

Overview

1 Modern Civil Infrastructure Systems

- Industrial Revolution
- Transition to Information Era

2 Near-Term Challenges (2020-2060)

- Crisis in US Infrastructure Investment
- Urbanization and Sustainable Cities
- Infrastructure Protection and Recovery

3 Features of Modern Computing

4 Cyber-Physical and Digital Twin Systems

5 Urban and Global Applications

6 Summary (Connections to Scientific Computing)

Part 1



Modern Civil Infrastructure Systems



Modern Civil Infrastructure Systems

- Transportation: Good **roads**; parking; fast access to work.
 - Educational: Access to good **schools**.
 - Green Spaces: Access to **parks**, bike paths, etc.
 - Retail: Access to **shopping**; reliable **supply chains**.
 - Lifestyle: Access to social and recreational **spaces**.
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Urban Planning and Engineering Concerns:

- Understand short- and long-term planning needs.
- **Efficiency in design** – aesthetically pleasing design.
- **Efficiency in operations** – better use of limited resources.
- Improved response to unexpected events.

Bridges

Construction of the Golden Gate (1933-1937)





Bridges

Construction of the Golden Gate (1933-1937)



Bridges

Golden Gate Bridge (May 27, 1937)





Skyscrapers, Bridges → High-Density Urban Development

Urban Development in NYC



Urban Development in Shanghai





Advances in Computing and Analysis

Emergence of New Architectural Forms



Advances in Computing and Analysis

Parametric Architectural Design



References

- Array of Things: See <https://arrayofthings.github.io>
- Austin M.A., Delgoshai P., Coelho M. and Heidarinejad M. , Architecting Smart City Digital Twins: Combined Semantic Model and Machine Learning Approach, Journal of Management in Engineering, ASCE, Volume 36, Issue 4, July, 2020.
- Bello J.P. et al., SONYC: A System for Monitoring, Analyzing, and Mitigating Urban Noise Pollution, Communications of the ACM, 62, 2, 2019, pp. 68-77.
- Coelho M., and Browning L.S., INL Digital Engineering: Model-Based Design, Digital Threads, Digital Twins, Artificial Intelligence, and Extended Reality for Complex Energy Systems, INL/CON-22-69247, Idaho National Laboratory, Idaho Falls, Idaho 83415, September, 2022.
- Jordan J., Variational Autoencoders, Data Science, March 2018.
- Leveson N.G., A New Approach to Software Systems Safety Engineering, System Safety Engineering: Back to the Future, MIT, 2006.
- Tien J.M., Toward a Decision Informatics Paradigm: A Real-Time Information-Based Approach, to Decision Making, IEEE Transactions on Systems, Man, and Cybernetics – Part C: Applications and Reviews, Vol. 33, No. 1, February, 2003.