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Space Syntax as a platform for teaching analytical, research-based design: a pedagogical experience

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Abstract

The concept of analytical, evidence-based design is a somewhat obscure area in practicing and teaching urban or architectural design. Sometimes contested by certain designers, which pride themselves in highly intuitive approaches, as deterministic and sometimes labelled by other disciplines, which tend to have a more scientific approach, as pseudo-science, this field has not become a mainstream approach to design. However, if design is accepted as a process, in which intuition and rational thinking have to work hand in hand with different degrees of emphasis in different stages to generate a successful output, then the concept of analytical and researched-based design becomes a much less contestable proposition, since it can enhance the ability of the designer to use the evidence-based research to produce better work by evaluating the design outputs on the one hand, or assist others, including the decision makers and stakeholders, who need to have a more objective understanding of the impacts of architectural or urban design, on the other hand. Such a process has been addressed before in urban design and architectural research, using real-life examples from professional and research projects (Hillier and Stonor, 2010; Karimi, 2012a; Penn, 2008; Sailer et al., 2008). This paper focuses entirely on a different facet of this issue: how the process of analytical, evidence-based design can be taught. Based on the experience of teaching analytical design on the platform of space syntax in the past six years, this paper proposes a teaching methodology that can achieve this objective. The paper starts from theoretical and pedagogical complexities of the issue and moves on to explain the details of such undertaking. The results of student work on a multi-scale architectural and urban design project in the past six years are used not only to establish this process, but also to demonstrate some outcomes of it.

Keywords

Research-based, evidence-based, analytical design, space syntax, intuitive design

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01 Is analytical, research-based design possible?

This entire argument starts with a basic question: is analytical, evidence-informed urban design possible? This question has been dealt with in length in another publication (Karimi, 2012b), but a summary of the arguments is worth mentioning here. The very root of this problem is the inherent ambiguity of urban design as a discipline that shares certain characteristics with intuition-led design practices and with the other disciplines that consider design as a scientific process of problem solving (Johnson, 2009). Clearly, urban design is neither of those since it includes an iterative, interconnected series of explorations which sometimes is led by logical thinking and sometimes by intuitive creations. The key to reconcile these opposing methods is to understand that any form of design, in particular urban design, is a procedural entity, a process, not an instantaneous act of creating outputs.

There is an overwhelming body of theoretical and empirical evidence to support that any form of design is fundamentally the product of a process. In fact, any attempt for defining urban design has the concept of process in its core (Cama, 2009; Lang, 2005; Luckman and Cross, 1984; Moughtin et al., 1999; RIBA, 1980; Roberts and Greed, 2001; Rowe, 1987). Without getting into a complex debate about why design is a process, it can be simply argued that any design includes some sort of a brief, a knowledge-gathering exercise, idea generation, option generations, option selection, and design development. This is a sequential progression, which is the main characteristics of a process, but it is not a linear development, since an iterative flow of implementations can go back to earlier stages of the process and repeat certain elements of it, as much and as many times as needed (Karimi, 2012b). In reality, the iterations are limited by time and resources and in some cases, so in many cases iterations are reduced, or even skipped, but in any form of design iteration is theoretically imbedded.

The analytical design process, is a sub-set of design approaches, in which the first stage of the process begins with an analytical investigation of information, knowledge and data. By doing so, a more solid base for the idea generation is created, which can help reduce the risk of generating and developing design solutions that might be rejected at the later stage of the process. Furthermore, the analytical methods would be applied to evaluate objectively the design ideas, or design options (Figure 1), generated through a conjecture-test loop (Darke, 1984; Hillier et al., 1984).

The difficulty, however, is that it is quite difficult to find a methodology for this approach, since it has to be specifically spatial, inherently social and intrinsically analytical, to link meaningfully the spatial and functional aspects of design through an analytical approach that is imbedded in the design process, not an add-on layer. In the pursuit of an analytical methodology which could be applied to urban design process, it is argued that *space syntax*, a set of theories linking space and society and a set of techniques for analysing spatial configuration ((Hillier et al., 1983; Hillier and Hanson, 1998), can provide such an approach, since it provides a seamless relationship between a spatial, methods and tools, which are fundamentally spatial, social and analytical (Karimi, 2012b).

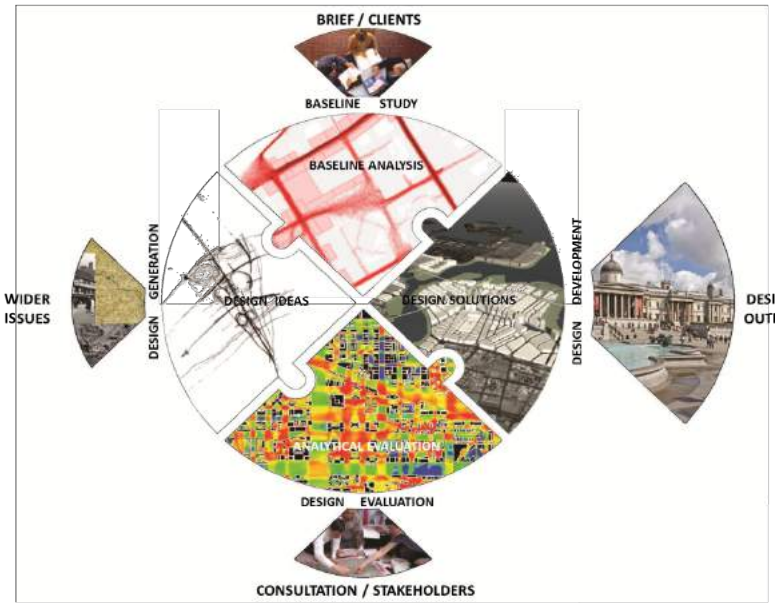

Figure 1: Analytical urban design process: an analytical phase, or a baseline analysis, takes place before the design generation phase. The analytical tools are applied again after the formation of design ideas, or design options, to evaluate them and feed back into the process (Karimi, 2012b).

