

Spring 2027

CP6552/ 4813 Design of Smart Urban Systems, School of City and Regional Planning
ARCH6447/ 4447 Urban Ecological Design, School of Architecture
College of Design, Georgia Institute of Technology

CP6552/4813 Design of Smart Urban Systems ARCH6447/4447 Urban Ecological Design

Perry P J Yang, Professor and Director of Eco Urban Lab, Georgia Institute of Technology

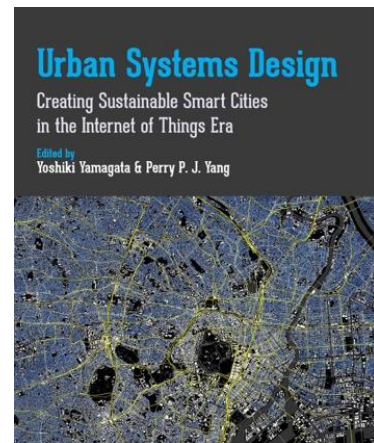
Contact: perry.yang@design.gatech.edu

Time: Friday 8:00-10:45am; Laboratory Hour: Friday 11:30-12:15pm

Venue: Kendeda 230; Laboratory Hour at Eco Urban Lab - ARCH EAST 304

Abstract:

Direct design of cities is often regarded as impossible owing to the fluidity, complexity, and uncertainty entailed in urban systems. And yet, we do design our cities, however imperfectly. Cities are created objects, intended landscapes, that are manageable, experienced and susceptible to analysis (Lynch, 1984). Urban design as a discipline has been focusing on “design” in its professional practices. Urban form and sensuous quality contain human values and decisions (Lynch, 1981). It is analytically distinct from “science” related research that tends to ask positive questions such as how cities function. The course introduces how urban design integrates urban ecology, systems science, data analytics and emerging technologies for shaping urban environments. Cities can be regarded as an urban metabolism or complex systems, in which the metabolic processes, or flows and fluxes of energy, matter, water, organisms, transportation and human movement as well as social and economic activities, determine the physical forms and spatial configurations of cities (Baccini and Brunner, 2012). The computable cities enable us to address urban problems that are complex, dynamic and uncertain (Batty, 2023). Empowered by new technologies, including digital and automation systems, cities are now far more designable than ever before. Urban design is becoming data driven. (Yang & Yamagata, 2019).



The 2027 class of **Urban Systems Design** in Georgia Tech focuses on **problem formulations, critical propositions, and organization of complex project through design and planning strategies in actual urban contexts**. An ability to handle massive data captured in cities or arising from people, devices, buildings and infrastructures, is critical to address problems occurring in places, streets, neighborhoods and cities in the era of internet of things (IoT), while creative design and critical thinking are crucial for challenges of the rapidly changing urban world. Students will learn principles of cities as ecologically sustainable systems, and how design as a transformative approach makes our cities greener, resilient, energy efficient and more adaptable to unpredictable future changes.

The course is structured by the following topics:

- 1) Urban design
- 2) Urban form
- 3) Urban landscape ecology
- 4) Urban complex environment
- 5) Urban energy and metabolism
- 6) Urban systems design

Students are expected to participate in lecture series, seminars, presentations and project design or research. Project Design focuses on urban design by group, 3-5 students per group. Research Paper aims to develop a term paper by individual. Four options are offered in Spring 2026:

- 1) Project Design A: A1 - [Georgia Tech Campus Planning](#); A2 – [Campus Vertical Farming](#)
- 2) Project Design B [Tokyo Central](#): B1: Nihonbashi Urban Design; B2: [Urban Resilience Analytics](#)
- 3) Project Design C: C1 – ATL [Airport City](#); C2 – [Space](#) Urban Systems
- 4) Individual Research D – Students can choose this option by defining a topic related to the course structure. The option D requires a 2-page individual proposal submission by 1/30 that needs approval from the instructor in advance. The proposal should include its data availability, and formulations of problems in an actual urban context. Original writing is required for the final term paper.

