CONFIGURATIONAL MORPHOLOGY

REFLECTION PAPER

TOPIC

Contemporary cities are under increasing pressure to accommodate growing urbanization efficiently and sustainably. The generic and rigid nature of existing predominant urban types limits a city's capacity to respond to such pressures, resulting in environmental, social and economic unsustainability of the urban fabric. One of the reasons for this genericness is the formally biased compositional design approach operating through top-down imposition of predefined forms without regard for local conditions. This lack of adaptability and responsiveness in urban form decreases its performance in all aspects and results in urban fabric unable to live up to its full potential. As an alternative, a configurational design approach operating on a higher level of abstraction - spatial relationships instead of form - is proposed, which could potentially lead to more adaptable, flexible and consequently better performing urban forms. The project tackles the question of viability of such an approach and is structured around three mutually reinforcing types of inquiry; first, a theoretical framework for configurational design in architecture is created by combining and developing ideas and precedents from diverse fields; second, a series of practical experiments attempting to test its practical applicability in architectural design of urban form and lastly a design project elaborating a configurationally generated design in a real-world setting. In tandem, they aim to uncover the potentials and limitations of configurational design for the analysis of existing, as well as the design of new responsive urban form.

APPROACH

Due to the nature of the study proposing an alternative (configurational) design approach - a fundamental aspect of architecture as a discipline and its practice - it was equally important to explore the theoretical possibilities as well as its potentials for practical implementation. To achieve this the research combined two methods, both responding to the current state of research on configurational design as well as the nature of architectural research. The use of a literature review for secondary research was paramount because not only did it provide a base and inform primary research by exploring precedents and past research within architecture, but crucially allowed for the expansion of disciplinary boundaries by looking at other fields for potentially complementary ideas and knowledge. In turn, research by design formed the backbone of the primary research by bridging the issue of a shortage of substantial precedents on configurational design of urban form. This simultaneously enabled further development of the theoretical framework for configurational design on one hand and speculation on its potential practical implementations through design experiments on the other.

To start, the research examines the theoretical and practical potentials of configurational design for architecture such as adaptability to local conditions,

the flexibility of designs and benefits of designing on a higher level of abstraction. Based on precedents, a system for abstracting space into configurations through the use of spatial networks was developed along with a corresponding system of notation; this formed the base for all following experiments. Next, the system was applied to the analysis of existing urban fabric of contemporary cities. Starting with multiple scales, ranging from an apartment to the neighbourhood, the general strengths and weaknesses of the approach were showcased. In the second part, the analysis was expanded at the scale of a building/urban block through a typological approach creating a catalogue of configurational types. Looking towards configuration as a design approach the research examines the theoretical potentials of the spatial network as a mediator between human and computer through a structured digital design interface, as well as its innate adaptive potential and how this enables interaction with the environment and consequently responsive urban form. Next, computational design was explored as a tool enabling the full adaptive potential of configurational design through simulation of high numbers of possible design iterations and their optimization according to defined parameters and the environment. This is supported by an experimental design of a configurational aggregation algorithm and a systematic analysis and comparison of generated urban forms to existing generic urban types. Lastly, in response to the proposition of configurational design combined with computational approaches, the project looks at the transformation of the architect's role from an all-controlling artist to a designer and orchestrator of systems and processes which become a crucial, partly autonomous part of the design process. Finally, the research reflects on the benefits and drawbacks of configurational design for architecture as a discipline, its practice, as well as society at large. Together the chapters form a comprehensive theoretical outline of a configurational design approach along with its benefits as well as drawbacks. Simultaneously, a tangible practical tool is developed; a configurational generative algorithm capable of translating configurational designs into responsive, site-specific urban form.

