Data-supported Design in Architecture and Urbanism
The Use of Geospatial Data for Transport Node Design

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Recommendation

Conference for Artistic and Architectural Research & Collective Evaluation of Design-driven Doctoral Training Programme

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Book of Proceedings

Recommendation

Conference for Artistic and Architectural Research & Collective Evaluation of Design-driven Doctoral Training Programme

Faculty of Architecture and the Built Environment,
Delft University of Technology

The Netherlands, Delft, March 28 – April 1 2022

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CA²RE+ Delft RECOMMENDATION: Conference for Artistic and Architectural Research & Collective Evaluation of Design-driven Doctoral Training Programme

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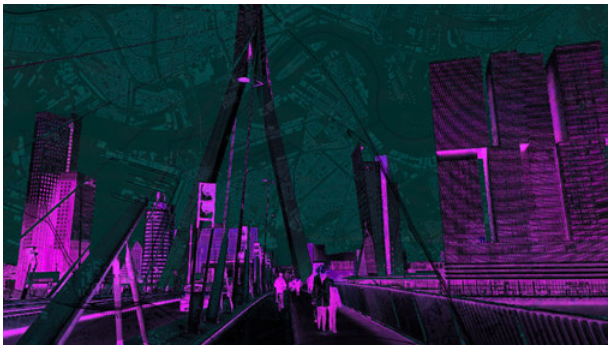
Data-supported Design in Architecture and Urbanism: The Use of Geospatial Data for Transport Node Design

Halina Veloso e Zarate, TU Delft



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Data-supported Design, Architecture & Urbanism, Complex Projects

Abstract

For the past three decades, the shift toward digitization propelled the implementation of data-supported design into contemporary practices and research in Architecture and Urbanism. The growing availability of data and broader accessibility to software and skills are introduced to designers and city makers as enablers of sustainable design solutions, aiming to address the global challenges of rapid urban growth and climate change. This brings an opportunity to explore the use of a specific type of data – geospatial data – in design methods. This paper focuses on understanding the relationship between the process of digitization and the use of data to support design in Architecture and Urbanism, through a literature review and case study. Adopting transport nodes as a type of project for the investigation of such methods, the paper brings in the case of the Sustainable Los Angeles 2050 project to explore how the use of geospatial data can influence the design of transport nodes.

DDR statement

This paper seeks to understand how data can be part of an integrated design approach, focusing on the use of geospatial data at the project scale between building (architecture) and district (urbanism). It qualifies as a Design Driven Research in several ways. First, the research frames the relationship between the shift toward digitization and the implementation of data-supported design into contemporary practices of Architecture and Urbanism. This theoretical contextualization reveals how research-by-design was determinant in discovering break-through skills and collaborations in the use of digital technologies and data-supported methods for design. Second, it looks into a theoretical background about design processes and how data can be appropriated by designers and influence the formalization of a design proposal. Here, the paper investigates existing methodological frameworks for design documented in scientific literature. The design frameworks explain in what consist the steps of design and in what order they are taken – but do not elaborate much on how data is used in the design process. Third and finally, a design case-study provides an illustrative example of how geospatial data can be used in transport node design. This case-study reconstructs the design process based on literature review, archive research and interviews with designers. The different design documents delivered as project milestones contained design material that evolved incrementally until the conclusion of the project. This archive was the main source for a near-to-complete list of geospatial data that was part of the process and conditioned the distinguished design scenarios for the five transport nodes.

The use of digital technologies and the application of data to inform design decisions has been in practice for many decades in the field of engineering. In Architecture and Urbanism, its use has only been incorporated into workflows over the past three decades.[1][2][3] The growing availability of data and broader accessibility to software and skills are introduced to designers and city makers as enablers of sustainable design solutions, aiming to address the global challenges of rapid urban growth and climate change. Data-supported design methods propose to enrich intuitive ways of design and city-making with more strategic and tactical methods. In the new millennium, Architects and Urbanists broadened their design skills and created new specializations and understandings of what is "data." The term "data" can refer to, among others, big-data data collected by sensors, GPS, mobile phones or social media posts;[4] digital 3D models and municipal building regulation data[5] or even architectural data-sets such as building plans;[6] transparency information about development processes,[4] geospatial data, which is data with spatial components located on Earth, visualized and communicated through maps.[3] Even though there lacks a single definition of what is "data" in Architecture and Urbanism, this paper focuses on "data" that has spatial components, is "readable" by design software,[4] and help designers evaluate a project's success in achieving a certain ambition or disciplinary agenda. This brings an opportunity to explore the use of a specific type of data – geospatial data – in design methods.

