Design-Driven Data
Tactics for Designers in the Data-driven City

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Abstract. How can parametric design best adapt to an increasingly data-rich context, the result of the last decade’s so-called ‘data explosion’? The title design-driven data is a deliberate reversal of the increasingly popular formulation data-driven design, signaling our intent to prioritize human judgement over data in a purposeful, transparent design process. Recent critique of parametric and data-driven design as gratuitous and opaque motivate this research.

The proposed tactics for design-driven data include: 1) winnowing, ordering, and critical examination of data in the analytic phase; 2) expressing subjective motivations via indexing in the transition from analytic to creative design phases; 3) using data to support negotiation and consensus over design scenarios. These tactics have been developed as a support to parametric technique in urban design and tested in academic studios.

Keywords: urban data, urban design, parametric design, design process, design thinking

1 Introduction

As a research project, design-driven data asks how parametric design can process respond to an increasingly data-rich context in a manner that emphasizes purposeful and transparent design. This question is formulated in response to recent critique of the use of parametric design and big datasets in responding to urban design problems. Increasing prevalence of the mantra ‘data-driven design’ inspires us to reverse this formulation, foregrounding design and designer.

My research on design-driven data begins from concern that combining parametric design with urban data to convert a complex (wicked) design problem to a well-defined problem is open to considerable hazard.¹ Data may be allowed to overdetermine the design process, overriding important non-quantifiable criteria, undermining the critical judgement of the designer and making design process opaque.

¹ For an explanation of the distinctions between wicked and well-defined design problems see section 2.1.
Furthermore, designers should remain aware that data does not appear *ex nihilo* but is constructed by human actors with deliberate motivations. In using acquired data sets (as opposed to self-made data) the designer should exercise critical judgement in examining the motivations and techniques used to produce data and any biases that may result from this.

I do not suggest that these hazards are unavoidable, nor do I suggest that designers should avoid working with new sources of urban data. On the contrary I hope this research contributes to the use of new sources of urban data in parametric design in a purposeful, epistemologically diverse, and transparent manner.

In a first section the theoretical basis and contemporary urgency of design-driven data is established. A second section describes how parametric design can build off urban data to respond to design problems, along with some potential hazards inherent to this process. A third section describes tactics of *design-driven data*: critical data collection, projective use of the index in data-visualization and as parametric input, and the meta-map as tactic for expanding transparency and participation in the evaluation of parametric design results. A final section describes efforts to evaluate the research: the challenges and limitations of using results from academic studios and methods of autoethnography and stakeholder interviews. Collaboration with design studio students at EPFL and SUTD over the last two years has supported research on the use of these tactics; examples from these studios are used as illustrations throughout the text.

1.1 Design-Driven Data: Theoretical Background and Motivation

Big urban data and artificial intelligence are revolutionizing the study of the city and its operation, but the effects of this change remain contested, and their eventual impact on the design professions is unclear. This revolution has been heralded by authors like Alex Pentland, whose *Social Physics* previewed how the future city will be studied and managed through the collection and instrumentalization of petabyte-scale datasets. [18]

“To ensure a sustainable future society, we must use our new technologies to create new citizen systems that maintain the stability of government, energy and public health systems around the globe. […] We must use these technologies to reinvent societies’ systems within a feedback framework: one that first senses the situation; then combines these observations with models of demand and dynamic reaction; and finally, uses the resulting predictions to tune the system to match demands being made of them.” [18]

From these statements we can extrapolate a data-driven trajectory for the design professions; producing more efficient and responsive designs by integrating insights

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2 This point is made by Rob Kitchin: ‘Data are both social, in that they are situated in context, and material, in that they have a form (as bits, as symbols, as numbers, etc.) […] Big data are reliant on the discursive, political and economic discourses that support their roll-out.’ [9] p. 20
from growing urban data sets. Urban data as a category refers broadly to data generated by citizens, sensors, and simulations within or in relation to the city. The design community has begun to integrate insights from urban big data, with Dietmar Offenhuber and Carlo Ratti’s 2014 book *Decoding the City* leading the pack. [17] With time, however, critical concern has grown over excessive or uncritical reliance on urban data. Ratti himself recently remarked that, ‘data-driven technocracy is threatening to overwhelm innovation and democracy.’ [20] In this context parametric design process, capable of formulating explicit design responses to urban datasets, has become a newly relevant tool but also finds itself exposed to a dual critique of gratuitousness and opacity.

