Visualization in Configurators: Reflections for Future Research

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Abstract

The increasing attention and investments in augmented reality (AR), virtual reality (VR), and mixed reality (MR) further highlight the importance of graphic representations as communication tools. However, numerous online configurators lack advanced visualization and very few utilize virtual reality. Considering the expense associated with advanced visualizations, it becomes crucial to understand the incremental utility of such visualizations within the configuration process. This positioning paper aims to call for and pave the way towards a deeper understanding of the role and value of visualization in configurators, not limiting to AR, VR, and MR but considering all forms of visualization.

Keywords

Configurator, product visualization, virtual reality, value

1. Introduction

"A picture is worth a thousand words!" This statement resonates with many of us, reflecting the widely recognized power of visual representations in effectively conveying concepts. For example, in the communication of a product for sale, it is highly beneficial to have effective and realistic visualizations of the product and its features [1]. The increasing investments in augmented reality (AR), virtual reality (VR), and mixed reality (MR) [2] further confirm the importance of graphic representations [3].

In the context of product configurators, a primary objective is to provide clear and easy-to-understand information about the choices, their impact on the overall product, and the resulting final product [4]. Many configurators employ visualizations of product parts or the entire product to help customers make informed choices [5]. However, numerous online configurators lack advanced visualization techniques and even fewer utilize virtual reality. Interestingly, many configurators without advanced visualization techniques still perform well in achieving their purpose. Therefore, there is no clear dominant visualization that companies can refer to.

Considering the differences in costs associated with the various product visualizations, it would be highly beneficial to know the benefits of the various product visualization modes in the different contexts, as well as the related implementation costs and challenges. Unfortunately, we are far from this ideal knowledge, with the consequent problem of limited support provided to practitioners in making choices about product visualization in configurators.

This positioning paper aims to stimulate a scientific discussion to address the above-mentioned problem within the configurator development and usage community. Through our reflections, we aim to call for and pave the way towards a deeper understanding of the role and value of product visualization in configurators. When it will be available, this understanding will support companies in choosing visualizations for their configurators.

This discussion is particularly opportune now, given the growing attention to and availability of advanced solutions for visualizing configured products [e.g., 6, 7]. We suggest framing this discussion considering that the availability of powerful visualizations does not imply their profitability in all contexts and that, consequently, a company needs to assess them within its specific context and for specific purposes.

2. The importance of visualization in product customization

Product visualization is gaining importance in product customization. As product configuration takes place within the broader context of product customization, we begin our reflection by considering the following current trends.

First, customers, especially those who purchase custom products, demand more visual support. Visual

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experiences guide people's judgement, decision, ability to learn and retain information (90% of what we process is visual; we respond 60,000 times faster to imagery than text; 65% of the world is composed of visual learners) [3]. In today's market, potential customers have become increasingly accustomed to the visualization of products. Di et al. [1] provided evidence that images play a significant role in increasing buyer attention, trust, and conversion rates. Specifically, their research suggests that increasing the number of product images, which enhances the overall visual representation of the product, effectively improves sell-through. This result highlights the importance of providing a comprehensive visual experience to potential buyers to drive better sales outcomes [1]. This change in consumer behavior highlights the importance of visualization in helping customers customize products according to their individual needs [8]. During the customization process, it is crucial for customers to have a clear understanding of how the characteristics of the product align with their preferences to minimize any potential regret associated with their purchase decision [4]. By providing visual representations and interactive tools, companies can enable customers to make informed choices and ensure that the customized product meets their expectations. Effective visualization not only enhances the overall customization experience, but also mitigates concerns of post-purchase regret.

Second, companies have perceived this need and feel the need to invest in this direction. Big companies and brands that customize products such as Volkswagen, Nike, Ray-Ban with their investments in product visualization and with their interest in advanced product visualization project witness that they have perceived the customer need of seeing visually their products. But also SMEs that offer personalized products are perceiving the need to improve their product visualization [9].

Third, visualization technologies are making huge progresses. Product visualization technologies (AR, VR, etc.) are making incredible improvements [10]. For example, the launch of Apple Vision Pro, which tracks a person's eye movements and responds accordingly, and its integration with the Mac world, offers vast cutting-edge possibilities for users while being accessible.

Fourth, AR, VR, and MR are expected to have a fast growth in shopping. In 2028, the AR, VR and MR market will be nine times more than in 2021 [2]. Consumer confidence rises by 4% globally when using immersive technologies [11]. 71% of shoppers think they would shop more often if they used AR apps [12]. 61% of shoppers said they prefer to choose stores with AR over those without it [12]. 55% of shoppers said AR makes shopping more fun and exciting [12]. 83% of shoppers point to product images as the most influential factor in their purchasing decision [13]. The use of VR to build virtual online change rooms can help retailers improve conversion rates by more than 6.4%, increase order value by 1.6%, reduce fulfillment costs by 5%, and lower returns by 5.2% [14]. Virtual presence is something that is becoming increasingly important in online activities [15].