This paper seeks to understand how data can be part of an integrated design approach, focusing on the use of geospatial data at the project scale between building (architecture) and district (urbanism). The first step of this investigation is a contextualization that frames the relationship between the process of digitization and the implementation of data-supported design in Architecture and Urbanism. This section aims to trace a retrospective of the development of digital technologies and the use of data in design research and practice. It builds upon the report "The Digital in Architecture: Then, Now and in the Future," by the scholar M. Claypool, 2019.[7] Based on this investigation, it is possible to derive the key periods of development of data-supported design in Architecture and Urbanism. This paper proposes to name them the Age of Utopia, The Age of Experimentation and the Age of Awareness, as indicated in [D1iagram 1]. From this overview, it is interesting to observe how relevant geospatial data becomes to design explorations, as spatiality is an intrinsic quality to design. To better understand the use of data in the design process, a complementary literature review is conducted about the design phases and steps. This is done from the point of view of architecture design methods,[9] integral design approaches[10] and geodesign.[3] It reveals what types of design frameworks have been documented to explain the design process, but not necessarily clarify how data is used by Architects and Urbanists, especially in what refers to the creation of formal design outputs. Therefore, this investigation reveals a gap in the scientific literature on integral design approaches, on how geospatial data can be incorporated in the design process.

The second part of this paper traces a parallel with the emergence of sustainability as a strong disciplinary agenda for the design practice[7] in the latest stages of development in data-supported design (20102050,