Course Schedule

1) Urban design

- 1/15 Urban design: a normative theory
(Lab hour: Project A, with GT CPSM team: **Georgia Tech Campus Planning**)

2) Urban form and data

- 1/22* Urban data: spatial visualization and analytics
Joint lecture with Prof. Takahiro Yoshida
Seminar on urban data visualization and analytics
(Lab hour: Project B, with Prof. Yoshida: **Tokyo Nihonbashi**)
- 1/29** Urban form: representation, measure and sensuous quality
Seminar on urban form
(Lab hour: Project C, with Dr Michael Balchanos: **Airport City & Space Urban Systems**)

3) Urban landscape ecology

- 2/5* Urban ecology, landscape urbanism and ecological urbanism
Seminar on urban ecology
- 2/12*** Proposal presentation (Lightning Talk)**
(8:00-12:00pm, 2-3 pages proposal, 3 slides & 3 minutes talk from each student)

4) Urban complex environment

- 2/19 Urban complex environment – North American cities
Urban complex environment – Tokyo, Guest lecture by Prof. Akito Murayama

5) Urban energy and metabolism

- 2/26 Urban energy systems
Design for urban metabolism
- 3/5 Seminar on urban climate, air, energy, food and water (online only)
- 3/12 Spring break**

6) Urban systems design

- 3/19 Digital engineering design: guest lectures
8:00am: Digital twins: An overview, Prof. Olivia Fischer
9:30am: Digital twins for infrastructure, Dr. Michael Balchanos
- 3/26 Urban systems design
Seminar on future cities I

4/2 Seminar on future cities II
Project preview and work session

Final Review and Submissions

4/9*** **Final Presentation I** (ARCH6447 and ARCH4447, **8:00-12:00pm**)
4/16*** **Final Presentation II** (CP6552 and CP4813, **8:00-12:00pm**)
4/30 Final Submissions (TBA)

*1/22, 1/29, 2/5: Project briefing at Eco Urban Lab during the lab hour: 11:30-12:15pm

**1/29: Deadline to sign up for the project options: Project design A, B, C or Individual Research.

***2/12, 4/9, 4/16: Please note that the Proposal (2/12) and Final Presentation (4/9, 4/16) sessions will be four hours from 8:00am to 12:00pm.

Laboratory Hour and Office Hour (Optional, Eco Urban Lab – ARCH EAST 304, Friday 11:30 – 12:15pm)

- Laboratory hours will be offered every Friday at 11:30-12:15pm. Students can use Eco Urban Lab for project teamwork or discussion.
- Office hours will be offered for students who would like to have their feedback of project design or research paper after the midterm. Time is to be arranged.

Learning objectives

Students will be exposed to the following theories, methods and tools and techniques:

- Foundations in urban design and urban systems design.
- Urban ecology for urban green and blue systems planning.
- Understanding of smart urban systems and their performance of energy, material, water, air and human flows in urban environments.
- Design techniques and problem solving for urban complex systems.

Learning outcomes

Students who successfully complete this class will be able

- To be familiar with recent literature of urban design and smart city movement;
- To develop a research design for the performance measure of sustainable urban systems;
- To develop teamwork experiences for a sustainable urban design project;
- To complete a group project of urban ecological design or design of smart urban systems, or alternatively, an individual term research paper under the guidance of the instructor.

Criteria of Performance Evaluation

1. 15% weekly reading note and class attendance
2. 15% seminar participation
3. 15% proposal, including writing (2-3 pages in WORD) & presentation (max 3 slides) on 2/12
4. 15% final presentation on 4/9 or 4/16
5. 40% final submission on 4/30 (TBA): project design report or research paper

Submission Requirements

1. Weekly readings

The weekly readings are divided by “required” and “recommended”. Students are to complete “required” readings and submit a reading note (half to one page by WORD) before the class begins. (required on 1/22, 1/29, 2/5, 3/5, 3/26, 4/2, optional on 1/15).

2. Seminar

Students will select one article/presentation from the “Seminar” reading list. Each seminar reading will be assigned to at least one student for making presentation in the class. Students should upload the presentation slide of seminar reading before the class begins.

3. Proposal:

Each student will submit individual work on: 1) an “idea paper” as a project proposal or an extended abstract of the term paper (2-3 pages for each student in WORD document, including figures), and 2) presentation (max 3 slides, 3 minutes for each student). Please note that the 3-slide proposal presentation should be submitted by **2/11 Thursday** before 6:00pm to be included.