3. Virtual reality and configurators

The previous section justifies the relevance of visualization and, in particular, visualization advancements (such as VR, AR, MR) in product customization. Given the importance of visualization for product customization and configurators for mass customization, we would expect a lot of research on the use of visualization in configurators. Vice versa, current research on product visualization in the configuration process is limited, with a focus on advanced visualizations while neglecting the more commonly used basic forms of visualization.

The literature on product configuration has been paying attention to VR/MR/AR since 2003, and a great increase in attention started more recently in 2015. More specifically, by using the SCOPUS database and looking at this literature in five-year intervals, we can find the following trend with a five-year time frame: 1 publication (2000-2004), 3 publications (2005-2009), 2 publications (2010-2014), 8 publications (2015-2019), and 5 publications (2020-2023).

Most of this literature investigates the possibility of applying advanced visualization by developing and demonstrating feasibility of new applications and approaches [16-25]. Some publications, still focused on the feasibility, go further by considering capabilities, potentials, and usefulness of advanced visualization technologies in configurators [e.g., 26, 27].

Finally, five publications (mostly recent) focus more on investigating the benefits of adopting advanced visualization technologies than showing the possibility of using them [6, 7, 28-30]. To this last set of papers, we should add Hvam and Ladeby [5] that even do not focus on the benefits, consider different possibilities of advanced visualization and call for considering the relative difference in benefits while designing a visual configurator.

Surprisingly, no articles on the level of adoption of various visualization solutions and technologies are provided. Limited discussion of different benefits of different visualization solutions is provided. No comparison of different investment requirements and implementation difficulties is provided. Additionally, consideration of suitability for different company sizes and skills is limited.

4. Visualization in actual configurators

The presence of different product visualization modes for configurators is recognized [e.g., 5]. Unfortunately, a systematic and comparative characterization of these modes is not available. Below we recall and briefly describe a number of these modes. We rely on our knowledge, accumulated over years through the analysis of hundreds of online sales configurators, on a recent survey on the presence of configurator functionalities in almost 100 Italian and Austrian SMEs, and on the working with companies.

Augmented reality allows one to see the product in a real context of use, in a real world environment, in a

room, etc., for example, furniture in the customer's living room.

Virtual try-on allows one to see the product on the user's face or body. Examples of products that can use this technology include makeup, personal accessories, clothing, and shoes.

Virtual reality allows one to interact with and experience virtual products by creating a fully immersive virtual environment. Users can examine the product from different angles, change configurations, and assess its features, all within a simulated environment. Examples can be virtual showrooms of custom cars and interior design configurators.

3D walk-through allows one to virtually visit an environment (e.g. an apartment).

3D models allow one to view products from different angles and perspectives (e.g., footwear, jewelry, cars, furniture).

360 view allows one to explore a product from all angles. Users can interactively rotate the view horizontally and vertically to see the product from different perspectives.

2D image represents the product in two-dimensional graphical representation. It can be a drawing or a sketch.

Other modalities are *video and animations* of the real product or of the virtual image of the product, *photo* of the real product or v*irtual image* of the product (e.g., rendering), c*ross-section views* to see the internal structure or components.

Additionally, many techniques exist to interact with the configurator and see the effects of the user customization actions on the customized product. For example, *interactive configuration* allows users to manipulate certain product attributes directly on the image itself (e.g., users can click on different parts of a product image to change colors or select additional features). *Live previews* allow one to dynamically update the visual representation of the product depending on the user selections. The product visualization can *change simultaneously* with the modification of the chosen options or not. The product can *be set in motion* or not. The product visualization is *done only at the end* of the user configuration process or can also be *done during* the choice selection process.

5. Opportunities for future research and conclusions

The information and reflections presented up to this point have highlighted that: (1) The ability to offer suitable visual information to customers is increasingly important, even more when products are customized, eventually using an online sales configurator. (2) Many product visualization modes can be applied in configurators, both innovative (e.g., AR, VR, and MR) and established ones (e.g., 2D images and 3D models). (3) The business needs to which the visualization should respond are various (e.g., providing an approximate idea or a very detailed and realistic description of a product). (4) The business contexts in which to apply the visualization modes can be very different depending on many variables (e.g., customers, company size). (5) Studies investigating the suitability of the various visualization modes for the various business needs and contexts are lacking.

Therefore, an important research opportunity consists of providing a comprehensive and comparative description of the various product visualization modes in configurators and investigating the effectiveness and challenges of different visualization modes across business needs and contexts. By describing and comparing the various forms of product visualization, as well as their utility and challenges in different contexts, research could help companies make well-informed choices regarding the adoption of visualization technologies in their configuration processes.

Let us conclude with a final consideration on the positioning of this line of research. Although exploring the new possibilities offered by virtual, mixed and advanced reality is crucial for technological advancements, it is equally important to provide managerial guidance to companies to make informed decisions regarding product visualization in configurators. Assessing the adoption levels of different technological solutions and understanding how users appreciate these solutions can provide valuable insights to companies. This information is not only valuable to companies but also helps researchers understand which aspects of technologies meet or fail to meet the needs of companies.

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