1.2 Gratuitousness and Opacity: A dual challenge for parametric design

“Instead of more gratuitous parametric modeling, we need to think about urban epistemologies that embrace memory and history; that recognize spatial intelligence as sensory and experiential; that consider other species’ ways of knowing; that appreciate the wisdom of local crowds and communities; that acknowledge the information embedded in the city’s facades, flora, statuary, and stairways (...).” [16]

This recent statement by media theorist and smart city critic Shannon Mattern led me to reflect on the epistemic limits of parametric design. Is parametric design necessarily gratuitous in its inability to reflect experience, memory and history, or could a non-gratuitous parametric design inhabit an epistemologically diverse space spanning the unquantifiable information Mattern emphasizes, as well as the precision and explanatory potential of urban big data? Parametric design process is already well-suited to the task of integrating diverse and multitudinous inputs, weighing them against each other. To respond to the critique of gratuitousness, parametric design process would need to establish *purposeful* responses to quantified urban data, but also ensure the ability for a human designer (and other stakeholders) to interject epistemologically-diverse input at crucial break points.

To raise the critique of opacity in data-driven systems we turn again to Mattern, “We should reject data-driven models that delegate critical, often ethical decisions to the machine.” [16] I link Mattern’s critique of loss of critical agency to the problem of opacity: an urban system, or design algorithm must opens itself to a broad range of human scrutiny so that its possible ethical implications may be judged. The critique of opaque urban software is not new; Douglass Lee’s *Requiem for Large Scale Models* describes how in the 1960s stakeholders lost confidence in black-box urban simulations. [13] Parametric design process, however, was never intended to be opaque, indeed McNeel’s ubiquitous parametric design software, *Grasshopper* was initially called *Explicit History*. Significantly for the critique of opacity, the question is not if the parametric design process is explicit, but to whom and under what conditions. Analogous to Donald Knuth’s *literate computing* of the 1980s, parametric design as applied to the data-driven city may need a reorientation toward broader transparency:
'Instead of imagining that our main task is to instruct a computer what to do, let us concentrate rather on explaining to human beings what we want a computer to do.' [10]

If we wish to avoid opacity, it is not enough for one digitally-literate designer to understand and control the explicit logic of a parametric model. A non-opaque parametric design process would include steps to open to wider scrutiny and reflection the decisions embodied in the parametric model. The critique of opacity and gratuitousness are not unrelated: establishing *purposeful* design is often only possible through the *transparent* articulation of design process and design intent, and the *dialogical examination* of this process and intent by other minds. To respond to the critique of opacity, data-rich parametric design process would need to ensure that critical, ethical decisions not be buried in a black-box but be deliberately opened to interrogation and debate.

1.3 Design-driven data: Research Question and Goals

As a research project, design-driven data asks, ‘how can parametric design process respond to urban data in a manner that emphasizes purposeful and transparent design?’ The goal of this research project is to develop tactics to (1) judiciously incorporate new sources of urban data as inputs for design process in general and parametric design in particular, (2) appropriately apply data to the reframing of wicked problems for parametric design, and (3) communicate the parametric design process transparently and inclusively.

2 Urban data in parametric design

“The designer first establishes the relationships by which parts connect, builds up a design using these relationships and modifies the relationships by observing and selecting from the results produced.” [26]

This quote by Robert Woodbury concisely describes the parametric design process. However, urban designers often use parametric design in a significantly different way. Instead of beginning with part-to-part relationships, urban designers using parametric design software will also often begin with *context-to-part relationships*. By this I mean that a design is developed in response to an urban context, which, to interface with parametric software must be represented by a spatial dataset. With the prevalence of new urban datasets, even architects designing at smaller scales may begin the design process with urban data in the form of point-cloud, meteorological data, or even social media data. (Fig. 1) The purpose of the design tactics described in section 3 of this paper is to provoke the designer and design student to think critically about the process of using urban data to create a parametric model. Urban design problems are almost always wicked, as we will see below, and reframing them as a parametric model based on urban data is not as simple as it may initially seem.
2.1 Using urban data to respond to wicked design problems

Urban designers are confronted by complex design problems requiring response to overlapping social, economic and aesthetic aspirations of a city. A major challenge in responding to these design problems is redefining the problem and breaking it into manageable pieces. Our recent studios at EPFL and SUTD have taken on problems like innovation districts, tourism in rural villages, ecological housing and the re-introduction of automated manufacturing into post-industrial districts. We are not alone in tackling these difficult problems; an overview of contemporary architecture and urban design studios will yield many similar design problems.