4. Final Presentation:

- For Project Design, students will form small project groups, around 3-4 students for each group. Students will choose from one of the following options:
 - 1) Project A: A1 - Georgia Tech Campus Planning; A2 – Campus Vertical Farming;
 - 2) Project B: B1 - Tokyo Nihonbashi Urban Design; B2 – Urban resilience analytics
 - 3) Project C: C1 – ATL Airport City; C2 – Space Urban SystemsThe Project Design aims to create an urban design master planning or site design, with a focus on creative urban design or scenario planning based on GIS data analytics, or a combination of both.
- 4) For Individual Research D, students will present the progress of your research paper based on a topic that is within the scope of the six topics in the course outline. Problem formulation, data inquiry or urban design/planning strategies in actual urban context are required for forming individual research. It's critical that student should complete the final term paper by original writing.
- Students will present Project Design or Research Paper by PowerPoints scheduled on **4/9 or 4/16**, no longer than 12 slides for each student. For the group project (e.g. 3 students), the total slides are no longer than 36 for the entire group.

5. Final Submission

- Students for Project Design will develop the design work into a professional Project Report to incorporate individual writings and design images (portrait by InDesign). Individual contributions to the group work should be reflected in the report. The following work from ULI Competitions is a good reference for your project work deliverables in the final report:
<https://americas.uli.org/2021-uli-hines-student-competition-finalist-cattlyst-georgia-institute-of-technology/>
- Students for Individual Research will submit a term paper based on **original writing**, no longer than 4,000 wordcount for undergraduate students (ARCH4447 and CP4813), and no longer than 5,000 wordcount for graduate students (CP6552 and ARCH6447)
- For both Project Report and Individual Research Paper, acknowledgment and citation of references should be included if applicable.

The deadline of final submission will be on **4/30 (TBA)**. All submissions are to be uploaded to Microsoft TEAM folders. Hard copies are not required.

Reading List

Topic 1: Urban design

1. **Urban design: a normative theory (1/15)** - Weekly reading note submission this week is optional only.
(required)
 - Lynch, Kevin, 1990, “Urban Design”, in *City Sense and City Design: Writings and Projects of Kevin Lynch*, pp 511-534, edited by T. Banerjee and M. Southworth, MIT Press.
 - Lynch, Kevin, Hack, G, 1983, Chapter One “The Art of Site Planning”, in *Site Planning*, the third edition, MIT Press.(recommended)
 - Hack, Gary, 2018, *Site Planning: International Practices*, MIT Press.
 - Steinitz, Carl, 2012, “Part 1” in *A Framework for Geodesign: Changing Geography by Design*, ESRI Press
 - Steinitz, Carl, 2014, Chapter 2 - Which Way of Designing? in *Geodesign: Integrating design and geospatial science in Europe*, Scholten H, Lee D and Dias E eds., Springer.

- Yang, Perry P J, 2014. Chapter 3 - Energy resilient urban planning, in *Geodesign: Integrating design and geospatial science in Europe*, Scholten H, Lee D and Dias E eds., Springer.

Topic 2: Urban form

2. Urban data: spatial visualization and analytics (1/22)

(required) - to select at least one from the two readings

- Batty, Michael, 2016, Big data and the city, in *Built Environment*, Vol. 42, No. 3, 321-337.
- Li, Feifei, 2025, From Words to Worlds: Spatial Intelligence is AI's Next Frontier.
<https://drfeifei.substack.com/p/from-words-to-worlds-spatial-intelligence>

(recommended)

- Claudel M, Nagel, T, Ratti, C, 2016, From Origins to Destinations: The Past, Present and Future of Visualizing Flow Maps, in Big Data and the City, Special Issue in *Built Environment*, Volume 42, No. 3, Page 338-355.
- Kandt J, Batty M., 2020, Smart cities, big data and urban policy: Toward urban analytics for the long run, in *Cities*.
- Lynch K, 1972, Chang made visible, in *What Time is This Place*, MIT Press. Batty, M, 2018, The Pulse of the City, in *Inventing Future Cities*, MIT Press.
- Lynch K, 1972, Managing transition, in *What Time is This Place*, MIT Press.
- Yamagata, Y., Yang Perry P J et al., 2020, Urban systems and the role of big data, in *Urban Systems Design: Creating Sustainable Smart Cities in the Internet of Things Era*, Yamagata and Yang eds., Elsevier.