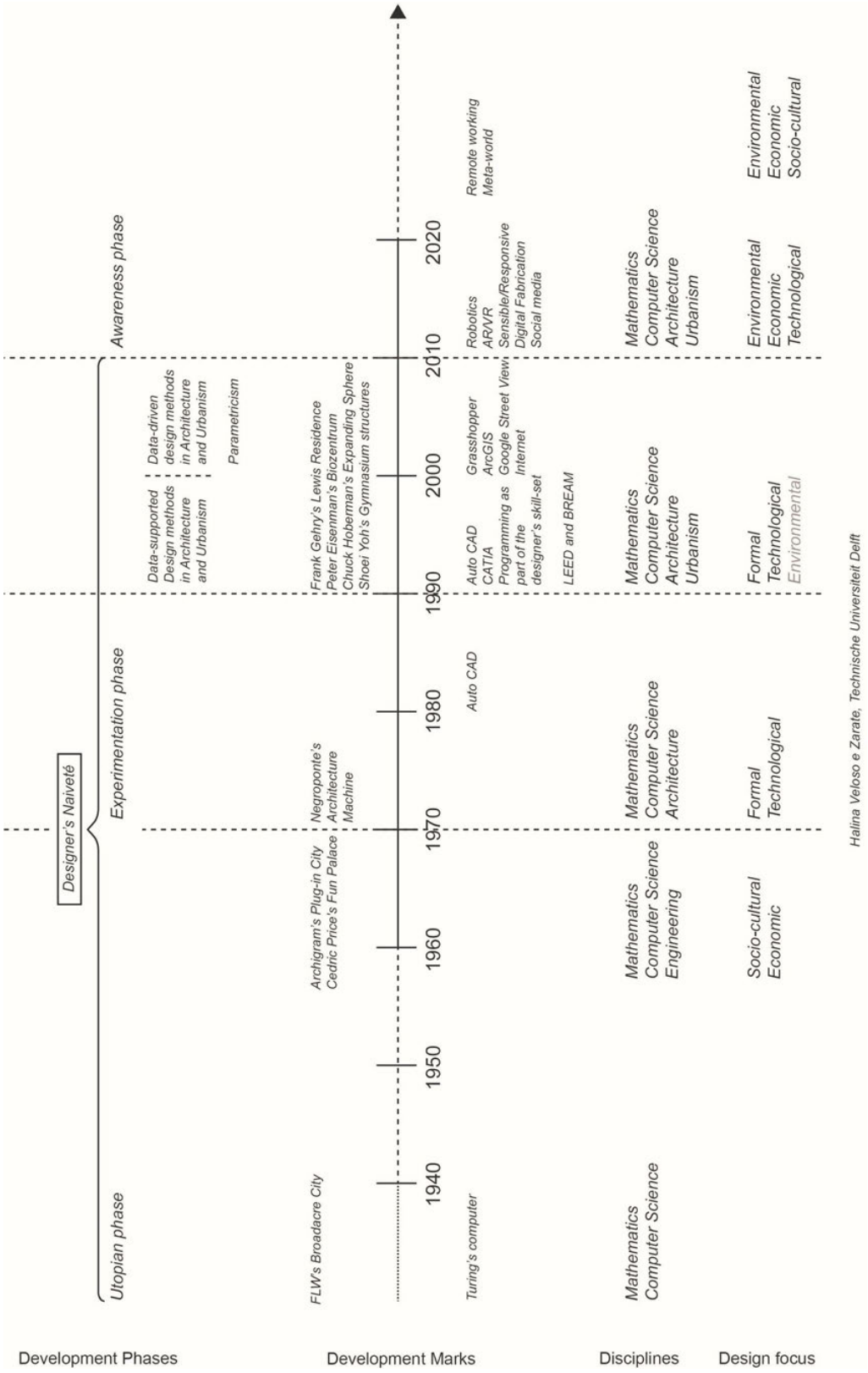

Development Phases
Development Marks
Disciplines
Design focus
Utopian phase
Designer's Naiveté
Experimentation phase
Awareness phase
1940
1950
1960
1970
1980
1990
2000
2010
2020
FLW's Broadacre City
Archigram's Plug-in City
Cedric Price's Fun Palace
Negroponte's Architecture Machine
Turing's computer
Auto CAD
Data-supported Design methods in Architecture and Urbanism
Data-driven design methods in Architecture and Urbanism
Parametricism
Frank Gehry's Lewis Residence
Peter Eisenman's Biozentrum
Chuck Hoberman's Expanding Sphere
Shoei Yoh's Gymnasium structures
Auto CAD
CATIA
Programming as part of the designer's skill-set
Grasshopper
ArcGIS
Google Street View
Internet
LEED and BREAM
Robotics
AR/VR
Sensible/Responsive
Digital Fabrication
Social media
Remote working
Meta-world
Mathematics
Computer Science
Engineering
Mathematics
Computer Science
Architecture
Mathematics
Computer Science
Architecture
Urbanism
Mathematics
Computer Science
Architecture
Urbanism
Socio-cultural
Economic
Formal
Technological
Formal
Technological
Environmental
Environmental
Economic
Technological
Environmental
Economic
Socio-cultural
Halina Veloso e Zarate, Technische Universiteit Delft

Diagram 1

The Age of Awareness). The social, environmental and economic dimensions of a project addressing global urbanization challenges[7 8 9 10 11] aim to respond to sustainable development goals. In this context, densely populated urban centres are presumed to be beneficial for the approximation between people, services and opportunities. They provide a chance to reduce demand for movement and CO2 emissions, leverage existing infrastructure, and ease the monitoring and control of the urban performance in regards to environmental quality.[10] This section of the paper points to a specific type of project that combines urbanization and mobility strategies, such as Transit Oriented Development (TOD). TOD is seen as a key to achieve sustainable urban development.[12 13 14] Such projects concern multiple scales: the regional transit network, the area of influence of a station, and the building scale of the station itself. Dealing with mobility adds large amounts of data to be considered in the design process of transport nodes – commuting patterns, passenger flows, walkability assessments, to name a few.[3] This paper brings in a brief literature review about this type of project, here referred to as "transport nodes." It aims to frame its relevance related both to the global issues in the spotlight in the first half of the 21st Century, and to the use of data-supported methods in integral design approaches.