02 Is the analytical, evidence-based design teachable?

This begins with a much wider question of if the design in general teachable? Without trying to get into a complex theoretical and pedagogical maze of discussions, we would just use the existence of so many design schools across the world, as the evidence that this statement is true. So, if design, or more particularly urban design, could be taught as a discipline, there is no reason to believe that analytical design could not be taught. On the contrary, since certain elements of the design process is led by logical thinking and analysis, it must be easier to be taught as a design approach. The question is, if this is such a common-sensical assumption, why this approach is not taught widely in design schools?

The answer to this conundrum should be sought in the prominence of the 'idea generation' phase in the design process. The fact is that idea generation is perhaps the most complex, mysterious and perhaps unteachable part of the design process. Design is considered as a wicked or ill-defined problem, which requires creative solutions (e.g. Casakin, 2007; Rittel & Webber, 1984). This is why most of the design teaching is focused on forcing the students to generate new, novel ideas. Depending on the style of the architectural or urban design schools, the extent of this tendency goes from highly romantic Beaux Art style creativity, to more complexity-challenged contemporary styles of creativity, such as generative algorithms, intensified by the availability of computing power.

This huge weight of generating creative ideas and presenting them in the most attractive way in the design teaching curricula, is so significant in design teaching that other stages of the design, such as knowledge accumulation, design evaluation and design impact assessments are by and large ignored in prevalent design teachings. This emphasis is, to a certain extent, quite acceptable in the early stages of the design education, since the students need to somehow manage to overcome the enigmatic complexity of generating ideas. The trouble, however, is that analytical thinking, the other ingredient of a successful design, is not seamlessly built into the process even at the higher stages of architectural and urban design education, such as master's courses.

This problem has been acknowledged in many universities by trying to integrate architectural and urban design teaching in a faculty of built environment, in which other expertise, such as technology, environmental science, social and anthropological diciplines, and various other fields are taught in parallel with teaching design, aiming to create synergies between disciplines by putting them next to each other. This approach has a limited impact, since the schools move from a university-wide to a departmental micro silo-isation, and more importantly, the analytical thinking hardly gets built into the process by only neighbouring various disciplines.

So, what could be done to address this poblem? It is argued here that a different approach to design is needed, in which analytical, research-based thinking is taught as part of the process, not as an add-on ingredient. As introduced in another publication, such a process begins with an analytical phase, in which the designer scrutinises the brief, data and facts analytically before generating design ideas or design options (Figure 1). In this approach two specific phases are added to the process and are treated as equally important as the design idea/option generation phase. The first phase is an analytical 'baseline' study, undertaken as the first step, in which models, analyses and data interrogations are used in parallel with normal qualitative knowledge to form a solid base for the next step: the idea generation.

It is still debatable, if an analytical exploration can create design ideas, or can contribute to their formation. We will come back to this discussion later, but even if this is not certain, still any design idea, generated by any other means of creation can be informed by the baseline to shape the preliminary design options, which sometimes are ignored or neglected in urban design projects (Bayne, 1995). More importantly, the models and analytical baselines can be used to assess, evaluate and select the design ideas and design options.

Despite more recent attempts to develop analytical design methods in urban design (Arisona et al., 2012; Duarte et al., 2012; Stouffs et al., 2012), this field has remained rather undeveloped since the early attempts in 1960s and 70s. It seems that this approach works only if a powerful spatial theory, a set of effective methodologies and a series of analytical tools are provided within the design approach (Figure 2).

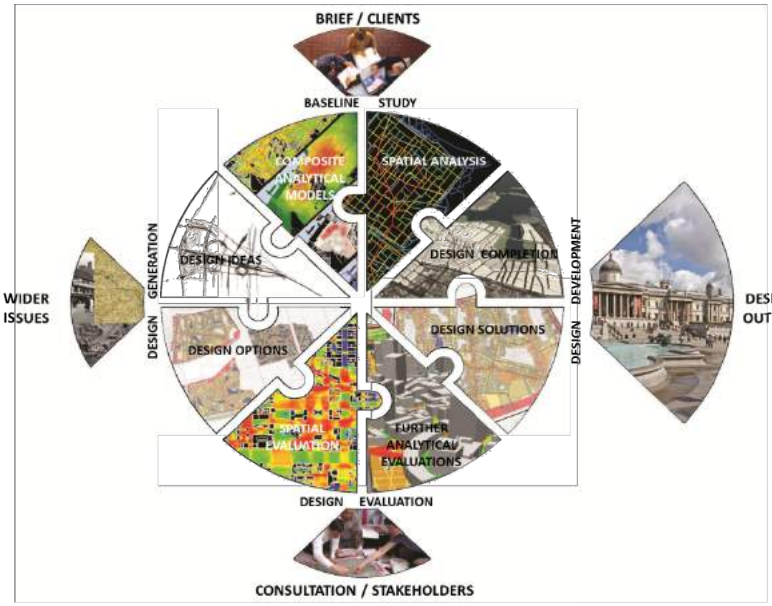

Figure 2: The configurational approach to analytical urban design: space syntax methodology. In this approach the foundation of the analytical baseline study and analytical design evaluation is spatial configuration analysis. Further composite models of evaluation could be built on the spatial layer to enhance the responsiveness of the methodology (Karimi, 2012b).

03 A programme of teaching analytical, research-based design

In this part of the paper, a programme of teaching is explained and it is argued that it can achieve the objectives of teaching analytical, research-based urban design. This programme has been implemented through two modules of teaching: Space Syntax Methodology and Analytical Design (SSMAD, 15/180 credits) and Analytical Design Research Project (ADRP, 30/180 credits), as part of a master's programme, Space Syntax: Architecture and Cities, at the Bartlett School of Architecture, UCL.

The effectiveness of teaching these modules is strongly related to the adoption of space syntax, an overarching spatial theory of society, as the foundation of the analytical thinking. This has to be the most important element of this approach since it provides two advantages. Firstly, it links the urban design, achieved by shaping or manipulating spatial configurations, directly to how the spaces function are used by people. This means that analysis, does not stagnate as an abstract entity and could provide wider social and behavioural meanings. Secondly, the analysis of spatial configuration becomes a powerful, effective first step to generate the first layer of evidence, upon which the other layers could be constructed. The important thing about the latter is that various layers of data and information, even the most qualitative ones, could be spatially mapped and linked with other layers of analysis to provide a multi-layered data and analysis base to deal with the complexities, or wickedness of design.