The problems I describe above can be characterized as wicked, and design thinking gives us a definition for them and a framework for thinking about them. In his 1987 book *Design Thinking* Peter Rowe explains the difference between well-defined, ill-defined and wicked design problems. He emphasizes that most designers work with wicked problems, where no definitive formulation of the problem is possible, additional questions lead to continual reformulation, there is no explicit basis for the termination of the design process, and alternative solutions can always be provided. [21] In contrast, in a well-defined problem the variables and their relationships have already been identified and all that remains is to find best (or optimal) values for these variables. [21]

In solving a wicked problem, the designer can develop a series of more or less well-defined sub-problems to navigate toward a general solution. The parametric model is one means of crafting a well-defined sub-problem on the way to producing a general design solution for a wicked problem. In the contemporary data-rich environment, a parametric model can be optimized in response to one or several urban datasets (environmental, social, economic, mobility data are all conceivable here).

Our research begins from the concern that the temptation to combine a parametric model with urban data to convert a wicked problem to a well-defined problem is open to considerable hazard. A first hazard is that urban datasets may be taken up by
designers without reflection on how the data was collected and what its underlying biases may be. A second hazard is that a wicked design problem will be reframed to respond to an urban dataset simply because the dataset is available, but not because it is pertinent. A final concern is that the designer may choose to present the design produced by a parametric model operating on an urban data set as a fait-accompli without remaining open to epistemically diverse inputs or outside voices. The tactics I present below are meant to respond to these hazards, giving designers tools of thinking and working that allow them to combine parametric models and urban data in a non-gratuitous and transparent manner.

3 Tactics for Design-driven Data

3.1 Purposeful Data Collection

Converting urban data into actionable knowledge for a design problem requires the deliberate exercise of human judgement, to critically evaluate, winnow, and order the data. Critical examination of data should strive to uncover any potential bias that may influence the eventual design outcome. Winnowing and ordering make it possible to derive actionable information from the data deluge. Site data in contemporary practice are obtained by an almost exclusively digital process: data can be mined from large public databases or from many small user-generated sources, data can be simulated, and can be directly measured from the field.

Data does not appear ex nihilo but is constructed by human actors with deliberate motivations. In using acquired data sets (as opposed to self-made data) the designer should exercise critical judgement in examining the motivations and techniques used to produce the data and any biases that may result from this.

An anecdote from a recent studio illustrates the need to critically examine ready-made urban data sets. For a master plan design in Glasgow students narrowed in on problems of urban noise as they reformulated the studio design brief. The students acquired several urban noise datasets for our site. Critical examination of these data yielded relevant information on the motivation behind their creation and their technical limits. The data were produced via simulation by contractors working for the Scottish government. Though displayed as smooth contour maps, they were produced with an accuracy of 10 meters and are measured 4 meters off the ground. The effort to produce and disseminate the noise maps was initiated by the European Commission’s noise directive of the early 2000s which mandated the creation of these maps to better inform the public on sources of noise pollution and to ultimately produce local noise action plans to reduce problematic noise.3

From this brief examination we understand an inherent technical bias of the noise dataset: features smaller than ten meters are not meaningful even if the smooth contours of the noise map belie this. Politically we understand these datasets as part of a European-wide initiative to initiate informed plans to respond to urban noise. Any use of this data should be openly framed within this context to avoid naïve, biased or opaque use of the data set.

Winnowing data refers to the process of removing data which is not relevant to the design problem at hand. Contemporary data abundance makes this task particularly crucial. Often for a given site or city a plethora of statistics are available via open data platforms. Finding the data that is relevant is difficult, and if this data is not adequate the decision must be made to make additional measurements in the field, or simulations to supplement it.

In the above example of noise data in Glasgow we were confronted with sixteen different layers of noise data. The data were collected in two distinct cycles, with each cycle considering three distinct noise sources (rail, industry, roads) as well as a map of all noise sources consolidated. For each cycle and source two time-averaged measurements with different time frames are available: $L_{den}$ (day, evening, night) and $L_{night}$ (night). To design in response to noise data, we had to decide which layers to focus on and which to discard. These choices are non-trivial: $L_{night}$ data may be chosen over the more global representation of $L_{den}$ because this time frame highlights noise that will disrupt the sleep of urban residents. Without winnowing the designer cannot move from data to design, this process deserves our close attention as part of the contemporary design process, as the quantities of data we work with will only increase in the foreseeable future.

