

Digital 3D Surveying and Documentation of Archaeological Sites, Egypt



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Background

Digital 3D surveying and documentation in Egypt relies on advanced technologies such as photogrammetry, laser scanning (LiDAR), drones, and total stations to accurately record archaeological sites. These methods generate high-resolution 3D models of monuments to enable precise analysis while preserving fragile heritage.

The archaeological site of El-Ashmounein (Fig 1) (ancient Hermopolis Magna) represents one of Middle Egypt's most significant multi-period cultural landscapes, encompassing Pharaonic, Greco-Roman, and Early Christian remains. An integrated digital methodology was applied to key monuments at the site, including the Basilica Church, the Amun/Thoth Temple, and the Roman Komasterion temple, ensuring detailed documentation of both geometry and structural condition.

Interdisciplinary documentation and monitoring in action

Beyond the geometric recreation, the results demonstrate that this multi-software approach (SketchUp and Photoshop) facilitates a more intuitive interpretation of deterioration patterns across the multi-period site. The model serves as a "living" digital archive, enabling researchers to simulate structural behavior and plan conservation strategies with higher efficiency than traditional 2D methods (Fig 2).

This methodology not only supports immediate restoration interventions but also establishes a reliable baseline for long-term monitoring. Centralizing this data, the project provides an important foundation for interdisciplinary collaboration, ensuring that future heritage management strategies are rooted in precise, measurable structural data.

