Data in Architecture: Structure and Context

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Architectural space is exposed to the influences of numerous stimuli, such as daylight, ambient humidity, occupants' needs, and historical and cultural contexts, all of which substantially differ in their relative characteristics. Consequently, the detection and documentation of these stimuli may produce various materials and information through the modeling, visualizing, and analyzing of their behaviors and investigation of their effects, interactions, and respective (re)design processes. The forms of such materials can be numerical, drawing, audio, video, geospatial content, etc. These materials can be mobilized as evidence to support an argument. In the scientific research community, such recorded factual materials for validating a research argument are defined as "data" per the Code of Federal Regulations 2 CFR, Ch. II § 200.315.[1] This general definition describes that data can be represented in many different types (e.g., observational, experimental, derived or compiled) and stored on many different supports (e.g., paper, electronic file, physical model). Comparatively, architectural researchers and practitioners are increasingly dealing with these factual materials, but do not always speak of these objects as "data." As such, in the architectural field (as in other areas of research), data have been commonly embedded via both explicit and implicit ways into various architectural studies and practices. Moreover, in order to satisfy the increasingly diversified architectural community, more diverse data concepts and methods of analysis are being accepted by architectural researchers and practitioners.

In architectural and associated research disciplines, providing an authoritative definition of data is helpful, but also challenging. Two main features of the data landscape in architecture are responsible for this phenomenon. In architectural research, data can be highly contextual and share many relationships with other resources and collections, which also reflects the diversity of disciplines and communities involved in current architectural research and practice. This leads to challenges in consolidating and coordinating data and processing practices used in current architectural research. Furthermore, structured data have identifiers and follow an explicit and consistent schema. Compared with that, data in architecture can be semi-structured or unstructured, in which some or most boundaries of individual components and their relations do not necessarily conform to a fixed or precise schema.[2] This results in ambiguities that make it difficult to employ traditional definitions of data and workflow (e.g., gathering, processing, analyzing) as these activities relate to architectural research. Therefore, one of our motivations for publishing this "OPEN" issue with the subtheme of data was to encourage critical thinking and understanding regarding how to define, collect, process, and analyze data in different architectural research contexts. At the same time (and consistent with the previous "OPEN" issue), *TAD* is using this issue to motivate a broad community of researchers and practitioners in architecture to contribute new knowledge and establish new discoveries, as well as to encourage the exchange of ideas, inclusive of all topics and types.

The collection of research in this issue embraces a wide range of topics such as machine learning for creative design, heritage architecture digitalization, and building envelope performance analysis. Various data objects and analysis processes are involved and manifested in these works. As noted above, one major challenge to data integration in architecture is related to the unstructured nature of the data being collected. Data retrieval methods must be intuitive and not based on complicated data schemes. They must be specific in their return and deliver the precise piece of information the researcher requires or is interested in. This is fairly straightforward with simply structured information if it is correctly described, but highly complicated when it comes to unstructured information, as is common in architecture. Narratives, paintings, and stories are semiotic systems that have dimensions beyond the physically measurable, but they depend on the context. However, with emerging machine learning techniques, it is now possible to effectively and efficiently "datafy" unstructured data and enable researchers and practitioners to make use of analytics technologies for various design purposes. In other words, these commonly "unstructured" materials in architecture may be machine-readable and machine-processable. Therefore, data science and related algorithms, such as machine learning, image processing, and text

mining have become important in extracting essential contents, patterns, and trends from these materials in architecture. This is highlighted in research by David Newton. In his study, Newton describes the generative adversarial networks technology and explores its application as a design tool for creative design purposes. This study also demonstrates the technology's potential ability to read and process design images and photos in order to extract design information that could be understood in the field of architecture. Similarly, in Lynne C. Manzo's essay, photos and narratives (which can be considered unstructured or semi-structured data) are produced in a qualitative paradigm (e.g., interviews, observations, and photographs from the perspective of participants) in place-based research. She illustrates the importance of using qualitative approaches to understanding the social dimensions of architectural design and describes methods of collecting and analyzing datasets.

In addition to the structural features of architectural data, the integration of data into architectural research is nontrivial. Danielle Willkens, in her optical experiments at Sir John Soane's Museum, highlights how scanned datasets and their byproducts can be used to study the design qualities of and spatial perceptions in historic spaces. Daniel Chung and Jin Wen involve the effects of durability and degradation in their numerical analysis of thermal and moisture-related building envelope behaviors. Sekou Cooke extracts design data from cultural contexts and investigates the applicability of a humanistic approach to integrating such data into architectural design processes. Ute Poerschke et al. integrate historical, numerical, and experimental dimensions of architecture into examining the energy performance of double-skin facades. Katie Graham et al. propose a workflow based on a new geometric data classification method that encompasses heritage-based features of space and is capable of translating building information modeling data to the virtual reality environment.

The work in this issue demonstrates the expansive nature of data in architectural research and illustrates the variety and depth of approaches to collecting, processing, and analyzing data for the diverse research questions posed by architecture researchers. With the arrival of cyber-physical systems and the "Internet of Things" era, it can be envisioned that massive human- and machine-generated data may create unprecedent challenges and opportunities for data integration in architectural research.

EDITORIAL

Notes

1. Office of Management and Budget Guidance for Grants and Agreements, Code of Federal Regulations, title 2 § 200.315 (2018): 120, https://www.govinfo.gov/content/pkg/CFR-2018-title2-vol1/pdf/CFR-2018-title2-vol1-sec200-315.pdf.

2. R. Kitchin, *The Data Revolution: Big Data, Open Data, Data Infrastructures and Their Consequences* (London: SAGE, 2014).