While the SSMAD and ADRP modules provide a theoretical base for teaching through a series of theoretical lectures, they also have to rely on other modules within the programme to expands and strengthen its theoretical stance.[2] Moreover, further hands-on teaching is needed to inform the students about the application of analytical design, in general, and the approach taken in this module, in particular. This is achieved through three parallel set of activities: a series of lectures on theories, methods and applications; a series of workshops on methods, techniques and software; and a 'Project', in which the students apply their learnings to a challenging urban project.

The lectures in these two modules cover a whole series of theoretical, methodological and technical grounds, to introduce the students to the application of methods in real-life research and consultancy projects. The workshops cover not only the fundamental space syntax techniques and software, such as convex space analysis, axial or segment-angular spatial network analysis, Visual Graph Analysis (VGA) and agent-based modelling, but also other complementary technologies such as Geographical Information System (GIS), statistical analysis, behavioural observation techniques and spatio-cognitive analysis. The workshops provide an intensive learning mechanism to push the students towards using tools in analytical thinking process.

[2] These modules include: Design as a Knowledge-based Process (15/180 credits), Buildings, Organisations and Networks (15/180 credits), Architectural Phenomena ((15/180 credits), Spatial cultures (15/180 credits) and Spatial Justice (15/180 credits).

04 The Project: an analytical exploration of the built environment: From 'micro' to 'macro' scale

The 'Project' is the most effective way of introducing students to the analytical design process, by doing it. This project is planned to create a pragmatic and practical route to applying the theoretical and technical knowledge that students acquire in this module and other modules of the course in the first term.

The main objective of this project is to apply the analytical techniques of spatial modelling and observing human behaviour to construct an evidence-based understanding of the built environment. The study is either done in groups of 4-5 students, or and as an individual project. In these projects, students learn how to enhance their understanding of the built environment by studying it systematically and analytically. This study will contribute to an assessment of the architectural and urban spaces and identification of their strengths and potentials. The students are also expected to develop strategic design solutions that enhance the performance of the built environment.

A major aim of the project is to explore the built environment from a 'micro' to a 'macro' scale. The conventional partitioning between building, public spaces, urban areas and cities still exists in the realm of built environment and as a result, designers (as well as planners and decision makers) tend to look at a narrower strip of this spectrum. This project attempts to challenge these partitions and bridge across the scales to develop a multi-scale and contextual approach.

The case studies are mainly selected in most challenging parts of London to give the students the opportunity to visit and collects first had data, but this could be achieved in any other cities as well. Normally, the studnets work on clusters of case studies, or urban areas, to make sure the useful knowledge flows between the projects. The group projects that students have worked on in the past six years include: The City Fringe Opportunity Area (2018, 5 projects), The City of London Area Enhancement Strategies I (2017, 5 projects), The City of London Area Enhancement Strategies II (2016, 5 projects), Queen Elizabeth Olympic Park, the Legacy (2015, 6 projects), The Barbican (2014, 6 projects), South Kensington Knowledge Quarter (2013, 3 projects), King's Cross and British Library Development Areas (2012, 3 projects). The important thing about choosing the case studies in one city and as clusters is that the students learn from each other and from previous years' experience. Moreover, the body of data generated by the students provides a bigger source of knowledge in long term.

While the project brief gives the students a set of general design and research questions, it only provides a general framework for the study. Each project is required to reflect on its framework and define its own design and research questions for the various scales of the study. The objectives of the project for each group should be tightly linked with their review of planning documents and policies, adopted and proposed urban planning and design projects within their areas, as well as the demands of the local residents and community groups.

The students are encouraged to use a series of spatial analysis and observations methods, based on (but not entirely limited to) space syntax approach. What the students are expected to do in this project is to bring together their theoretical, practical and technical trainings into a practical framework and produce strong, useful and coherent results. The methods of spatial analysis which are used in the project include (but are not limited to) convex space analysis, spatial graph analysis, axial analysis, segment-angular analysis, isovists (fields of vision) analysis, VGA (visual graph analysis). The students are also requested to collect and map data on historical, social, behavioural, functional and environmental issues related to their areas. The data can be obtained from available resources, but the students should also collect their

own first-hand data, such as (but not limited to): land use and frontages, pedestrian movement flows, pedestrian traces (movement tracks), stationary activities, ethnographic and qualitative information. through observational methods.

The students are then asked to explore the data, analysis and evidence that they have accumulated to respond to their research and design questions. They are required to identify objectively the strengths and weaknesses of their designated projects and develop design ideas to respond to the problems and potentials of the buildings and public spaces. Due to the limitations of the teaching modules, students are not required to develop full-scale, detailed design projects, but they are expected to produce a sufficient level of design work to respond to their research questions. A very important part of this project is the 'design assessment' phase, in which the students have to demonstrate objectively how their design would perform and what impacts it would create.

05 The Project: an example

To provide a clearer picture of what can be achieved in this programme of teaching, we try to focus only on a project undertaken in 2018, but this is intended to serve as a representative example of the teaching output (Figure 3). In this year all projects were done on the *City Fringe Opportunity Area*, identified by the London Plan[3].

Opportunity Areas are London's major source of brownfield land which have significant capacity for development – such as housing or commercial use - and existing or potentially improved public transport access. The City Fringe Opportunity Area (OA) is now defined in the London Plan as being approximately 900 hectares of land covering parts of the London boroughs of Islington, Tower Hamlets and Hackney. Five groups of students have worked on 5 areas of this Opportunity Area, identified by the City Fringe Draft Opportunity Area Planning Framework[4].