The design phase of the project builds on both the theoretical framework and the practical configurational aggregation software developed in the research. By taking the created techniques and processes and extending them into the realm of real-world design and (assumed) construction, Configurational design as an approach is further stress tested and its legitimacy strengthened through a proof-of-concept project of a site-specific high-rise residential tower/vertical urban block in Rotterdam based on the configuration of the typical Dutch row house. Additionally, while the research is focused on how to generate urban complexity, the design phase explores how this complexity can be managed in the process of design development through notions of computation and automation as crucial tools for the future architect. Starting from the somewhat abstract configurational design generated by the configurational software it is elaborated further through issues of structure, circulation, building codes, fabrication, plan layout, building systems, materiality and identity, ending with the possible construction of the building. As such, the design phase presents a crucial extension of the research process capable of further validating or disproving the previously developed approaches and assumptions.

SCOPE

While it is imaginable to apply configurational design principles at all scales ranging from a chair to the city, if not even the world, this study focused on a narrow range of scales from the apartment unit to the urban block. The reason for this is that it is within this domain that the morphological disposition of urban form most affects its own, as well as a cities performance in aspects such as density, sunlight, view quality, privacy etc. Programatically, the study focuses on predominant everyday uses such as housing, offices and commercial spaces, which constitute the majority of the built environment and thus have the greatest effect on our well being and experience of our cities. Furthermore, the project intentionally operates at an intermediate scale between architecture and urbanism; more than a building but not quite an urban plan, a no man's land for which everyone and no one is directly responsible, but nonetheless has a strong influence on how our built environment looks, feels and performs. Through the reconnection of architecture, urban design and urban planning, Configurational Morphology aims to propose a holistic design process in which the complex interdependencies between scales are acknowledged and productively channelled as powerful parameters for generating new urban form.

RESULTS

The described project structure with its combination of precedents and research by design has proven to be the right choice for a fundamentally broad topic questioning the architectural design approach. More specifically, the interplay between examining established precedents and speculative design offers freedom crucial for pushing the boundaries of architecural design and its established norms while ensuring that the final body of work adresses most if not all aspects pertaining to the design process. Content-wise, Configurational Morphology examines the potentials of configurational design for designing responsive urban form in the scope of two activities crucial to the architectural design approach; analysis and projective design.

Analytically, configurational design has proven to be a valuable tool for investigating and recording the socio-spatial patterns underlying the urban fabric of our cities by reducing three-dimensional space into abstract configurational Spatial Networks. These patterns in space are important not only because they govern how our cities are constructed, but also because they are a direct reflection of our society and way of life. Additionally, a configurational analysis of space enables the extraction of such patterns while separating them from physical form and making them ready for use as design inputs for the configurational generation of new urban form. The renewed focus on the configuration of space essentially enables a refocus on the social aspects of space allowing architects to consciously design in accordance with our ever-evolving society and behavioural patterns. Contrary to existing form based on aesthetics or formal precedents, this could lead to socially responsive architecture and urban form directly based on the way we live together and interact, consequently increasing our quality of life.

Projectively, configurational design has proven a capable design approach for generating designs organically growing out of local conditions and architect-defined constraints. In the case of urban form, configurations, especially when combined

with computation, can enable the production of more responsive site-specific urban form better adapted to the site and environment in which it is placed. A top-down approach imposing rigid slabs and towers is replaced with a process of configurational aggregation where urban form emerges as the direct result of both top-down forces of configuration and spatial requirements, as well as complex bottom-up urban forces of local environmental conditions. Using Spatial Networks extracted from established urban types through configurational analysis such adaptivity can be channelled to extrapolate these types into new urban fabric better adapted to the forces of contemporary urban areas. The use of configurations as a generative design medium also entails a shift to a more scientific, fact-based design approach utilising urban datasets and digital analysis of urban conditions to guide the generation of design schemes. This systematism often leads to increased building performance in various categories such as density, sustainability or spatial quality as evident in the conducted morphological experiments.