Among the datasets pertinent to the design problem, the designer generally will establish an order or priority. While noise data may be important in the examples cited above, often an urban designer will be obliged to consider more basic problems of density (as measured through Floor Area Ratio) before addressing phenomena like urban noise. What order is assigned impacts design outcomes, but also is instrumental in the creation of the parametric model which will address data inputs in an explicit order.

3.2 The projective index

Designers must be aware not only of the potential exterior subjective influences on the data that they work with, but also of their own subjective impact on the data they work with. This secondary question of the objectivity of data lead me to consider if the subjective intent of the designer on her datasets should not be openly harnessed as an asset to the design process, as opposed to resisted or repressed. To harness the designer’s subjective impact on datasets it may be productive to overtly project a design aspiration into an index that initiates the design process or is used to evaluate its results: a projective index.
Visualization of spatial data is almost invariably achieved by some form of index. A color, or often a vertical bar, will represent a varying quantity at the location of its sampling in a two-dimensional space. We have become accustomed in everyday life to contoured or heatmap indices where data from a limited number of sample points are interpolated in two-dimensional space to give a smoothly modulated field – the impression of a continuous infinitely sub-dividable field. Airport noise contours are an early and currently ubiquitous example of this type of indexical visualization of urban data.

In architecture the index has been used in the recent past to mask or efface the subjective intent of the designer. This effacing of design intent is the opposite of what we have tried to achieve with the idea of projective index. To clarify it is helpful to remember that architecture inherited the index from American art of the late 1970s and its articulation in the writing of Rosalind Krauss. For the artists Krauss wrote about, like Deborah Hay, the index was a way of producing a ‘message without a code,’ and thus attempting to elude symbolism. In the work of Peter Eisenman we subsequently find the index used to generate architectural design which also transmits a ‘message without a code.’ Independently of the New York scene, the datascape work of the late 1990s and early 2000s arising in the Netherlands, sought to solicit architectural design directly from indexical representations of data. For the datascape designer, data overdetermined the design process and extrapolating a data-driven process toward an extreme end was an act of design research and a critical reflection on society. Still others sought to discover emergent architectural form in/through an indexical representation of environmental data. In each of these historical examples of the use of index, the designer represses or subverts her message or agency. In contrast the projective index would seek to revalorize the designer’s intent as not only unavoidable, but also instrumental to design advocacy (purposeful design) and to opening design to dialogue and negotiation (transparent design).

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4 [11] p. 59. Krauss is quoting from Roland Barthes to explain the work of Deborah Hay when she mentions a ‘message without a code.’ This page, annotated by Peter Eisenman, can be found reproduced in Tracing Eisenman, p. 48.

5 Some may recall the Noisescape project in FARMAX. p. 493-509
Fig. 2. *Projective index*. Design intent is projectively inscribed into a layer of data as transition from analytic to creative phases of design process: see ‘quiet zones’ in noise map 03.

The *projective index* overtly expresses a design aspiration via data, visualized as an index. In so doing a wicked design problem is reframed as a response to this self-made or bricolaged data and initiates a first attempt at formulating a well-defined design problem via a parametric model. This is perhaps best explained with a concrete example. In a recent urban design study for a district in Glasgow, already discussed above, students were asked to examine the secondary effects of the insertion of a drone port in the district. The droneport, depending on the airspace corridors created would contribute to an increase in urban noise in the district. Students were asked to study how this new noise source should be located in the existing noise map of the district by combining pre-existing public noise data with a new layer of simulated drone noise. In a subsequent step, students were asked to consider rebalancing the new and higher average district noise level to match the previous average district noise level. (Fig. 2) By subtracting noise from certain areas in response to the new source of drone noise, students could develop a concept of noise rebalancing visualized as a series of indexical heat maps of time-averaged noise levels. This *projective index* allowed students to overtly apply their judgement to the problem of how to introduce and accommodate the drone port in the district before beginning to design urban form. The projective index, as data layer, was fed directly into the parametric process as input, or as a benchmark to test design results against.
3.3 Meta-mapping

To foster purposeful and inclusive communication of design results from parametric urban design I propose a final tactic called meta-mapping: a remapping of the design process as a series of explicit, discrete steps. The meta-map is tree-like and, distinct from the grid-like representations often associated with optimized design studies, it invites the audience of the design project to engage with the design project and enact their own judgement both with the selection of design variants, but also in the paths taken to arrive at the presented variants. This explicit and critically reasoned representation of design does not seek to elide criticism, but to invite debate and negotiation as the best means of ensuring not just quality of design, but consensus on the means and goals of a design.