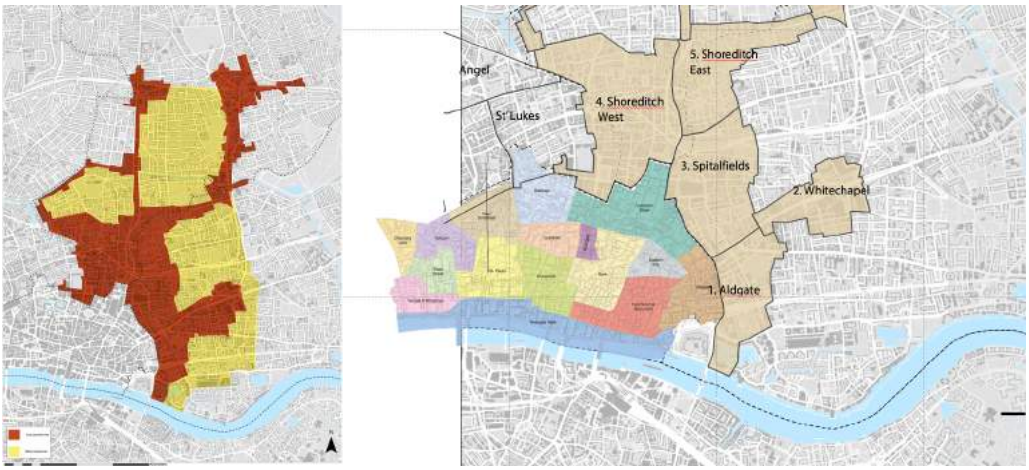

Figure 3: The project example: The City Fringe Opportunity Area (OA). Five areas have been studied by the students.

[3] https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/opportunity-areas/opportunity-areas/city-fringe

[4] https://www.london.gov.uk/file/20818/download?token=oAX_rDxw

To make this a meaningful discussion, in the rest of the paper we focus only on one project, the Whitechapel Area, one of the five areas that were studied by the students.[5] We use this project as an example to explain the process and its outcome.

06 Accomplishing an analytical, research-based design

The process of defining the urban design and planning questions, is an important element of the project, which takes place after a reflection on the project brief, a study of planning documents, and a literature review on various issues related to this area, including socio-historical, environmental, political and transport issues. By identifying design/research questions the students take the first step in linking research with design. The students are required to define at least three questions on the macro, meso and micro level. The intention here is to introduce them to the issue of scale and how the analytical methods should be adapted to deal with the problems of various scales (Figure 4).

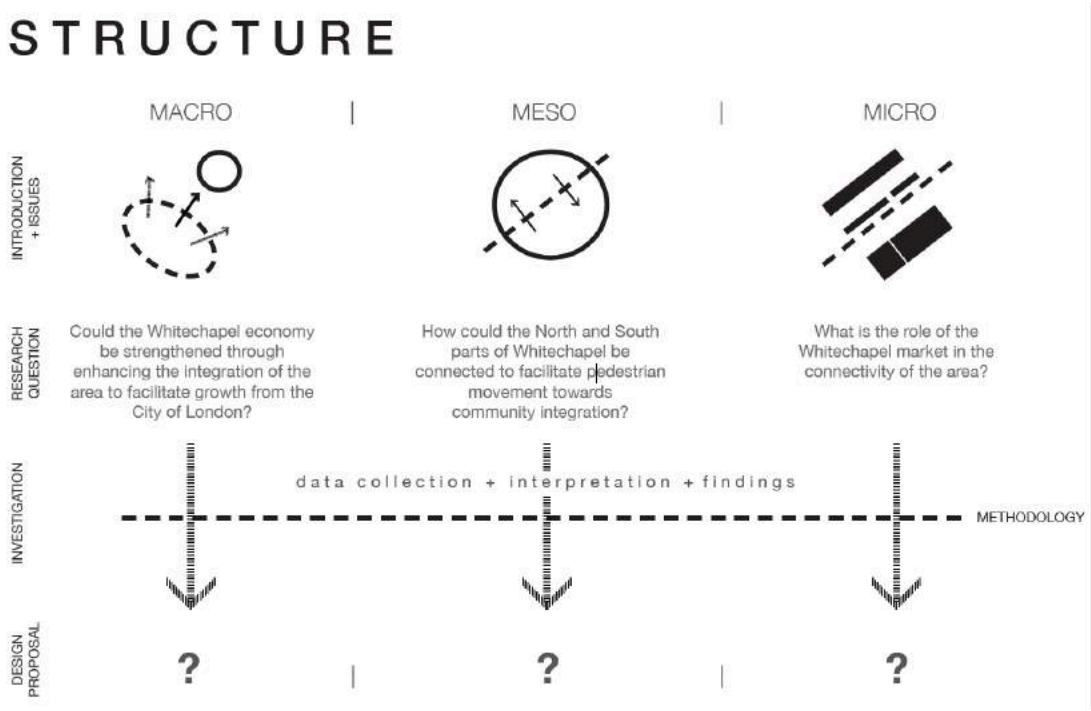

Figure 4: The summary of questions defined by the Whitechapel project.

These questions are intended to connect directly to the important urban design challenges that are currently defined by the planning authorities, or by the communities within this area. More specifically in the Whitechapel project, the main focus was the 'deprived economy' on the macro level, the 'disconnected community' on the meso level, and the 'segregated market' on the micro level. To research these questions, the group adopted a methodological framework, which included a combination of data collection, data mapping, on site observations, spatial analysis and various other methods, but the primary layers of analysis were either spatial or socio-spatial analyses (Figure 5).

[5] The students that undetook this project were: Hangming Ye, Alexandra Wilmot, Leandro Poco, Junya Yang and Quan Zuo, at the Space Syntax Laboratory, the Bartlett School of Architecture, UCL. What this paper presents is only a selection of their extensive work in Autumn 2018.