2s. Seminar on urban data visualization and analytics (1/22)

(seminar)

1. UCL Centre for Advanced Spatial Analysis (CASA) – Current Projects <https://www.ucl.ac.uk/bartlett/casa>
(1 student to present, to select at least two projects/research papers)
- 2.3 MIT Senseable Cities Lab –Projects on urban flows - <https://senseabledb.mit.edu/labmap/>
(2 students to present, each student to select at least two projects/ research papers)
- 4.5 Future Cities Lab, ETH Zurich & Singapore - <https://fcl.ethz.ch>
(2 students to present, each student to select at least two projects/ research papers)

3. Urban form: representation, measure and sensuous quality (1/29)

(required) - to select at least one from the two readings

- Lynch, Kevin, 1981, What is the form of a city and how is it made? in *Good City Form*, MIT Press.
- Lynch, Kevin, 1981, Sense, in *Good City Form*, MIT Press.

(recommended)

- Cherry N, Nagle K, 2009, *Grid/Street/Place: Essential Elements of Sustainable Urban Districts*, American Planning Association.
- Lynch K, 1981, *Good City Form*, MIT Press.
- Lynch K, 1976, "Appendix 2: A Glossary of Technique" in *Managing the Sense of a Region*, pp. 88-164, MIT Press.
- Lynch K, 1972, *What Time is this Place*, MIT Press.
- Lynch K & Rodwin L, 1958, A Theory of Urban Form, *Journal of the American Institute of Planners*, 24:4, 201-214.
- MVRDV, 2006, *FARMAX: Excursions on Density*, 010 Publishers.
- Oswald F, Baccini P, 2003, "3.2 The Morphological Tools" in *Netzstadt: Designing the Urban*. Birkhauser, Berlin

3s Seminar on urban form (1/29)

(seminar)

1. Batty, M, 2009, Defining density, in *Environment and Planning B: Planning and Design*, **36** 571-572.
Batty, M, 2008, How tall can we go? How compact can we get? in *Environment and Planning B: Planning and Design*, **35** 1-2.
2. Martin L, March, L, 1972, The Grid as Generator, in *Urban Space and Structure*, Cambridge University Press.
3. Lee, T., Density Atlas. <http://densityatlas.org>
4. Sarkis H, Allard P, Hyde T, 2002, Introduction in *Case: Le Corbusier's Venice Hospital and the Mat Building Revival*, Harvard Graduate School of Design.

Topic 3: Urban landscape ecology

4. Ecological urbanism, landscape urbanism and urban ecology (2/5)

(required) - to select at least one from the two readings

- Forma, Richard T T, 2014, Chapters 1 Foundations in *Urban Ecology: Science of Cities*, Cambridge University Press, London.
- Corner, James, 2006, Terra fluxus, in *The Landscape Urbanism Reader*, Waldheim C ed., Princeton Architectural Press.

(recommended)

- Berger A, 2006, *Drosscape: Wasting Land in Urban America*, Princeton Architecture Press.
- Burdett R, Sudjic D, eds. 2007, the part 'Cities' in *The Endless City: The Urban Age Project by the London School of Economics and Deutsche Bank's Alfred Herrhausen Society*, Phaidon Press Ltd.
- Dramstad W E, Olson J D, Forman R T T, 1996, *Landscape Ecology Principles in Landscape Architecture and Land-Use Planning*, Harvard GSD & American Society of Landscape Architects, Island Press.
- Andres Duany and Emily Talen eds., 2013, *Landscape Urbanism and its Discontents: Dissimulating the Sustainable City*, Island Press.
- Field Operations, 2006, *Fresh Kills Park: Master Plan*, New York City Department of City Planning.
- Forman R T T, 2008, *Urban Regions: Ecology and Planning Beyond the City*, Cambridge University Press.
- Forman R T T, 1995, *Land Mosaics: The Ecology of Landscapes and Regions*, Cambridge University Press, London.
- Graedel T E, Allenby B R, 2010, *Industrial Ecology and Sustainable Engineering*, Prentice Hall.
- Hall P, 2002, Ch.5: The City in the Region: The Birth of Regional Planning; Edinburgh, New York, London 1900-1940" in *Cities of Tomorrow: An Intellectual History of Urban Planning and Design in the Twentieth Century*, Blackwell.
- McHarg I, 1992, *Design with Nature*, John Wiley & Sons Inc., New York.
- WA, 2010, Special Issue on Ecological Urbanism, *World Architecture (WA)*, Tsinghua University.
- Waldheim C, 2006, Landscape as urbanism, in *The Landscape Urbanism Reader*, Waldheim C ed., Princeton Architectural Press.
- Yang Perry P J, 2013, Landscape ecology and its urbanism, in *Landscape Urbanism and its Discontents: Dissimulating the Sustainable City*, Andres Duany and Emily Talen eds., Island Press.
- Yang, Perry P J, 2009, Questioning urban sustainability: social sufficiency, ecological efficiency and ecosystems compatibility. In *Journal of Urbanism*, November 2009, Vol. 2, Issue 3.