With the precision of new tools for distinguishing quantitative payoffs between design alternatives, designers in turn need to adapt their methods of presenting design results. Recent years have given us powerful new tools to explore the multiplicity of design solutions a parametric model may produce: showing us solutions along the pareto frontier or visualizing multi-dimensional design spaces to identify promising solution areas. [28] These tools, by expanding the optimum from singular result into a range of options, reflect the responsibility of choice back upon human judgement. How we deploy our judgement in evaluating the results of the design process is crucial- my intuition is that one final evaluation of a grid of optimal results is inadequate. What is needed instead is a more comprehensively argued overview of the design process highlighting crucial breakpoints in the design where the designer exercised intent and outside minds may be invited to debate this choice. Optimization tools may be used once or multiple times along this meta-map as support to the process of decision-making, but not as a culminating gesture which veils the many potential paths a design may take.

The tree-diagram is a familiar visualization of design process, notably presented in Christopher Alexander’s Notes on the Synthesis of Form and treated in Peter Rowe’s Design Thinking as decision trees, and as a technique of problem space planning. [1] [21] The tree diagram was adopted by the designers of parametric software early on as an effective means of allowing designers to build up complex geometrical forms from combinations of basic relationships. This is the case of familiar design tools like Generative Components and McNeel’s Grasshopper (initial named explicit history.) Robert Woodbury has examined the implementation of the tree structure in parametric design in Elements of Parametric Design. [26] From the beginning, however, the visual programming language interfaces of parametric design depicting tree-like data flow from node to node were unsuitable for representing the design process, unintelligible to any but the most determined technophile. A similar critique can be advanced of the problem-space planning presented by Alexander, that these techniques have only ever
really worked to promote self-reflection on the part of the designer. To represent design results as paths to be debated and negotiated with a wide variety of voices via a range of quantitative data requires something other than a one-to-one reflection of the parametric environment or an Alexandrian problem space planning.

To open up the parametric design process and use it as an instigator to conversation, the meta-map identifies a limited number of discrete break points. Series of linked break points produce different design options which branch out to produce an array of meaningful design variants. Each break point should represent a crucial decision, aesthetic, ethical or social, where the judgement of the designer is supported by quantitative evidence but open to a broader range of human judgement. Identifying, describing and representing these breakpoints in and of itself is a critical task for the design, which is largely retrospective. Instead of post-rationalization, the meta-map represents a form of retrospective clarification, setting the stage for the discussion with stakeholders as a means of soliciting opinions and judgements. The meta-map should also provide evidence for the designer to advocate for a specific design variant based on her professional expertise. In this sense the meta-map can be a tool both for guided negotiations between dissenting voices, but also as a means for a designer to advocate for informed consensus by presenting a range of information. This ability is crucial in urban design where many stakeholders need to be heard alongside the voice of professional expertise.

A meta-map example is shown below. (Fig. 3) Here students have identified five successive break points in the design process for a parametric model of an urban block in the same master planning project described above. These break points do not exhaust the possibilities of design search for the given design problem. On the contrary they represent issues the designers have found pertinent or problematic as they engaged and narrowed the initial design problem. The break points are presented here as way-points along the path toward a design, but more importantly as opportunities to solicit outside commentary or debate. Each break point defines one level of a tree diagram with multiple possible variants emerging at each level. For each design variant a combination of quantitative data and subjective judgement is present (abbreviated for legibility in the illustration below.) The students have identified one path through the meta-map, which is then highlighted in a larger scale axonometry at left. Other variants of the parametric model populate the remaining areas of the masterplan alongside pre-existing buildings. Ideally the meta-map should allow someone exterior to the design process (or even the design professions) to trace possible design paths and debate their relative merits.