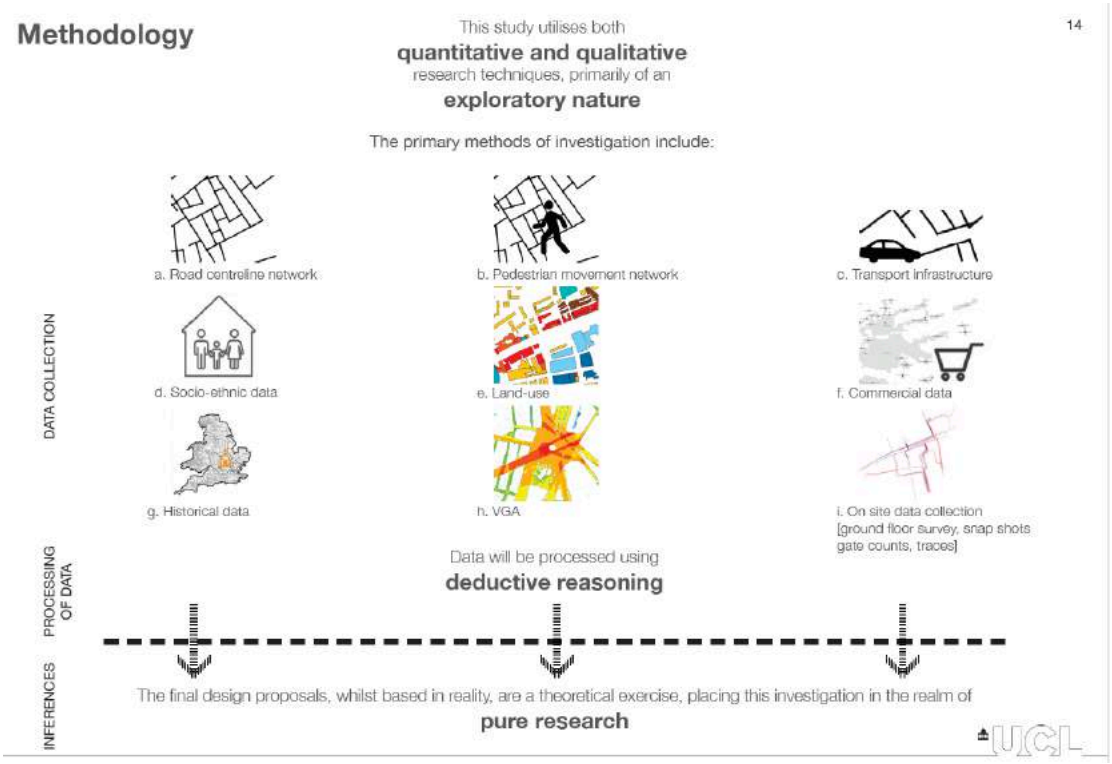

Figure 4: The methodological framework adopted in the Whitechapel project.

06.1 Data compilation and data mapping

The students mapped, represented and interrogated all layers of data in a GIS system (QGIS software in this case). Early site visits and on-site interviews with the residents is normally an important part of this stage of the work, which is normally followed by a historical analysis of the site and thorough review of the planning policies and major development proposals for the area (Figure 5).

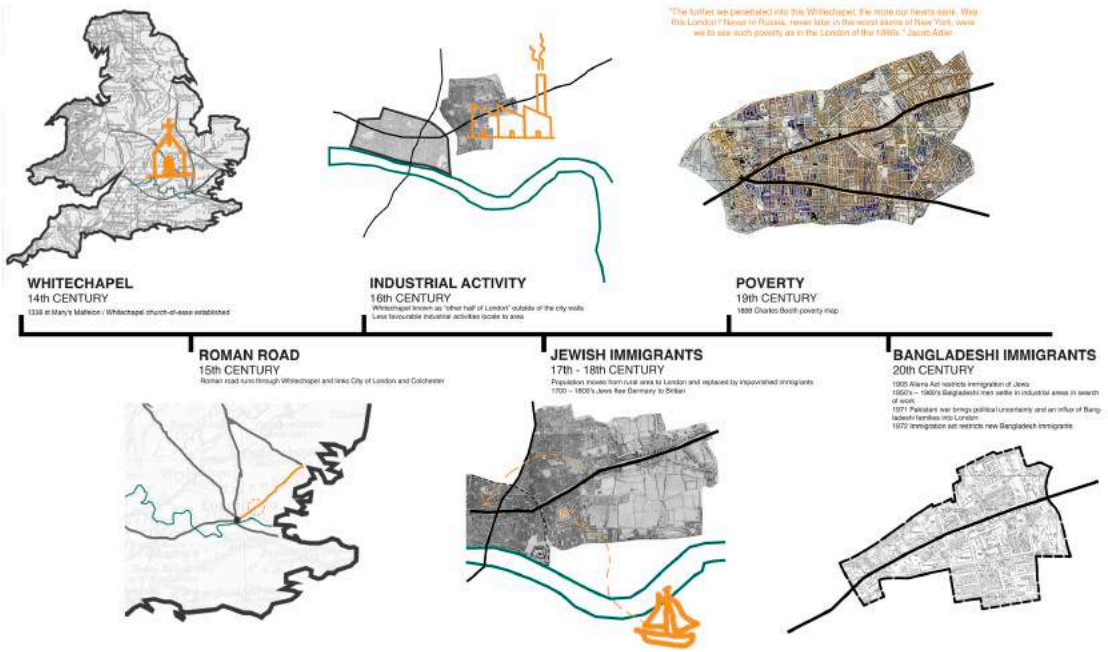

Figure 5: Photographical surveys (top) and historical transformation of the area in the Whitechapel project (bottom).

The students tried to find as much relevant data as possible and mapped them on their GIS platform. The data, such as road network, pedestrian movement, residential densities, employment, ethnicity, land use, income, indices of multiple depravations, environmental conditions, lighting, traffic, public transport, and so on could be collected by the students themselves, or be extracted from various sources (Figure 6).

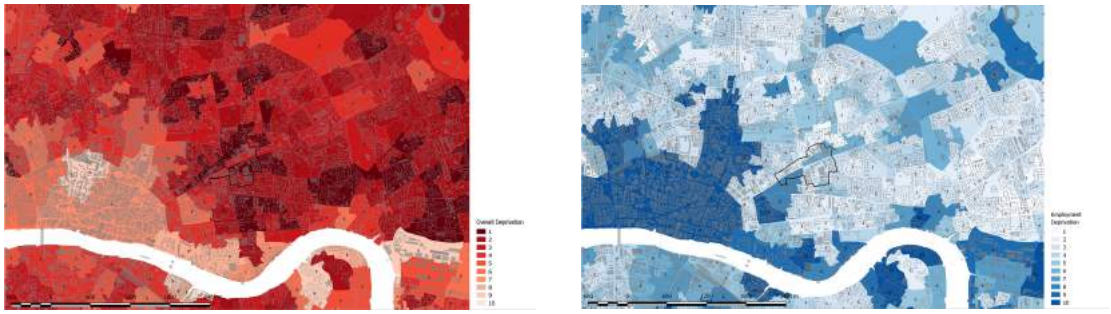

Figure 6: Indices of Multiple Deprivation (IMD), left, and employment density, right, in the Whitechapel project.