4s Seminar on urban ecology (2/5)

(seminar)

1-6, Forman, Richard T T, 2014, Chapters 3, 5, 6, 10, 11, 12 in *Urban Ecology: Science of Cities*, Cambridge University Press, London.

5. Proposal Presentation (2/12)

(2-3 pages proposal due in writing, and 3 slides/3 minutes presentation for each student - 8:00-12:00pm)

Topic 4: Urban complex environment

6. Urban complex environment (2/19)

(required)

- Jacobs, Jane, 1962, Chapter 22: The kind of problem a city is, in *The Death and Life of Great American Cities*, originally published Random House.

(recommended)

- Allen S, 2009, Mat Urbanism: Think 2D, in Part three: Cities. Practice: Architecture Technique + Representation, Routledge.
- Easterling K, 1999, Part one in *Organizational Space: Landscapes, Highways and Houses in America*, MIT Press.
- Habraken, J, 1987, The Control of Complexity, Places, Vol. 4, No.2.
- Jacobs J, 1962, *The Death and Life of Great American Cities*, originally published Random House.
- Loukaitou A, Banerjee T, 1998, Chapter 2: Models of Downtown Urban Design, in *Urban Design Downtown*:

Poetics and Politics of Form, University of California Press.

- Marshall R, 2003, *Emerging Urbanity: Global Urban Projects in the Asia Pacific Rim*, SPON Press, London.
- MOMA, 1967, The new city architecture and urban renewal, The Museum of Modern Art. www.moma.org/calendar/exhibitions/2593
- MVRDV, *The Vertical Village: Individual, Informal, Intense*, NAI Publishers
- Newman, Peter & Thornley, Andy, 2011, Ch7 New York and Ch13 Tokyo, in *Planning World Cities: Globalization and Urban Politics*, Palgrave MacMillan.
- Yang, Perry P J, 2007, Review of *Enduring Innocence: Global Architecture and its Political Masquerades*, Author: Keller Easterling, MIT Press, 2005", *Journal of Architectural Education*, 02.
- Yang, P P J, 2005, "From Central Business District to New Downtown: Designing Future Sustainable Urban Forms in Singapore", in *Future Forms and Design for Sustainable Cities*, Jenks M & Dempsey N eds. Architectural Press.

Topic 5: Urban energy and metabolism

7a. Urban energy systems (2/26)

(required) - to select at least one from the two readings

- Ratti, Carlo., Raydan D., Steemers K., 2003, Building form and environmental performance: archetypes, analysis and an arid climate, *Energy and Buildings* 35 49-59.
- Yang Perry P J, Quan Steven J, 2016, Urban form and energy resilient strategies: A case study of the Manhattan grid, in *Urban Resilience – A Transformative Approach*, Yoshiki Yamagata and Hiroshi Maruyama eds., Springer.

(recommended)

- Grubler A et al., 2013, Executive Summary and Introduction, page: 1310-1316 of the Chapter 18 Urban Energy Systems. In *Global Energy Assessment - Toward a Sustainable Future*, Cambridge University Press.
- Nocera D G, 2006, On the future of global energy, Dadalus Fall 2006, *the American Academy of Arts and Sciences*.
- Yang, Perry P. J., 2020, Urban Energy Systems Design: A Research Outline, in *Energy Efficiency*, Henry Kelly ed., World Scientific Publications.
- Yang, Perry P J, Quan Steven J, Castro-Lacouture, D, Stuart, B, 2018. A Geodesign method for managing a closed-loop urban system through algae cultivation, in *Applied Energy*, Vol. 231, 1372-1382.
- Yang, Perry P. J., Yan, Jinyue, 2016, Modeling Urban Design with Energy Performance, in *Energy Procedia*, 88 3 – 8.

