Signal-to-Noise Ratio

The ratio of relevant to irrelevant information in a display. The highest possible signal-to-noise ratio is desirable in design.

All communication involves the creation, transmission, and reception of information. During each stage of this process, the form of the information—the signal—is degraded, and extraneous information—noise—is added. Degradation reduces the amount of useful information by altering its form. Noise reduces clarity by diluting useful information with useless information. The clarity of information can be understood as the ratio of remaining signal to added noise. For example, a graph with no extraneous elements would have a high signal-to-noise ratio whereas, a graph with many extraneous elements would have a low signal-to-noise ratio. The goal of good design is to maximize signal and minimize noise, thereby producing a high signal-to-noise ratio.[1]

Maximizing *signal* means clearly communicating information with minimal degradation. Signal degradation occurs when information is presented inefficiently: unclear writing, inappropriate graphs, or ambiguous icons and labels. Signal clarity is improved through simple and concise presentation of information. Simple designs incur minimal performance loads, enabling people to better focus on the meaning of the information. Signal degradation is minimized through research and careful decision-making. For example, failing to use the correct type of graph to present a certain kind of data can fundamentally distort the meaning of the information. It is therefore important to make good design decisions at the outset, testing when necessary to verify design directions. Emphasizing key aspects of the information can also reduce signal degradation—e.g., highlighting or redundantly coding important elements in a design.

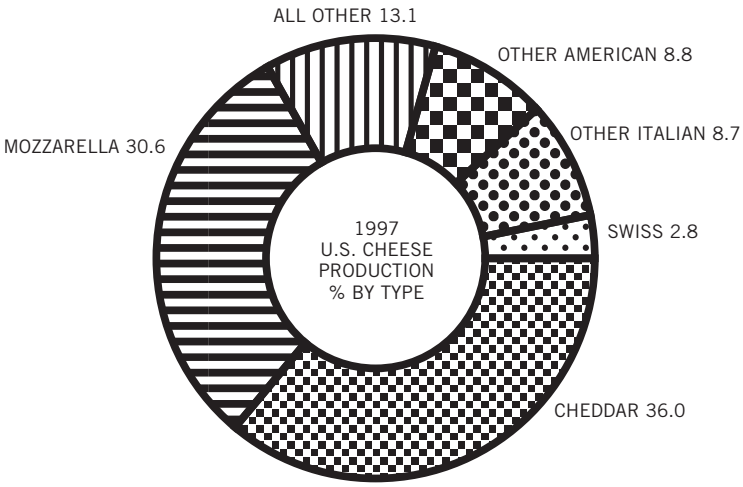
Minimizing noise means removing unnecessary elements, and minimizing the expression of necessary elements. It is important to realize that *every* unnecessary data item, graphic, line, or symbol steals attention away from relevant elements. Such unnecessary elements should be avoided or else eliminated. Necessary elements should be minimized to the degree possible without compromising function. For example, the expression of lines in grids and tables should be thinned, lightened, and possibly even removed. Every element in a design should be expressed to the extent necessary, but not beyond the extent necessary. Excess is noise.

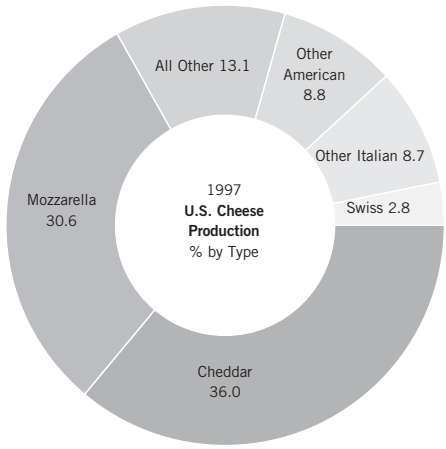
Seek to maximize the signal-to-noise ratio in design. Increase signal by keeping designs simple, and selecting design strategies carefully. Consider enhancing key aspects of information through techniques like redundant coding and highlighting. Use well-accepted standards and guidelines when available to leverage conventions and promote consistent implementation. Minimize noise by removing unnecessary elements, and minimizing the expression of elements.

See also Alignment, Horror Vacui, Layering, Performance Load, and Propositional Density.

[1] The seminal works on signal-to-noise ratio in information design are "A Decision-Making Theory of Visual Detection" by Wilson P. Tanner Jr. and John A. Swets, *Psychological Review*, 1954, vol. 61, p. 401–409; and *Visual Display of Quantitative Information* by Edward R. Tufte, Graphics Press, 1983.

The signal-to-noise ratio of each of these representations on the left is improved by removing elements that do not convey information, minimizing the expression of remaining elements, and highlighting essential information.





SOYBEANS		
	PRODUCTION Billions of Bushels	HARVESTED ACREAGE Millions of Acres
1997	2.69	68.1
1998	2.74	71.3
1999	2.65	72.5
2000	2.76	72.5
2001	2.89	73.2

Soybeans

	Production Billions of Bushels	Harvested Acreage Millions of Acres
1997	2.69	68.1
1998	2.74	71.3
1999	2.65	72.5
2000	2.76	72.5
2001	2.89	73.2