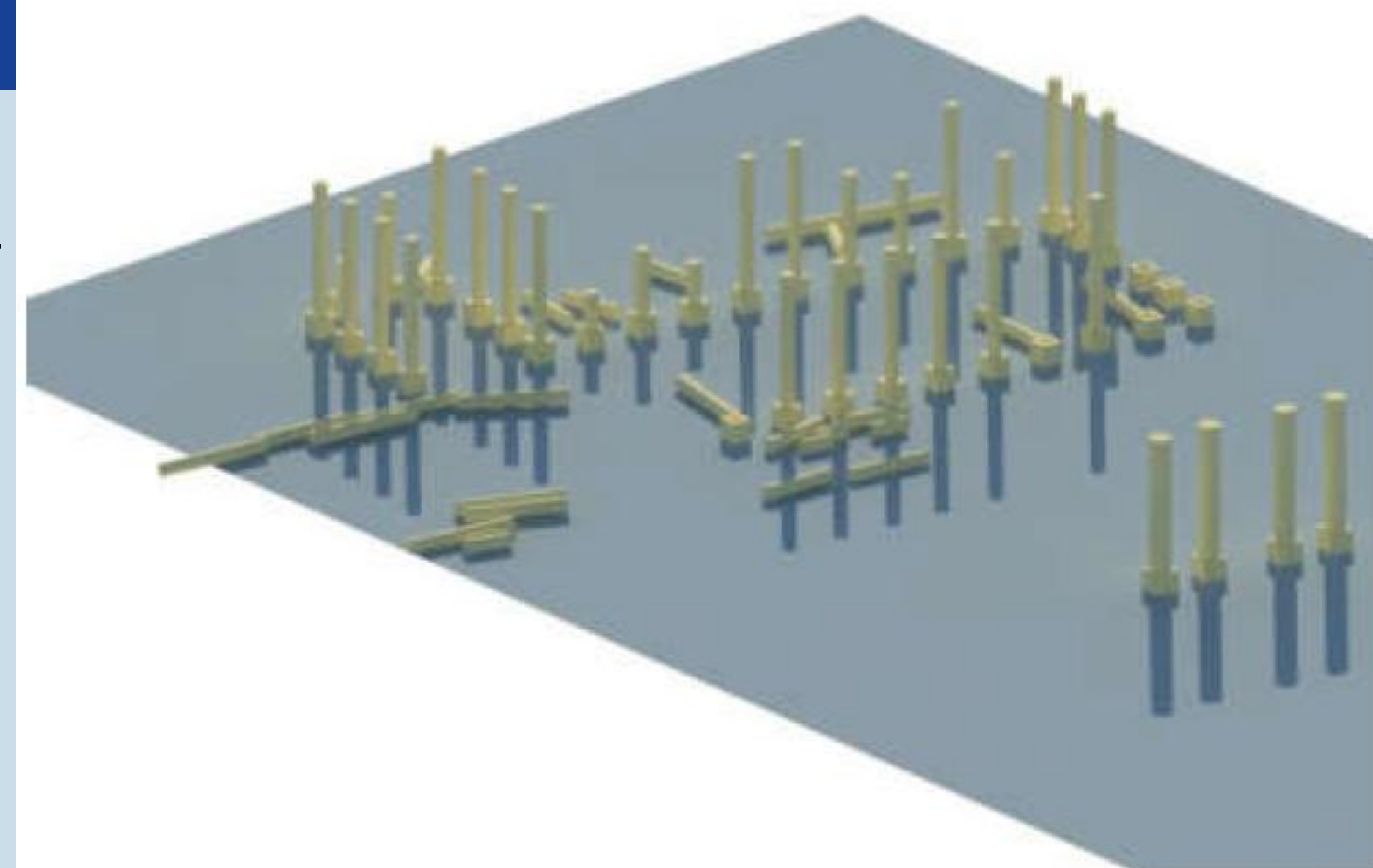


Fig. 2. 3D digital simulation of the tetrastyle columns and Basilica church at the Al-Asmounein archaeological site. The model generated to facilitate structural stability assessment and damage monitoring.



Fig.1. General overview of the archaeological site of El-Ashmounein (ancient Hermopolis Magna), illustrating its multi-period cultural landscape and the current state of preservation of its architectural remains, including visible structural deterioration and site conditions.

