



The Law of Requisite Variety

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The larger the [variety](#) of actions available to a [control](#) system, the larger the variety of perturbations it is able to compensate.

Control or regulation is most fundamentally formulated as a reduction of variety: perturbations with high variety affect the system's internal state, which should be kept as close as possible to the [goal](#) state, and therefore exhibit a low variety. So in a sense control prevents the transmission of variety from environment to system. This is the opposite of information transmission, where the purpose is to maximally conserve variety.

In active (feedforward and/or feedback) regulation, each disturbance D will have to be compensated by an appropriate counteraction from the regulator R. If R would react in the same way to two different disturbances, then the result would be two different values for the essential variables, and thus imperfect regulation. This means that if we wish to completely block the effect of D, the regulator must be able to produce at least as many counteractions as there are disturbances in D. Therefore, the variety of R must be at least as great as the variety of D. If we moreover take into account the constant reduction of variety K due to [buffering](#), the principle can be stated more precisely as:

$$V(E) \geq V(D) - V(R) - K$$

Ashby has called this principle the law of requisite variety: in active regulation only variety can destroy variety. It leads to the somewhat counterintuitive observation that the regulator must have a sufficiently large variety of actions in order to ensure a sufficiently small variety of outcomes in the essential variables E. This principle has important implications for practical situations: since the variety of perturbations a system can potentially be confronted with is unlimited, we should always try maximize its internal variety (or diversity), so as to be optimally prepared for any foreseeable or unforeseeable contingency.

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Ashby's Law can be seen as an application of the [principle of selective variety](#). However, a frequently cited stronger formulation of Ashby's Law, "the variety in the control system must be equal to or larger than the variety of the perturbations in order to achieve control", which ignores the constant factor K, does not hold in general. Indeed, the underlying "only variety can destroy variety" assumption is in contradiction with the [principle of asymmetric transitions](#) which implies that spontaneous decrease of variety is possible (which is precisely what buffering does). For example, a bacterium searching for food and avoiding poisons has a minimal variety of only two actions: increase or decrease the rate of random movements. Yet, it is capable to cope with a quite complex environment, with many different types of perturbations and opportunities. Its blind "transitions" are normally sufficient to find a favourable situation, thus escaping all dangers.

[Ashby's](#) law is perhaps the most famous (and some would say the only successful) principle of cybernetics recognized by the whole Cybernetics and Systems Science community. The Law has many forms, but it is very simple and common sensical: a [model](#) system or [controller](#) can only model or control something to the extent that it has sufficient internal variety to represent it. For example, in order to make a choice between two alternatives, the controller must be able to represent at least two possibilities, and thus one distinction. From an alternative perspective, the quantity of variety that the model system or controller possesses provides an upper bound for the quantity of variety that can be controlled or modeled.

Requisite Variety has had a number of uses over the years , and there are a number of alternative formulations. [Variety](#) can be quantified according to different distributions, for example probabilistic entropies and possibilistic nonspecificities. Under a stochastic formulation, there is a particularly interesting isomorphism between the LRV, the 2nd Law of Thermodynamics, and [Shannon's](#) 10th Theorem .

See also: Dictionary: [LAW OF REQUISITE VARIETY](#)

Reference: Heylighen F. (1992): "[Principles of Systems and Cybernetics: an evolutionary perspective](#)", in: Cybernetics and Systems '92, R. Trappl (ed.), (World Science, Singapore), p. 3-10.

[Discussion](#)

- [Bacteria and the strong form of Ashby's LRV](#),
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