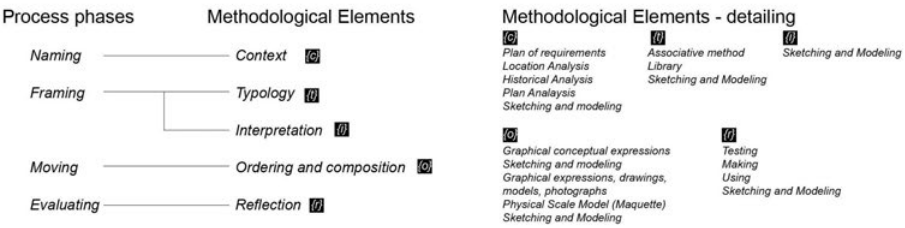
The third part of this paper adopts transport nodes as an object for investigation about the research gap regarding the incorporation of geospatial data in the design process. Geospatial data can be valuable in the design process of transport nodes, for example: data on pedestrian flows may be used as a spatial determinant for design gestures enhancing walkability around the station, such as direct connections through blocks or streetscape redesign. Another example is data on noise nuisance, passenger flows and commuting patterns. These may influence the determination of fills and voids of space in the station area. This section adopts a case study, the research project Sustainable Los Angeles 2050. The case study is conducted through literature review of the publications about this project, combined with archival research and interviews with some of the designers that worked on the project. The aim was to understand the design process of this project and which geospatial data was taken into consideration, as indicated in [Diagram 2] and [Diagram 3]. Finally, based on interviews, the paper identifies certain challenges and risks in the use of geospatial data for the design of transport nodes.

In summary, this paper contextualizes the use of data-supported design in Architecture and Urbanism; identifies the research gap in the use of geospatial data in integral design approaches; and determines the type and scale of project – transport node design — for selecting and conducting a case study. As an outcome, this paper offers learnings about the challenges and limitations of the use of geospatial data in transport node design. As rebuilding design processes of existing projects may leave behind unregistered but important details, a follow-up to this paper is necessary. This is especially relevant for urban contexts focused on the densification around public transport stations. This is the case, for example, of the city of Rotterdam, which has published a Vision Plan[15] proposing strategically located transport nodes to bear the projected urban growth of 50,000 new homes by 2040, while complying with local

Capacity Study (modelling/testing densities - uniformly or in hubs - considering different housing types and mix of programmatic uses to accommodate +1.5 million people in the study area, while responding to sustainable goals) {f}	*Dense living typology reference models (global metropolis), height envelope, Floor Area Ratio, Gross Floor Area per land use type, population density ratio, open space area per capita*	●	●	○	s
Speculative geospatial investigation with before and after performance analysis in the scale of potential Transit Oriented District {f} {c}	*accessible green area per person, water& energy consumption, waste production, food demand*	○	○	○	s
Geospatial analysis in the scale of potential Transit Oriented District {c}	*land use, Gross Floor Area per land use, Floor Area Ration, Height Envelope, points of interest, mobility split,*	●	●	●	s
Urban Character analysis in the scale of potential Transit Oriented District {c}	*text, pictures, character diagrams, sketch models*	●	●	○	nns
Definition of (top-down and bottom-up) strategies and design principles, for Wilshire Corridor as a system of complementary parts {f}	*text (list of potential strategies), reference studies, flowchart*	○	●	●	ns
Transit Oriented District Study (identifying districts with resticted densification capacity, redistributing population density only on non-restricted nodes) {c} {f} {f}	*metro stations, restrictive criteria (proximity to school district, hospital district, low change acceptance society, already saurated density districts, historic preservation*	●	●	○	s
Definition of 5 high-potential Transit Oriented Districts (Santa Monica, Century City, Fairfax/LACMA, Koreatown, Westlake/Downtown LA) {c}	*target population per hub, main character (initial assumption)*	○	●	●	s
Definition of targets sustainability targets and specific roles per station area, considering them as part of a larger system, of Wilshire corridor	*text, urban design diagrams and concept drawings*	○	●	●	nns
Transition from Wishire corridor scale to Transit Oriented District scale, subdivision of research group, delopment of separate design proposals {c}	*3D model (Rhino) at TOD scale and resolution*	●	●	●	s
Speculative scenario making testing composition potentials to achieve the sustainability targets {c} *referring back to pre-set goals to use clean energy, locally sourced water, and enhance ecossystem health* {f}	*sketch 3D models with initial design gestures, surface areas, benchmark references, performance estimations*	○	●	●	s
Finalizing design proposal (morphology, GFA per land use, new features, new character)	*3D Model, renderings, diagrams, descriptive text*	○	●	●	ns
Packaging for delivery	*Indesign packages, Illustrator files, Rhino models, Photoshop collages, GIS package, videos*	○	○	●	nns
Post production for publication (double-checking, correcting, adjusting as needed)	*delivery package*	○	○	●	nns
Publication	*books, web application tool, videos*	○	○	●	nns