Practically, the configurational approach has shown to be capable of creating adaptive site-specific structures of great spatial complexity. Apart from improved performance this can lead to greater diversity and spatial quality of the urban fabric with some examples approaching the spatial characteristics of vernacular organically created towns with a pronounced human quality and scale. In spite of its many advantages such an approach also brings issues and difficulties mainly relating to the potential detail development and construction of such highly customized structures. This raises the crucial question of how can an architect limited by time and resources afford to develop a megastructure containing hundreds of apartments each with a different plan layout, facade disposition and spatial characteristics? To make such projects viable, automation through computation presents architects with a possibility to design custom tools capable of not only dealing with the detail development of highly complex compositions through procedural design whilst simultaneously improving our efficiency, competitiveness and influence within the AEC industry. By enabling design with complexity, automation consequently makes configurational design possible, effectively opening the door towards configurationally generated site-specific urban form better adapted to the pressures of contemporary cities.

LIMITATIONS

While configurational design as a theoretical framework has proven to hold much promise for creating adaptive and sustainable architecture, its practical application explored throughout this project has been subject to numerous limitations imposed both by the restricted scope and time, as well as characteristics of the configurational approach itself. These limitations open new questions that could guide further research into the viability of configurational design as a practical design approach for not only urban form but architecture in general.

The most glaring limitation of the current research has been its focus on generic urban tissue such as residential urban fabric. While these indeed represent the vast majority of built space, the scope of architecture is far larger and includes complex public buildings such as schools, hospitals, museums, stadiums and shopping malls to name only a few. Theoretically and analytically the approach as presented can

deal with all the above-mentioned building types, it is in the computational generative phase where this is harder to apply, mostly as a result of the increased complexity of topological connections within the configurational graph / Spatial network.

Next, the practical application of configurational thinking was currently restricted to a narrow range of scales of a building and an urban block, mostly as a consequence of the desired focus on urban form. As a result, the potential of configurational design as an analytical and projective approach needs to be further explored on smaller scales such as the unit or room, as well as larger scales ranging from the street to neighbourhood to the city. It is at these larger scales where the approach becomes similar to one of its precedents, the urban analysis tool Space Syntax, along with all of its benefits and issues. Similarly to other scales, the biggest challenge here remains how to translate the analytically capable configurations into an efficient and effective generative design driver for a new architecture.

To improve the practicality of configurations as a design medium the digital design interface would need to be further developed past the conceptual sketch presented as part of this project. This would make configurational design accessible to users irrespective of their programming skills whilst making it more time-efficient and intuitive. Concerning user experience, the currently implemented generative algorithms, whilst producing interesting designs, can often behave very unpredictably as a result of their complexity and difficulty in setting optimal parameters. Sometimes this can lead to frustrating and time-consuming behaviour where the algorithms produce large numbers of inefficient results purely as a result of poorly defined settings which the algorithm is unable to optimize. Consequently, an important step in development would be the implementation of machine learning or evolutionary optimization within the generative algorithm, allowing it to self-regulate thereby leaving the designer with more time to focus on the effects different configurations and their requirements have on the quality of generated schemes.

Lastly, there remains the dilemma of selecting parameters guiding both the generation of new designs, as well as their evaluation. Due to the systematic and logical nature of the configurational design process presented here, the developed generative algorithms operate exclusively through quantitative metrics such as sunlight hours, view degrees or privacy distance. Although such parameters are very successful at describing the economical, and environmental performance of a building, one could argue that spatial quality can never be fully described merely through simple metrics like sunlight access but is also affected by subjective perception. Further research is required (and ongoing) in this field to explore if qualities such as ambience are truly subjective, in addition to if and how they could be quantified. These new metrics must then complement existing ways of quantifying spatial features such as visibility or convexity used in Space Syntax and traditional parameters already used in the configurational approach to empower the method to generate designs of superior performance on all fronts. These questions, along with many more left unmentioned, represent the next step in the research and development of configurational design as a practical design approach.

Nevertheless, in spite of the aforementioned drawbacks of the approach and the

limitations of this research it is evident configurational design is deeply relevant as a theoretical design framework, a legitimate design approach for architectural practice, as well as a method for creating socially responsive and sustainable urban fabric.