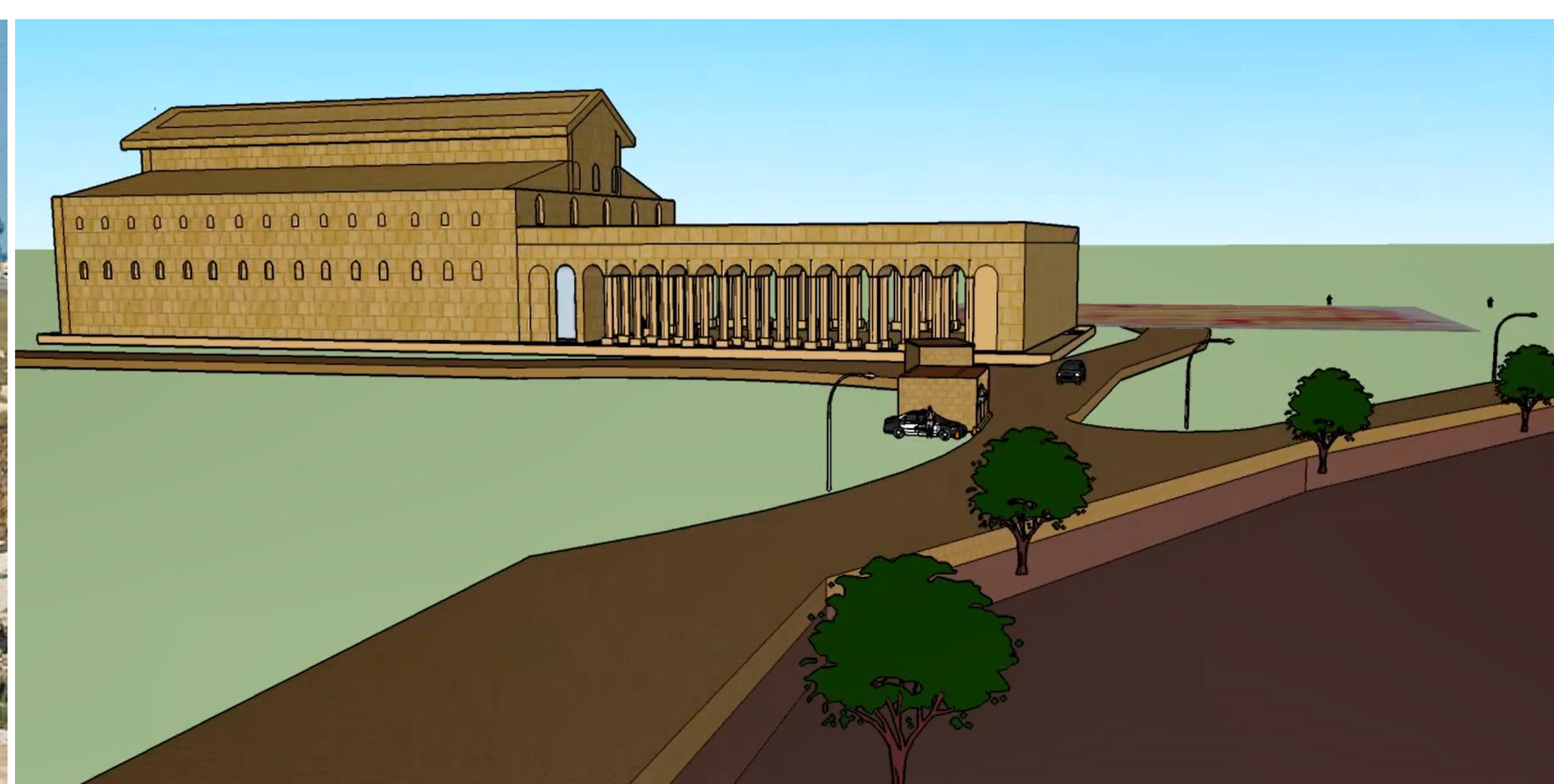


Fig.3. 3D digital reconstruction of the Al-Asmounein site, demonstrating the integration of the historical monument within its modern urban and landscape context. This model serves as a primary tool for site management, allowing for the evaluation of visitor access routes, surrounding infrastructure, and potential rehabilitation strategies that balance archaeological preservation with modern functionality.

Methodology

Using total station measurements, accurate layouts and control points were established, with special focus on free-standing tetrastyle columns (8.75–9.70 m high), where inclination and displacement were analyzed to assess structural stability. The data were integrated into digital platforms such as AutoCAD, Revit (BIM), SketchUp, and Photoshop to produce comprehensive plans, sections and 3D models.

This workflow enabled full architectural recording and reconstruction of the monuments while supporting conservation planning and long-term monitoring.

The study demonstrates how combining high-precision surveying with 3D modeling enhances documentation accuracy, structural assessment, and the interpretation of complex, multi-period archaeological sites. Additionally, the integration of these digital tools facilitated efficient data management and visualization, allowing for clearer interpretation of structural behavior and deterioration patterns.

This workflow also supports interdisciplinary collaboration and provides a reliable digital archive that can be used for future research, restoration interventions and heritage management strategies

Site management and rehabilitation

The implementation of 3D digitization at Al-Asmounein represents a shift from static archaeological recording to dynamic heritage management (Fig 3). By creating a high-fidelity digital twin of the site, stakeholders can move beyond traditional observation to simulate and test rehabilitation strategies in a risk-free virtual environment. This digital framework is essential for managing the complex relationship between the ancient monumental fabric and the encroaching modern infrastructure (Fig 4).



Fig.4. Virtual simulation of site rehabilitation, highlighting the integration of modern amenities to enhance visitor engagement within the archaeological context.

SDSS for archaeological rehabilitation

The use of 3D digitalization as a Spatial Decision Support System (SDSS) transforms the rehabilitation process at Al-Asmounein from speculative planning into a data-driven "single source of truth." The integration of digital "scale models", such as furniture and human figures, planners can accurately prototype the functionality of proposed interventions to ensure that modern infrastructure harmonizes with the monumental scale of the columns rather than overwhelming them.

This digital environment serves as a powerful tool for stakeholder communication, providing a clear, immersive visualization of the final result that bridges the gap between complex blueprints and the practical needs of government officials and funding bodies, ultimately facilitating more informed and efficient site management decisions.

Conclusions

3D digital documentation enhances accuracy in recording, analysis, and conservation of complex archaeological sites. It provides a reliable, data-driven framework for sustainable heritage management and long-term monitoring.

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