**The listed steps in the design process were reconstructed from the progress deliverables of the UCLA Grand Challenge and Wilshire Densification projects. These files are part of the author's personal archive, as a team member that workd on every deliverable. They are here listed in chronological order, as they were produced during the course of the Masters program, The Now Institute studio 2015-2016. The Now Institute: (Faculty) Thom Mayne, Eui-sung Yi. (GSR) Ryan A. Doyle, Devika Tandon, Rizzie Walker, Halina Zárate. (Masters students) Shareefa Abdulsalam, Yitao Chen, Çağdaş Delen, Ryan A. Doyle, Elisabet Ollé, Beyza Paksoy, Rupal Rathi, Niketa Sondhi, Devika Tandon, Wei Tang, Rizzie Walker, Halina Zárate.*

Legend of labels based on Visser, 2020:



Source of Process phases and Methodological Elements: Visser, J.L., Creating a New Perspective by Integrating Frames Through Design An Exploratory Research into the What, Why, and How of Integrated Design. 2020, TU Delft. p. 293.

Diagram 3

The steps in the design process & related data

Steps in the design process	Type of Data Present on process materials*	# of interviewees that mentioned this step/data	Spatial (s); Not Necessarity Spatial (nns); non-spatial (ns)
Literature review of existing governmental reports, plans, and academic work [c]	*text*	● ● ○	ns
Literature review of news and social media contents about clean energy, water sourcing, transportation trends [c]	*text, pictures, evidence of local community lifestyle, habits, traits*	● ○ ○	ns
Historic development of key sustainability events and challenges [c]	*text, historic photographs, historic planning documents*	● ○ ○	nns
Global comparison with other metropolis [c]	*text, key performance indicators (consumption patterns, density, housing typology, parcel size, average commute time...), physical characteristics, design drawings, pictures*	● ● ○	ns
Summary of problems and potentialities in achieving the sustainable goal of 100% sustainability [c]	*water/energy consumption, commuting times, housing type, lifestyle habits*	● ○ ○	nns
Case-studies and references for strategies considering policies, technologies, and lifestyle change towards sustainability transition [c]	*text, images, statistical data about technology trends*	● ● ○	ns
Geospatial analysis (California, LA county) scale, first at illustration format, then in GIS (collection, selection, classification according to the 3 main pre-set topics - energy, water, ecossystem- modelling and overlaying of factors) [c]	*Geospatial data about Energy (transmission lines utilities, power plants, carbon footprint, electricity consumption - total demand and demand per sector -, solar power potential, congestion, commuting time, public transportation lines and service areas, walkability);* *Water (drought, rainfall, water flows, water supply acqueducts, consumption - total demand and demand per sector);* *Ecossystem (nature preservation, wildfires, impacts of climate change on ecosystem, climate zones, extreme heat days, habitat);* *Other (educational institutioins, hospitals, police and fire stations, crime, income, ethnicities, administrative jurisditions, innovation projects, land coverage, urban gorwth, land use, residential housing type, landmarks and destinations)*	● ● ●	s
Supply and Demand understanding: main potential strategies and design principles considering policies, technologies, and lifestyle change towards sustainability transition [d]	*Flowcharts of supply and demand, breaking down key top down and bottom up factors that influence the overall balance*	● ○ ○	nns
Analysis of building typologies in relation to household density and consumption patterns [c] [d]	*design drawings (building type, area), 3D digital model, statistical data (people her household, consumption of energy/water per household*	● ● ○	ns
Exploration about possible growth scenarios (sprawl, limited sprawl, densification near transport nodes) [c]	*geospatial data such as county outline, urban land coverage, infrastructure*	● ● ●	s
Definition of (top-down and bottom-up) strategies and design principles, for Los Angeles County to become sustainable by 2050 [d]	*flowchart, text (list of potential strategies), reference studies*	● ● ●	ns
Establishment of a preferred scenario and a study site: Wilshire Boulevard [c] [d]	*criteria for chosing study site (most demographically and urban diversity, highly accessible jobs and opportunities, already high-rise and high-density, planned robust public transportation services)*	● ○ ○	s
Transition from regional scale to local scale, making 3D digital model and maquette for regional and local scale	*selected shapefiles to be clipped and exported from the large GIS scale and resolution and imported into architectural software (Rhino) for the making of a more detailed 3D basemodel (topography, infrasturcture, adminsitrative boundaries, buildings, open spaces, plus data described in the following geospatial analysis steps)*	○ ○ ●	s
Geospatial analysis in the scale of study site (Wilshire Corridor) [c]	*Selected geospatial data about study site area: administrative boundaries, education, ethnicity, household size, housing ownership, income, population density, public transportation access, cultural facilities, open spaces, hospitals, land use*	● ● ●	s