Depending on their research questions, the students also collect qualitative data, such as resident's satisfaction, perception of crime and aesthetic evaluations, but they attempt to map their qualitative data spatially to be able to compare against the other layers of data.

06.2 Modelling and analysis

After compiling a full set of data, the students begin the analytical phase (Figure 7). This phase, which normally begins with spatial analysis, includes the use of modelling techniques, such as axial and segment-angular analysis, high-resolution spatial network modelling, visibility and Visual Graph Analysis (VGA).

Furthermore, the students analyse their movement data (pedestrian or vehicular) to create an in-depth understanding of human activities and interactions in their areas. They also try to use statistical analysis to understand the movement data better and explore the relationship between human activity and spatial configuration. This part of the work, which tries to link the most fundamental characteristics of the urban space with the most basic pattern of human behaviour, is perhaps the most distinct element of the approach that distinguishes it from other analytical approaches.

Figure 7: Segment angular analysis (top left), high resolution segment angular analysis (top right), pedestrian movement flow analysis (middle left), pedestrian trace analysis (middle right), land use analysis (bottom left), access to public amenities analysis (bottom right).

Further analytical explorations are undertaken by the students to deepen their understanding of their project, from the use of statistics, to the application of more complex methods of anaysing various layers of data, such as multiple-regression analysis,

06.3 Interpretation of the analysis and diagrammatic summaries

Through various layers of analysis, the students try to find some clear answers to their questions and spatialise these answers to create a base for their design explorations. This is perhaps one of the most difficult stages of this process since there is always a possibility of disconnect between the findings of the study and the direct design attributes that correspond with the findings. In many cases, the students find the use of simple summary diagrams, overlaid on the analytical maps very helpful (see Figure 8 as an example).

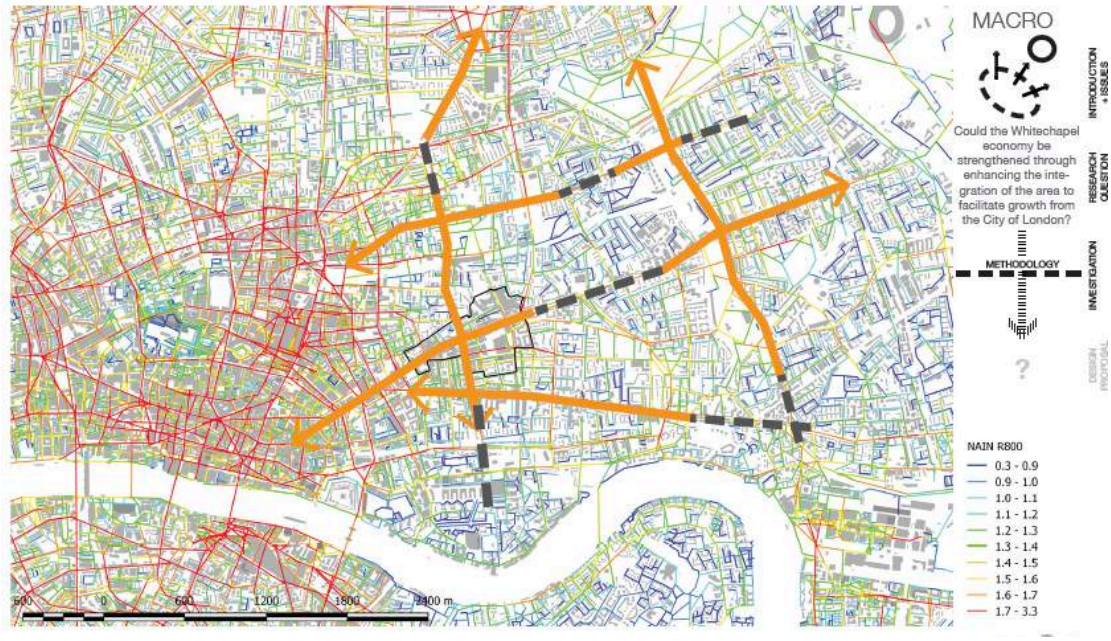

Figure 8: Summary diagram showing the discontinuity of the urban centrality in the Whitechapel area.

06.4 Urban Design idea/option generation

As soon as they can interpret their analyses and link them back spatially to their research questions on all scales of their work, the students begin to address the urban design questions in two ways. They either develop design ideas directly from their analysis, or get the design ideas from other sources. In the former approach, the design idea is a natural product of the analysis, so the transition from analysis to design is seamless (Figure 8). In the latter case, however, the design idea is set against the evidence base created in the first stage of the work. The ideas that are inconsistent with the evidence are refuted and the ideas that correspond with the evidence are keep and developed further.

