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Using Map-based Dashboard to Improve Geo-knowledge Communication: a use case on Digital Twins

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Abstract:

Geo-knowledge is the knowledge about locations, spatial distributions, semantic attributes of individual geographic objects, and correlations or causations between two or many geographic objects. Domain experts use the geo-knowledge to answer where, when, what, how, and why questions (MacEachren, 2017), thus supporting decisions in many applications such as urban planning (Pinos et al., 2020), policy-making (Kang et al., 2020), marketing (Suhaibah et al., 2016), and education (Würstle et al., 2020). With their at-a-glance view and interactivities, map-based dashboards serve as intuitive tools to synthesize complex geodata and empower users to visually analyze spatial information. Digital Twins provide an environment that represents geo-knowledge of physical assets in a holistic way (Grübel et al., 2022). Map-based dashboards can be specifically designed to integrate multi-source, multi-dimensional, and multi-scale data within digital twins, enabling a holistic view that encompasses both the geographic and non-geographic components. This abstract outlines the features of map-based dashboards and their applications on digital twins.

A map-based dashboard is characterized by a number of useful properties for accessing Digital Twins. First, it may bring the information in different granularities together. The users can obtain both an overview and details on demand. Second, it can present information from different perspectives. Each panel can set a different focus on the type of geo-knowledge presented to the users, e.g., temporal trend, spatial distribution, and summary (Zuo et al., 2020). The users are then able to relate and compare the variables visually. Last but not least, the users can grasp the information from the dashboard in a short time through the affordances provided by the medium (Scaife & Rogers, 1996; Gibson, 2014).

Map-based dashboards should be integrated into digital twins as essential components (Grübel et al., 2023) and enable stakeholders to intuitively comprehend information and make strategic decisions. For instance, they can aid in evaluating the need for constructing a new railway and determining the optimal number of charging stations. Designing a map-based dashboard within a digital twin follows five key stages as Figure 1 shows: Setting the design goals, defining the users' cognitive tasks, preparing the data, designing the visual interface, and collecting users' feedback. Each stage takes into account the specific requirements of digital twins, and the stages are iteratively refined through the integration of feedback from other stages. Eventually, the map-based dashboard will be customized to effectively support the stakeholders of Digital Twins.

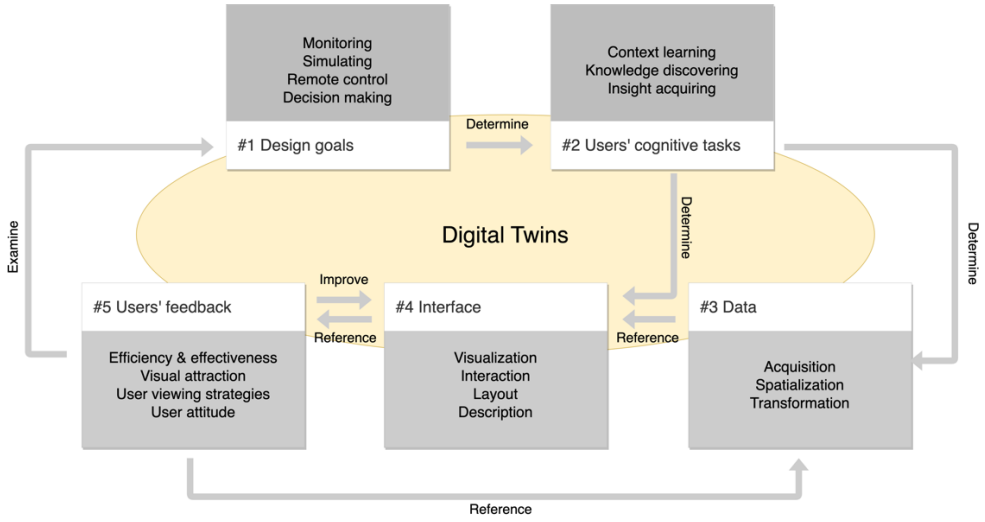

Figure 1. The workflow for designing a map-based dashboard for digital twins (Zuo, 2022).

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In the future, we will design map-based dashboards as powerful tools for integrating multiple data sources, analyzing data using built-in functions, and presenting complex information in the Open Digital Twin Platform (ODTP; Grübel et al., 2023). However, it is worth noticing that the challenges remain in ensuring data suitability, real-time data synthesis, and cybersecurity.

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