7b. Design for urban metabolism (2/26)

(required) - to select at least one from the two readings

- Baccini P, Brunner P H, 2012, Ch5: Designing Metabolic Systems, in *Metabolism of the Anthroposphere: Analysis, Evaluation and Design*, P:281-361, The second edition, MIT Press, Cambridge
- Koolhaas R, Obrist H U, 2012, Birth of a Movement: Metabolism and the World Design Conference, in *Project Japan: Metabolism Talks*, P.174-221, Taschen.

(recommended)

- Agudelo-Vera C, Leduc W, Mels A R, Rijnaarts H, 2012, Harvesting urban resources toward more resilient cities, in *Resources, Conservation and Recycling* 64 3-12.
- Baccini P, Brunner P H, 2012, *Metabolism of the Anthroposphere: Analysis, Evaluation and Design*, The second edition, MIT Press, Cambridge
- Batty M, 2011, "Cities as flows, cities of flows", in *Environment and Planning B: Planning and Design*, Volume 38, 195-19.
- Graedel T E, Allenby B R, 2010, *Industrial Ecology and Sustainable Engineering*, Prentice Hall.
- Head, Peter et. al., 2008, Entering the Ecological Age: the Engineer's Role, Institute of Civil Engineering.
- Kennedy C, Pincetl S, Bunje P, 2010, The study of urban metabolism and its applications to urban planning and design, in *Environmental Pollution* 1-9.
- Lin, Zhongjie, 2023, *Kenzō Tange and the Metabolist Movement: Urban Utopias of Modern Japan*. Second edition. London and New York: Routledge, 2023.
- Yang, Perry P J, 2012, Complexity Question in Urban Systems Design, in *Journal of Architectural Engineering Technology*, editorial, Vol. 1, Issue 2.

- Yang, Perry P J, 2008, Tracking Sustainable Urban Forms and Material Flows in Singapore. In *World Cities and Urban Form: Fragmented, Polycentric, Sustainable?* edited by Mike Jenks, Daniel Kozak and Pattaranan Takkanon, Routledge.
- Yang Perry P J, Ong B L, 2004, "Applying Ecosystem Concepts to the Planning of Industrial Areas: A Case Study of Singapore's Jurong Island", in *Journal of Cleaner Production* (special issue on applications of industrial ecology), 12, 8-10, October 2004.

8s Seminar on urban climate, air, energy, food and water - I (3/5)

(seminar)

1. Stewart ID, Oke TR, 2012. Local climate zones for urban temperature studies. in *Bulletin of the American Meteorological Society*. 93:1879-900.
2. Ratti C., Baker N., Steemers, K., 2005, Energy consumption and urban texture, *Energy and Buildings* **37** 762-776.
3. Bribian I Z, Uson A A, Scarpellini S, 2009, Life cycle assessment in buildings: State-of-the-art and simplified LCA methodology as a complement for building certification, *Building and Environment*, **44** 2510-2520.
4. Reinhart, C. F., Davila, C. C., 2016, Urban building energy modeling: A review of a nascent field, in *Building and Environment*, 97 (2016) 196-202.
- 5-6. Proksch, Gundula, 2017, *Creating Urban Agricultural Systems: An Integrated Approach to Design*, Routledge.

8s Seminar on urban climate, air, energy, food and water - II (3/5)

(seminar)

1. Ng E, 2009, Policies and technical guidelines for urban planning of high-density cities – air ventilation assessment (AVA) of Hong Kong, *Building and Environment*, **44** 1478-1488.
- 2-3. UACDC, 2010, Low Impact Development: A Design Manual for Urban Areas., Arkansas.
- 4-6 Novotny V, Ahern J, Brown P, 2010, Chapters IV, VI, VIII in *Water Centric Community Communities: Planning, Retrofitting and Building the Next Urban Environment*, Wiley.