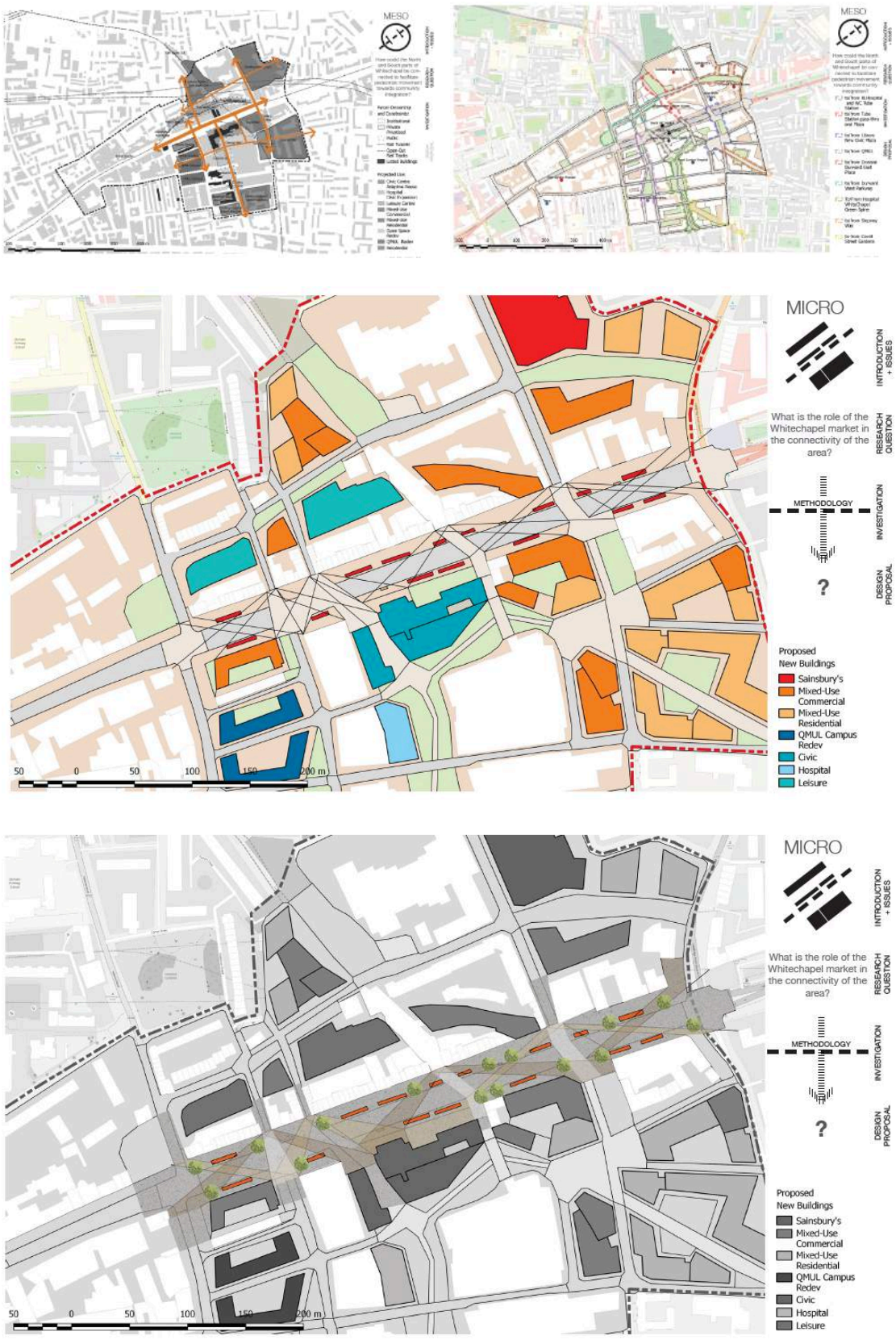

Figure 8: Design ideas and design option generation in the Whitechapel project. A strategic diagram of spatial links (top left) is turned into the design of spatial linkages (top right). Then other layers of analysis, such as visibility analysis, create the main geometry of the spaces and buildings (middle) and furthermore lead to a more detailed design of the market layout, pavement and landscape design (bottom).

06.5 Design evaluation and design iterations

The next phase of this process is to evaluate the proposals against the analytical evidence-base. At this stage the students apply their analytical models to see how their design proposals compares with the current conditions. The comparison between the 'before' and 'after' scenarios becomes easier since there are established models that could be interpreted objectively (Figure 9). Design iterations take place after the analysis of each option to improve the issues that are detected by the analysis and are not addressed by the design. This process continues until the analysis shows that the design is achieving its objectives.

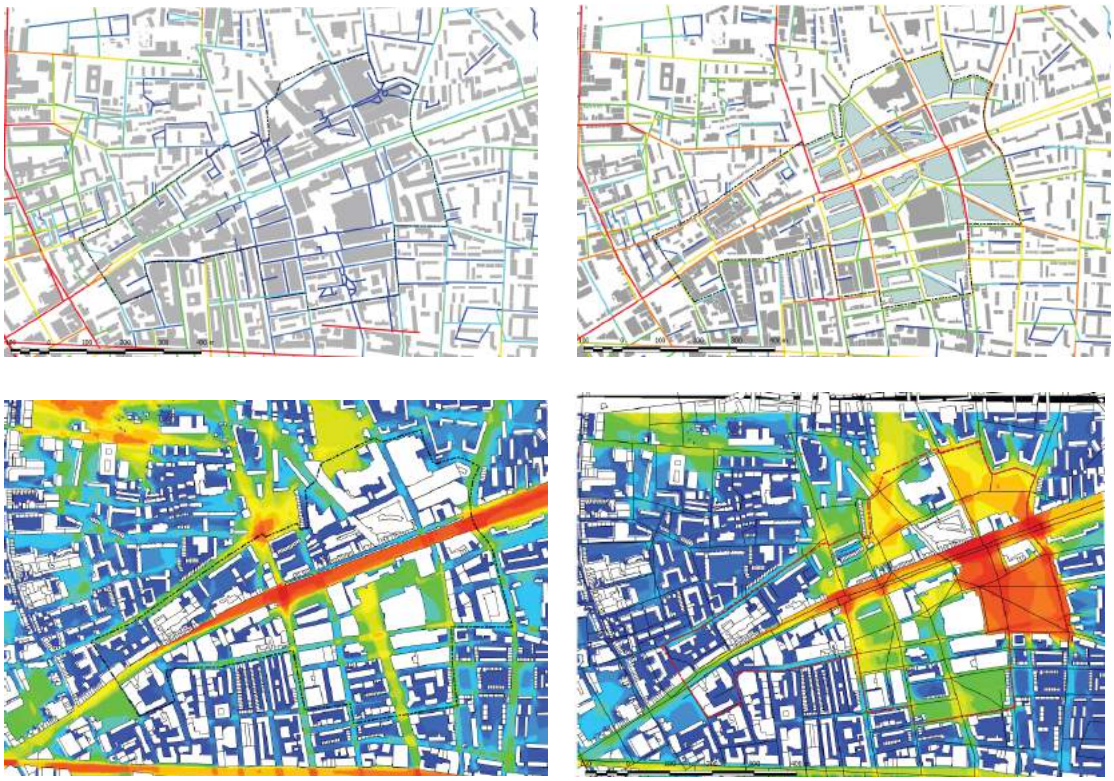

Figure 9: Design evaluation using spatial network analysis (top left and right) and visual graph analysis (bottom left and right). The visual and quantitative comparisons between the 'before' (top and bottom left) and 'after' scenarios help evaluate the design options. Furthermore, the evaluation is used to improve the design.

