.

For sure, this does not mean that one wants to increase the variety up to eternity. That would lead to chaos in organizations. But a well-balanced degree of interconnected elements (=network organization) is probably better able to respond to change than a rigid structure that is either not able or too slow in providing the necessary internal variety (time is a critical driver of variety).

Application of Ashby's Law

After all this theory, the reader might ask: How do I use it in real life, especially in the business world?

At first, I want to state that any cross-functional team is an answer to Ashby's Law. Such a team shall contain all skills (or capabilities) to built, as

independent as possible, something that generates value for a customer. It is hopefully obvious that this team has the Requisite Variety to deal with changing demands. It can solve problems on its own by reducing and generating possible system states.

Another example can be deducted from a typical customer journey. Usually, it starts with the customer who recognizes that she/he has a demand for a product or service. In this step, it is essential to be visible in a search engine, because nowadays almost every journey starts with a search for more information. Therefore the company must have online information available that can be found by a search engine and be presented at the top ten of the results page. Additionally, the displayed text snippet must contain enough keywords to trigger the potential customer to click on the link. All these aspects must be taken into account to provide the Requisite Variety to attract customers and fulfill all needs in the first step. This logic continues at all touchpoints to convert a potential customer into a buying customer. Every time the Requisite Variety must be offered which fits the needs of the individual in the specific context. This means to engineer the variety accordingly and to make sure that you never offer too little information (e.g., no price, availability, etc.) nor too much information (bad designed information architecture, over-designed user interface, etc.).

It is possible to generalize some typical actions and “thinking figures” to

either reduce or generate variety from a very high level. Peter Gomez has developed the following illustration in our mutual book, (2019).

Basically, it contains four heuristics per aspect:

Variety Reduction of a Complex Situation:

- **Patterns**: By redefining system boundaries, you make distinctions that lead to a reduction of complexity.
- **Emergence**: Identify feedback loops in the situation which enable levers to control the complex situation.
- **Scaling**: Discover power laws (magnitudes) in the situation that dictate the ability to grow. What are the sweet spots for effort vs. value generation?
- **Forecasting**: Find “Pockets of Order” in the situation to understand options for action.

Variety Generation of the Management System:

- **Leverage**: Start at the tipping points of the system. How can a trajectory be deflected towards the desired direction? What are the control factors of the tipping point?
- **Organization**: Design a loosely coupled system with the highest degree of aligned autonomy. Be able to adapt locally while maintaining the

overall optimum, not only a local optimum because that would produce silos. By reducing dependencies, one can prevent chain reactions.
- **Black Box**: Since it is useless to model a complex situation in each detail, one shall also conduct experiments to understand the context. This refers to the Empirical Process Control Theory, aka Lean and Agile. Only by experimenting, it is possible to build a useful model of the world.

Resilience: Intentionally integrate errors into the system and learn fast about weak spots of the system. Then it is possible to create functional redundancies that can deal with "stress" and unexpected behaviors.

Factors that influence Requisite Variety

Next to the definition of this term, it would be nice to understand the factors that influence variety. Unfortunately, it is impossible to provide a complete list of all the aspects that enhance the "space of possible system states," but some typical ones can be summarized.

- At first, it starts with **an individual's ability to perceive the surrounding environment** and **reflect on personal thinking processes**. This is related to critical thinking and meta-cognition. That's why Reflective Practitioners are crucial in complex situations.
- The next aspect tackles professional expertise about a certain topic. In short: **Knowing your craft** and understanding the devil in the details is essential to deal with high variety.
- Lastly, the **quality of social interactions** is important. Often it depends on the capability to ensure productive interpretations of reality. From my praxis, I recommend always going through the process of sense-making, and that implies creating a shared understanding of terms. Many misunderstandings can be prevented when a common language is in place. It might be painful to define the EXACT meaning. Therefore it should be the goal to share the INTENTION of the meaning.

Here are some classical deadly factors to reduce requisite variety

- Ideologic Ignorance (variety is finite = it can not be changed)
- Cognitive Biases (missing system states, intellectual blindness)
- Logical Fallacies (underdeveloped craft of thinking)
- HIPPO-effect (Highest Paid Persons Opinion, often found in traditional hierarchies)
- Structural stupidity of organizations (bad slicing of the organizational structure which consequently leads to over-complex processes and under-complex solutions)

The consequences of too high variety

The last part of this essay deals with some typical phenomena observed if a human being is overwhelmed by high variety (= complexity). Dietrich Dörner has originally developed the following thoughts in his famous book, “The logic of failure” (Die Logik des Misslingens, 1989). To make it more tangible, Peter Gomez and Timo Meynhardt had created the next illustration in 2010. It shows how time is influencing the behavior of an actor.

The chain of thoughts starts with the dilemma, that often the time needed to make a decision is inversely proportional to the available time. This correlation worsens when the decision situation is very dynamic – the gap between both time aspects is getting bigger and bigger.

This pressure leads to an overreaction, accompanied by insufficient goal definition, a self-limitation on parts of the situation, and a focus on unilateral measures.

In the very end, this leads to neglecting secondary effects, over control, and authoritarian behavior.

Conclusion

Ashby's Law of Requisite Variety is an invariant. You can ignore it or whim about it, but it would be as effective as protesting against gravity (borrowed paraphrase from Niklas Luhmann). Therefore, I propose to look at it like a feature of nature and not a flaw.

Reference: Ashby, W.R. (1956) Introduction to Cybernetics, Chapman & Hall http://pespmc1.vub.ac.be/books/IntroCyb.pdf.

October 18, 2020 Mark Lambertz Grundsätzliches, Kybernetik

ashby, complexity, control, cybernetics, law, system, variety

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3 responses to “Ashby’s Law of Requisite Variety”

Alex B says:
31. October 2020 at 16:56

As always a good read and well explained –> after the fact that it really helped to understand the idea my favorite section is “Factors that influence variety” as it finally makes all of the theory very tangible and transferable into practice (though header formatting here might not be correct 😉

Reply

:roduction to the Viable System Model – Intelligente-Organisationen says:
. March 2021 at 21:24

[…] Startseite/Experimente, Grundsätzliches, Kybernetik/Introduction to the Viable System Model Zurück […]

Reply

Jake Witmer says:
30. October 2022 at 7:21

You have done a great service to humanity by posting this concise summary. It was precisely what I was looking for. One can either use the laws of cybernetics, or one can be used by those who use them.

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