[21] p.73. ‘The procedure allows decisions made by a designer about parts of a problem, and about their interrelationships, to be systematically structured so as to produce an explicit picture or diagram of the problem space at varying levels of generality.’
Crafting the meta-map, presenting and negotiating its eventual outcome is a task which requires great expertise and social intelligence. Making the design process explicit allows us to leverage human judgement in our interpretation and use of urban data to identify and distinguish between design options, but also foster greater precision and inclusiveness in producing purposeful design.

4 Evaluation

To evaluate the ‘design-driven data’ process as described above we made a systematic effort to reflect on the process in a series of structured interviews with students and invited experts who have taken part in studios following these practices. These interviews are an attempt to step outside of accustomed roles and reflect upon our practices and assumptions as designers and instructors. In reviewing the conversations, we have extracted three key points are relevant to the initial research goals.

The design-driven data techniques have been developed in academic studios in urban design and architecture. Though I emphasize ideas of dialogue and consensus, my ability to exercise these ideas has been limited to interactions with a small number of critics and stakeholders we have been able to interact with at site visits and reviews. Though we anticipate wider applications of these techniques, we must acknowledge that their evaluation has only taken place within an academic context.

4.1 Data opportunism

“Since we knew it was a parametric studio … we were looking for data to incorporate that were actually measurable […] because we knew it was easier to handle the data.” [Appendix 1] This quote, from an interview with a student at the end of a recent studio, is an example of data-opportunism that we had hoped to avoid through the design-
driven data process. The student, motivated, hard-working and eager to please, has nonetheless fallen into the pitfall of gratuitousness. Instead of initiating her design based on a purposeful intent or advocacy for a specific matter of concern, the student has perceived the studio as an effort to create design from data, and for this reason searched for datasets that are most conducive to generating parametric form. This data-opportunism allows the availability of data to pre-determine the choice of design direction.

The student quoted above worked extensively with urban daylighting and shadow patterns and produced a project that was highly evaluated by visiting critics. If the student had not been so forthright about her motivations and instead claimed a concern for daylighting as a determining factor in urban design, would we have objected? If we follow the arguments present thus far we must take the position that, if the designer cannot from the beginning of the design process articulate a purpose for the design, be it social, spatial, tectonic, then the exercise of design, being unmotivated is gratuitous in the sense of being purpose-less. The observation of the student, that the ‘studio is about data’, is perhaps key in this observation. How the design process is framed to our students and to our clients is key in their perception of the role of the design relative to data: is data driving or is the designer driving? Additionally, as designers we need to cultivate the ability to seek out or produce our own data in response to a purposeful reframing of the design problem.

4.2 Non-quantifiables

In our evaluative discussions with students we asked them to reflect on their projects and consider what, if any, crucial information they needed to formulate their designs that could not be expressed in terms of quantitative data. While all students agreed to the general blanket statement that not all inputs to the design process could be quantified, not all were able to articulate exactly what non-quantifiable inputs were crucial to their designs and why. One non-quantifiable that was mentioned more than once by students was the idea of ‘scale.’ Under this blanket term students described an intuitive sense of the appropriate size and distribution of the urban design proposal relative to its context. While we worked extensively with measurements of density in the design studio, testing multiple Floor Area Ratio (FAR) scenarios, the students referred to the sense of scale as something other than quantitative measures of density: an intuition that they developed upon visiting and walking the site. Whether the sensation of scale is or is not quantifiable, what categories of urban morphology it responds to, whether it is a visual perception or more complexly proprioceptive is unclear from our discussions and beyond the scope of our research. Pertinent to our research question, however, is the extent and manner in which this arguably non-quantifiable perception was integrated into a data-informed parametric design process.

As a case of the integration of a non-quantifiable intuition into parametric urban design, I will describe briefly how one student worked with the problem of scale. This student began his design process with a study of a series of four towers adorning abandoned
19th century warehouses on the site. The proportions and arrangement of these towers on the site defined for him a monument-like sense of scale. To create a project on urban farming, the student began by designing vertical greenhouses in proportions that imitated the pre-existing towers on the site. With these proportions he could calculate how many people an aquaponic system of this scale could feed, how the towers would need to deployed relative to each other to avoid self-shading, and thus determine much of the density and massing of the project via a few parametric steps. In this design process a subjective or intuitive impression of the site became a driver for a parametric and data-informed design. While this process seems to satisfy design-driven data’s first goal of epistemic hybridity and purposeful design, it is unclear if it satisfies the second goal of transparency. A non-quantifiable design driver should not provide carte-blanche, removing the design’s motivation from scrutiny. In this case we are left to debate the nature of monumental scale and how it should be deployed, to whom this sensation might be relevant, and why it is a valid motivator for a district master plan than some other starting point.