9. Spring break

Topic 6: Urban systems design

10. Digital engineering design (3/19) - weekly reading note not required.

(recommended)

- Batty, Michael, 2024, Digital Twins in City Planning, Vol.4, Page 192-199, *Nature Computational Science*.
- Bettencourt, Luis M. A., Recent achievements and conceptual challenges for urban digital twins, Vol.4, Page 150-153, *Nature Computational Science*.
- Cardarelli G, et. al., 2021, The role of complexity for digital twins of cities, Vol.3, Page 374-381, *Nature Computational Science*.
- Duncan, S., Balchanos, M., Sung, W., Kim, J., Li, Y., Issac, Y., Mavris, D., Coulon, A.: Towards a data calibrated, simulation-based campus energy analysis environment for situational awareness and future energy system planning. In: ASME 2014 8th International Conference on Energy Sustainability Co-located with the ASME 2014 12th International Conference on Fuel Cell Science, Engineering and Technology (2014). doi:10.1115/ES2014-6695
- Mavris, D. N., Balchanos, M. G., Pinon-Fischer, O. J., & Sung, W. J., 2018, Towards a Digital Thread-enabled Framework for the Analysis and Design of Intelligent Systems. In 2018 AIAA Information Systems-AIAA Infotech@ Aerospace (p. 1367).
- Mavris, D.N., Pinon, O., Balchanos, M.G. and W.J. Sung. A Data Mining and Visual Analytics Perspective on Infrastructure Planning. In International Conference on Data Mining and Big Data (IC-DMBD'2016), P.330-341 Bali, Indonesia, June 2016 (Invited Paper).
- Pinon-Fischer, O. J. et al., 2022, Digital Twin: Reference Model, Realizations, and Recommendations, INSIGHT, Volume 25, Issue 1 p. 50-55. <https://doi.org/10.1002/inst.12373>

11. Urban systems design (3/26)

(required) - to select at least one from the two readings

- Batty, Michael, 2018, Chapter 7: The Sixth Kondratieff: The Age of the Smart City, in *Inventing Future Cities*, MIT Press.

- Yang, Perry P J, Yamagata, Yoshiki, 2020, Chapter 1, Urban Systems Design: Shaping Smart Cities by Integrating Urban Design and Systems Science, in *Urban Systems Design: Creating Sustainable Smart Cities in the Internet of Things Era*, Yamagata and Yang eds., Elsevier.

(recommended)

- Batty, M. 2013, *The New Science of Cities*, MIT Press.
- Batty, Michael, 2018, *Inventing Future Cities*, MIT Press.
- GT Eco Urban Lab, 2020, Digital urban design tool box, Eco Urban Lab, Georgia Institute of Technology.
- Mattern, Shannon, 2021, *A City Is Not a Computer: Other Urban Intelligences*. Princeton University Press.
- Mitchell, W, 1995, *City of Bits: Space, Place and the Infobahn*, MIT Press.
- Yamagata, Y., Yang, Perry P. J. eds., 2020, *Urban Systems Design: Creating Sustainable Smart Cities in the Internet of Things Era*, Elsevier.
- Yang, Perry P J, 2006, Book review of Digital Ground: Architecture, Pervasive Computing, and Environmental Knowing, *Environment and Planning B: Planning and Design*, Vol 33, 793-795.

11s. Seminar on future cities design I (3/26)

(seminar)

Theme 1: The Computable City

- 1-4. Batty, Michael, 2024, *The Computable City*, MIT Press.
 - 1_Ch9 High- and Low-Frequency Cities
 - 2_Ch12 Big Data and Urban Analytics
 - 3_Ch16 Organizing Smart Cities
 - 4_Ch17 Unpredictable City

12s Seminar on future cities design II (4/2)

(seminar)

Theme 2: Autonomous vehicles for future city design

- 1-2. NACTO, 2017, *Blue Print for Autonomous Urbanism*, the Second Edition, National Association of City Transportation Officials. <https://nacto.org/publication/bau2/>
- 3 Toyota woven city and e-Palette: <https://www.woven-city.global>
https://www.youtube.com/watch?v=IQ_KX0qAEMo

Theme 3: Smart cities as living laboratory - <https://www.sidewalklabs.com/toronto>

- 4-5. Sidewalk Toronto: The Urban Innovations
6. Mattern, Shannon, 2021, Chapter 2 - A City Is Not a Computer, in *A City Is Not a Computer: Other Urban Intelligences*. Princeton University Press.

Theme 4: Eco urban systems performance evaluation and certification

- 7-9. Rueda, Salvado et al., 2015, Part I/ Part II - III/ Part IV - V, *Ecological urbanism certification: urbanism certification with sustainability criteria*, Barcelona Urban Ecology Agency.

13. Final Presentation I (4/9 - 8:00-12:00pm)

14. Final Presentation II (4/16 - 8:00-12:00pm)