06.6 Design developments and presentations

The last phase of this process is to develop the design further and get to the more detailed aspects of the design. In the Whitechapel project, the students not only designed the public spaces, they tried to design a modular system for market stalls to create the larger spatial layout that they wanted to achieve (Figure 10, top). Even this phase of the design was enhanced by an iterative process of evaluating the detailed layout and tweaking the proposed modular system.

When the design is developed and evaluated sufficiently, the conventional methods, such as 3D modelling, are used to visualise and present the design output, like any other design projects (Figure 10, bottom).

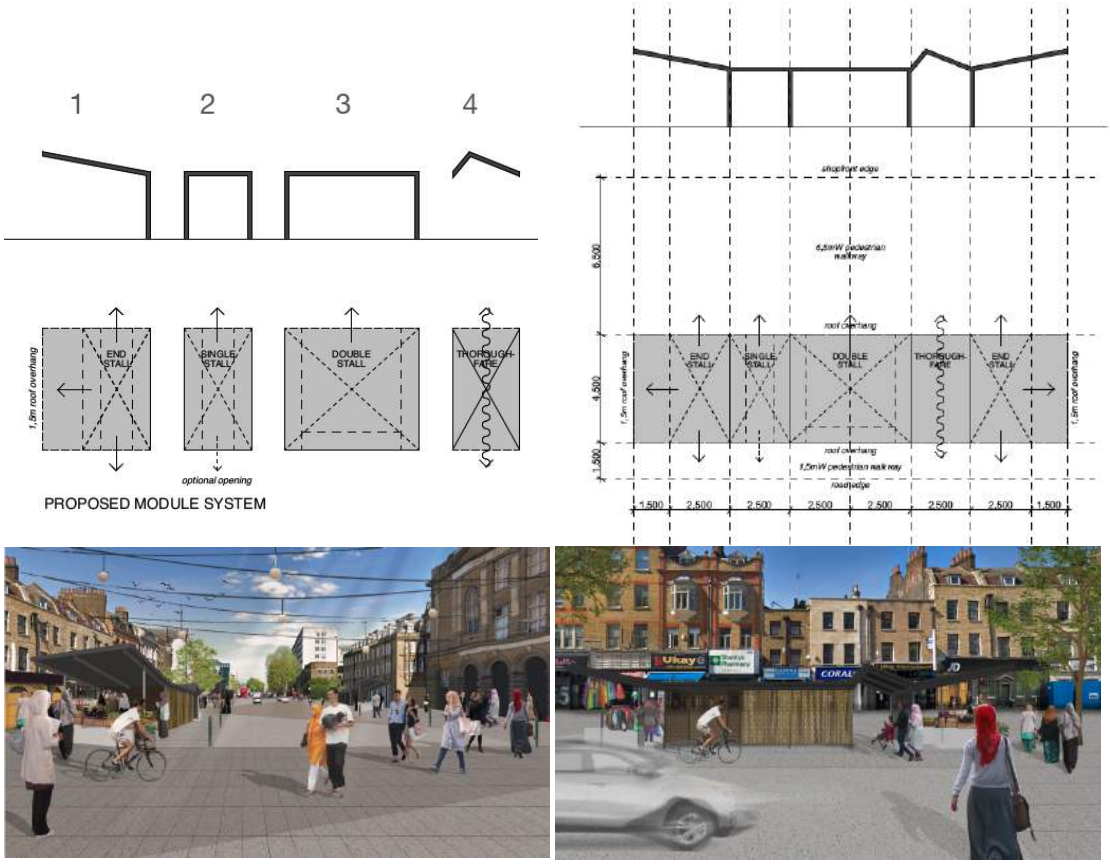

Figure 10: Detailed design is undertaken to develop a modular market stalls system in correspondence to the wider spatial layout design (top left and right). The design of the High Street and the market is visualised, using conventional architectural techniques (bottom left and right) for the Whitechapel project.

07 Discussions and conclusions

This paper builds its main argument on the proposition that analytical, evidence based urban design is possible. Although discussed briefly in this paper, the main arguments to support such a proposition has been documented in length elsewhere (Karimi, 2012b). As argued, this approach is possible, as long as it is specifically spatial, inherently social and intrinsically analytical, in order to bring together meaningfully the spatial and functional aspects of design through an analytical approach that is imbedded in the urban design process, not as an addition. It was also argued that a seamless relationship between the theories, methods and tools is needed to make this system work. For that reason, space syntax is a powerful platform since it fulfils all the criteria that have been recognised to be essential for achieving an analytical, research-based design.

The main focus this paper, however, has been about answering answer two major questions that stem from the original proposition: is analytical, evidence-based design teachable? and if yes, how could that be achieved? To answer these two questions, an empirical method of teaching has been presented that has been tried in the past six years and yielded some interesting results. The methods of teaching and some examples have been presented to support the core arguments of the paper. Based on the experience of applying of this method, it is becoming more and more evident that this system of teaching would work, as long as it is done in three parallel, interconnected streams of teaching on theories, methods and tools. This has can be achieved through a series of lectures, a series of methodology/software workshops

and a Project within a real urban context, in which the students can try and enhance their learnings.

Due to the limitations of the paper, only a small sample of the work undertaken by the students in previous years has been presented, but the outcomes of all student projects are consistent with what has been presented in this paper. In all cases, the students managed to creates a meaningful research base for their project and use it efficiently to understand their project better, generate ideas and options, evaluate their design and enhance it through an iterative design-analysis cycle.

An important finding in applying this teaching method has been that, almost with no exception, the students build successfully their project on a research platform and use data and analysis to identify issues, shape ideas, evaluate their design and produce designs which are heavily informed by analysis and evidence. It has also been consistently found that the base spatial configuration analysis can provide the students with a reliable foundation that is not only highly informative itself, but can provides an analytical base, upon which they can build and integrate more analytical layers.

The most complex part of this process still remains the conundrum that whether analysis and research can generate design ideas, or not. Based on the outcome of student projects, it can be confidently claimed that at least in some cases, the analytical process itself generated the core design ideas. But in some projects the core ideas were not necessarily the direct results of the analytical research. What brings all these projects together, however, is that after the generation of design ideas, the analytical methods have been successfully used to evaluate the design outcome and predict the impact of the design decisions. This is clearly an advantage for this method of design, since it creates some assurances that could be shared with the stakeholders and decisions makers.

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