4.3 False Equivalence

Using indices to represent multiple layers of data, especially when combined in an aspirational scenario – as is the case with the Projective Index described above- can lead to a misleading combination of non-equivalent inputs. False equivalence collapses and misrepresents a complex condition. This hazard of the use of multiple data layers or bricolaged data, was raised by a visiting critic during a review of one of our studios. While discussing a student project where noise from an anticipated drone port was merged with the existing district noise map, this critic objected to the conflation of drone noise with other traffic noise in the district. The critic argued that new drone noise, because of its novelty and its high pitch, may be more annoying than other more familiar traffic noises. According to her argument merging time-averaged decibels of drone noise with time averaged decibels of vehicle traffic was likely under-representing the disturbance drone port noise would create. This is a valid criticism and can be applied more generally to designers merging layers of urban data.

The problem of false equivalence of quantified conditions should be addressed first through the critical reflection of the designer. The designer must carefully evaluate the meaning of each layer of data – in this case measured traffic noise vs. simulated drone noise- and consider what inaccuracies may result from their combination. Subsequently in the development and communication of the design process the designer must transparently present what data is used and how it is combined, the value of combining these layers of data, but also any potential inaccuracies or loss of meaning that may result from this combination. Developing a design proposal is invariably a heuristic, bricolaged process of ‘making-do,’ but in pursuing the goal of transparency each of these small acts of data-bricolage must not be hidden but carefully re-presented for review. [12]
5 Conclusions

Looking forward, the critiques of gratuitousness and opacity are likely to become increasingly relevant for computational design as machine learning algorithms become wide-spread. While machine learning brings a powerful new intelligence to bear on design problems it remains non-explicit, opaque to penetration by human semantic explanation. [4] Even as its design applications become non-trivial, it will be difficult to integrate into the political or social arena of architectural and urban design, where designs must be open to dialogue and negotiation. Furthermore, the task of reformulating a wicked design problem as a well-defined problem will remain a laborious and necessarily human activity preceding any delegation to the machine. Given these observations, the impetus behind design-driven data and the tactics described in this paper will be increasingly urgent for future designers.

Data-dependent techniques like machine-learning make critical examination of initial datasets only more important, just as its opacity makes the implementation of critical break points necessary. For these reasons I would suggest that in parallel to efforts to advance non-trivial design applications for machine learning, an at least equal effort should be devoted to design thinking research to ensure designers critically analyze the data they use, adequately establish break points in design process, and communicate design in a way that fosters dialogue and consensus instead of naively believing stakeholders will defer to the judgement of a black box oracle.

Finally, it is possible that the explicitness of parametric design software will make it a welcome alternative to the opacity of machine learning in applications like urban design where a higher level of public scrutiny should be expected. Efforts invested in developing parametric tools and methods of design thinking should not be prematurely considered obsolete. As the collection of tactics we have called design-driven data evolve, we anticipate further adapting parametric design to an increasingly data-rich context, which alongside compartmentalized machine learning, will contribute to a holistic design process emphasizing epistemic diversity as well as purposeful and transparent design.
Acknowledgements. I would like to acknowledge the support of the EPFL’s Media x Design Lab, and SUTD ASD in giving me the opportunity to develop the ideas presented in this paper through my teaching. A big thanks to all the students I have worked with in recent years, in particular those whose work is referenced above, without whom this research would not have been possible.

References


Appendix 1: Transcript of student interview, (names withheld) 10.12.2018

Interviewer: Before you began generating forms, or in parallel, did you set goals for what you hoped the project would achieve and did you express these goals with quantitative or spatialized data?

Student 1: I think we began by designing with stuff… since we knew it was a parametric studio … we were looking for data to incorporate that were actually measurable like sun …

Student 2: We were already thinking about this… things like noise, sun, wind, water…

Student 1: We were thinking about doing a project about this because we knew it was easier to handle the data. That you actually… like historical things it is probably a bit more critical to, yeah, incorporate.

Student 2: Yeah, I guess those things we didn’t incorporate in the parametric side of the studio. We didn’t really think that it would be an approach that would be … for our project.