RELEVANCE

As a research project, Configurational Morphology attempts to question established modes of operation in architecture by introspectively looking into the fundamental core of design activity, our design process. After critically examining the existing object-based design approach the project points towards process-based configurational design as a viable alternative often capable of superior adaptation and performance, elaborating it not only through practical examples but a broader theoretical framework based on which other approaches and applications could be developed. Fundamentally, it is a case for a more scientific, objective and rigorous approach to architectural design, one capable of taking advantage of technological advancements. In the process, the project tries to crack open the shell in which architecture as a discipline sometimes encloses itself by attempting to find fertile connections to otherwise unrelated fields and disciplines such as computer science, biology, physics or mathematics. In many cases this cross-fertilization leads to new knowledge and techniques applicable within architectural design, showing both the importance of expanding the boundaries of architectural research as well as the value of speculative design as a legitimate architectural research activity through which the former can be achieved.

From the perspective of architectural practice, the project tries to show ways configurational design could empower architects to create buildings better adapted to their local conditions resulting in improved economical, social and environmental sustainability. Complemented by a proposed paradigm shift to quantitative performance-based design, adaptive designs interacting with the environment and its complex influences can be evaluated according to metrics of sustainability, economy and spatial quality allowing for improved performance projections within the development phase before the building is constructed. Applied in practice, such an approach could finally enable us to overcome the serial mass production of urban space leftover from modernism and replace it with diverse site-specific urban forms and buildings growing out of local conditions whilst utilising the full potential of available spaces. Today, such invention is more crucial than ever as the worsening climate crisis places increasing pressure on cities to be more sustainable than ever, while architecture has yet to respond effectively with sustainability usually superficially applied in the form of solar panels or greenwashing instead of being the main design driver of urban form. Furthermore, potentials of computation are explored as a tool facilitating the automation of the architectural design process. On one hand, this could increase our efficiency and productivity as well as increase our capacity to deal with complex conditions and design appropriate solutions. On the other hand, the digital algorithms enabling automation present potential intellectual property which architects could leverage to their own benefit and increased influence in the construction industry.

Although in itself Configurational Morphology is a profoundly architectural research

and design project, it also carries many broader implications for our society and the cities we live in. By virtue of its focus on configurations and consequently the socio-spatial patterns underlying our cities, configurational design can empower architects to create buildings in tune with the perpetually evolving patterns of living and interaction in contemporary society. Most importantly, this improved city-making process based on previously explained adaptivity could lead to urban spaces more capable of serving our needs through higher density, improved sustainability, more porosity and social interaction, increased identity, more diversity and higher spatial quality, producing cities of increased livability crucial for our future well-being. Nevertheless, despite all the overwhelmingly positive mentioned changes that such a design approach could bring, the introduction of automation and smart algorithms into the city-building process must be done with caution as their disruptive power could likewise be used to perpetuate the existing generic city along with all of its drawbacks. The importance of ethical use of such technologies can not be overstated if they are to be used for the benefit of the many as opposed to personal (financial) gain of the few.

CONCLUSION

To conclude, through its theoretical and experimental explorations Configurational Morphology affirms that with further development and refinement configurational design has potential to become both a comprehensive theoretical framework and a practical design methodology for designing adaptive urban forms responsive to the social, economical and environmental pressures of the contemporary city. Moreover, by virtue of its compatibility with digital and computational techniques it encourages the long-overdue inclusion of automation in the design process thus increasing productivity and efficiency on one hand, whilst offering architects the opportunity to create our own tailor-made algorithmic design tools and processes which can be intelectually protected thereby strengthening our role and relevance in the design and construction process. Lastly, the expansion and application of configurational design to other spatial scales could pave the way for a holistic performance-based design approach empowering us to create a more livable, equitable, affordable and sustainable built environment fit for the future of our society.