BIG DATA, DEEP LEARNING AND DESIGN INNOVATION

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Increasingly, design innovation is gaining prominence in the marketplace, with a growing number of firms innovating not only technologically but also visually. However, while measures of technological innovation, both on quantity and quality, have been standardized, less is known on ways to gauge design innovativeness. This study addresses this gap by answering: whether and if so, how does design innovation is measured?

I contribute to the literature by the following: First, I provide a quantitative indicator for design innovativeness using big data and novel machine learning methodologies. In so doing, I offer a measure of an innovation type that is substantially neglected and could be a basis for rigorous and large-scale empirical studies. Second, I develop a model to assess the likelihood of patent design applications to be granted. This will help product development managers to understand and focus on factors that enhance the chances of obtaining a design patent grant.

Theoretical works suggest that product design newness depends on the degree to which it has common visual attributes with other members of its category (Whitfield and Slatter, 1979). Hence, to create a quantitative measure for design newness, I consider timing, precedence, and atypicality.

I use abstracts from USPTO design patent applications (1930-2018) as the main data source. These abstracts contain a schematic diagram, design description, submission date, product name, and kind. Firstly, I train a neural network based on the visual schematic diagrams to determine the level of design innovativeness. That is, I feed product design sketches, date, product category, and grant status to the neural network. This set of information enables the model to analyse which common underlying characteristics exist to all granted patent designs on a given time and product category. Next, I utilize *Bidirectional Encoder Representations from Transformers* (BERT) to classify verbal design descriptions that are more associated with granted patents. Combining the output of these modelling exercises, I obtain an innovativeness index for each design patent application.

Several interesting insights could be derived from this study. First, results show that there are common time-consistent visual design attributes that are found in granted design patent applications. Similarly, there are verbal descriptions that increase the likelihood of design patent to be granted. Second, the trained model exhibits a high level of accuracy in predicting whether design patent applications will be granted.