Diagram 2

environmental, social and economic tasks. As such, a demonstration study of the transport nodes in Rotterdam would be an interesting next-step to this paper.

1 Lynn, G. (2013): »Archaeology of the Digital«, in: icam 17. Montreal, New York: Sternberg Press.

2 Calleja, Maria López/Stott, Rory. (2020): MVRDV's Datascapes were a precursor of BIM techniques. https://www.mvrdv.nl/stack-mag...

3 Lee, D.J./Dias, E./Scholten, H.J. (2014): Geodesign by Integrating Design and Geospatial Sciences. Switzerland: Springer International Publishing.

4 RIBA and Arup (2019):m Designing with data: shaping our future cities. R.I.o.B. Architects.

5 Noardo, Francesca/Wu, Teng/Arroyo Ohori, Ken/Krijnen, Thomas/Stoter, Jantien (2022): »The use of IFC models towards automation of urban planning checks for building permit«, in: Automation in Construction, issue, 134, [104097]. https://doi.org/10.1016/j.autc...

6 Newton, D. (2019): »Deep Generative Learning for the Generation and Analysis of Architectural Plans with Small Datasets«, in: 37 eCAADe and XXIII SIGraDi Joint Conference. Porto.

7 Claypool, M. (2019): The Digital in Architecture: Then, Now and in the Future. SPACE10, https://space10.com/project/di...

8 Meadows, D., et al. (1972): The Limits to Growth., New York: Universe Books.

9 UN HABITAT. (2021): Global Future Cities Programme 18 February – Session 4: Evidence-based Design & the Effective use of Data. 18 February 2021, from: https://www.globalfuturecities.org/thematic-programme/18-february-session-4-evidence-based-design-effective-use-data

10 IPCC (2021): Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

11 United Nations (1987): Our Common Future: Report of the World Commission on Environment and Development.

12 Bertolini, L./Curtis. C./Renne, J. (2012): »Station Area projects in Europe and Beyond: Towards Transit Oriented Development?«, in: Built Environment, issue 38(1), pp. 31–50.

13 Cervero, R./Suzuki, H./Iuchi, K. (2013): Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development. Washington, DC: The World Bank.

14 Triggianese, Manuela/Cavallo, Roberto/Baron, Nacima/Kuijper, Joran (2018): Stations as Nodes: exploring the role of stations in future metropolitan areas from a French and Dutch perspective. Delft: TU Delft Open.

15 Goudappel Coffeng/APPM/RET (2018): OV2040 Samen slimmer reizen. OV-Visie Rotterdam 2018–2040. Rotterdam: Gemeente Rotterdam.

CA²RE / CA²RE+, the Conference for Artistic and Architectural Research, is dedicated to promoting Design-Driven Doctoral Research (DDDr) through its conference series. This initiative aims to strengthen and expand the community of researchers interested in this subject. The Faculty of Architecture and the Built Environment at Delft University of Technology has gladly provided the platform for this noteworthy conference.

The central theme of this event revolves around the "RECOMMENDATION" for Design-Driven Doctoral Research. This theme is a natural progression from the main topics explored in the previous CA²RE+ conferences, which included OBSERVATION, SHARING, COMPARISON, REFLECTION, and FRAMEWORK. The CA²RE+ Delft conference seeks to scrutinize the progress made thus far and endeavors to formulate guidelines and recommendations for the establishment, introduction, development, and evaluation of DDDr.

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