Seeing Numbers: Considering the Effect of Presentation of Engineering Data in Design

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Abstract

Engineering is a hugely data-rich environment. Modern analysis has provided us with comprehensive engineering data, when matched with parametric design able to swiftly generate large ranges variations of complex structures this data is multiplied vastly. This has allowed engineers to explore the solution space thoroughly by considering many design options and possibilities. However, this is done at the price of imposing more intellectual load on designers, specifically in decision making under complex relationships between design variables and performance outcomes.

In this context although the content of any engineering analysis is of the most importance, the visual presentation of information can be shown to have a significant impact on the accuracy of understanding and insight by the consumer of this data [1]. Whilst the accuracy of engineering data itself can be rigorously verified, by contrast our perception of information when shown in tables, summarized, or as a visualisation has been shown to be highly subjective and open to influence from cognitive biases [2][3]. Unfortunately, this is the critical point that the data is consumed for decision making, thus it is important for engineers to understand the impact that presentation of complex data.

This paper seeks to highlight important visualization issues related to engineering design. Seeking to present empirically proven cognitive visual biases that should be avoided and how to make the clearest and best use of data for accurate, well informed and impartial decisions by engineers, but also clients, and other team members.

The work explores three main issues along with practical recommendations:

1. User fidelity of understanding of data is significantly affected by types of data (nominal, categorical, and/or ordinal) and the method used to display it (table, chart, visualization), recommending the best and worst combinations.
2. The amount of design data, the number of options, and how they are compared will significantly affect human intuitive comparisons away from rational selective decisions. Looking to limits of understanding large data sets and how to control this complexity.
3. Widely used existing engineering analysis tools often generate data that is hard to visually digest, specifically in the context of decision making. Recommending how this can be reduced by simple but carful changes to those data visualizations.

To validate these insights and recommendations, this research makes use of existing research in engineering and other domains related to visualization.

References

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