Creative Challenge and Cognitive Constraint:

Students' Use of *A Pattern Language* for Complex Design[1]

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Abstract

In *A City is Not a Tree*, Christopher Alexander identified the creative challenge of how to generate the intricate complexity of traditional urbanism. In doing so, he also hypothesized a cognitive constraint: that it is too difficult for planners to conceive the kind of complexity found in traditional urban structures in a single mental act. To explore the relationship between complex design, creative challenge and cognitive constraint, this chapter reports on student design exercises using Alexander's *Pattern Language* as a generator of urban form. The study provides insights into the creative challenge faced by students using patterns in their designs, and helps shed light on the cognitive aspect of design using patterns; and hence draws conclusions about the implications of using patterns for creating complex designs.

Introduction

In his classic essay *A City is Not a Tree*, Christopher Alexander identified a creative challenge facing urban designers and planners: that of how to generate the intricate complexity of traditional urban structures, instead of the more simplistic, dysfunctional structures of the Modernist planning of the day (1965). In doing so, Alexander also identified a potential cognitive constraint to planning complex urban environments: in effect, suggesting that it is too difficult for planners to conceive the kind of complexity found in traditional urban structures in a single mental act. This called into question whether it was actually possible to plan towns – in the sense of consciously recreating the complex functionality of successful urbanism. This is significant precisely to the extent these issues remain unresolved today.

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The creative challenge – in effect, how to design functional complexity – to a large extent remains unresolved. It is granted that urban designers and planners perhaps more than ever appreciate the almost organic complexity of cities and recognise the potential for bottom-up urbanism (Batty, 2005; Portugali *et al.*, 2012). But when it comes to actual professional designing and planning, these still tend to involve preconceived solutions where the complexity is mechanistically imposed, artistically contrived or superficial. This is perhaps seen most tellingly in the case of neo-traditional set-pieces such as Poundbury, where the irregularity of the layouts are precisely contrived prior to construction, almost as 'top-down' as if coming from a traditional Modernist master plan (Marshall, 2009).

That said, Alexander himself has continued to draw a clear distinction between 'designing' buildings or urban places, and 'making' them through other means. One could interpret Alexander's career since *A City is Not a Tree* as his own attempt to answer the challenge of generating viable complexity (Mehaffy, 2007, 2008), not least through *The Timeless Way of Building* (Alexander, 1979) and *A Pattern Language* (Alexander *et al.*, 1977), and subsequently, the *New Theory of Urban Design* (Alexander *et al.*, 1987) and *The Nature of Order* (Alexander, 2002–2005). In particular, *A Pattern Language* addresses ways of generating the interlocking, overlapping urban fabric that Alexander desires to recreate, that Modernist planning failed to do. Hence scrutiny of how designers use *A Pattern Language* could help us understand the challenges of designing for complexity[3].

But this is not all. The fact that the creative challenge does seem to remain unresolved raises the question as to whether the difficulty in creating viable functional complex designs is indeed due to the cognitive constraint originally suggested by Alexander. In fact, it seems that Alexander's hypothesis about the cognitive constraint remains untested (Marshall, 2012). This in turn raises the question as to what extent complex design is viable (where 'design' is in the sense of traditional 'designerly' way of generating form that is both complex and functional, as opposed to urban creation by more spontaneous forms of generation), and hence the possible limits of urban design and planning.

To explore the relationship between complex design, creative challenge and complex constraint, this chapter reports on experience of student design exercises using *A Pattern Language* as a generator of urban form. It provides some insights into the creative challenge faced by students using patterns in their designs, and also helps shed some light on the cognitive aspect of design using patterns. The chapter first reports on the interlocking, overlapping nature of Alexander-style patterns, and then goes on to describe the student exercises, analysing the students' experience of the creative challenge and cognitive constraint; and draws conclusions on the implications of using patterns for creating complex designs.

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[3] *A Pattern Language* follows the philosophy set out in *The Timeless Way of Building*, and is designed to be read alongside it, in effect as a two volume set. This chapter focuses on the former work, since we are most concerned here with the elements and structures that *A Pattern Language* makes explicit, whether or not we follow the entire philosophy set out in *The Timeless Way*.

Patterns: morphology, modularity and design

In *A Pattern Language*, Alexander and his co-authors (1977) set out a system of 253 patterns, each of which provides in effect a solution to an urban problem. These include familiar morphological phenomena such as concentric DENSITY RINGS, proffered as a target future form, as well as wider innovations such as NETWORKS OF LEARNING; and includes abstract concepts such as PUBLIC-PRIVATE GRADIENT as well as physically specific suggestions, such as the dimensions of SMALL PUBLIC SQUARES. Each pattern is not a stand-alone element but explicitly supports or is supported by other patterns, creating a complex, interwoven system of urbanism.

The system of patterns is seamless across scales (from regions to construction details) and across disciplines (planning, urban design, architecture, interior design and engineering). Of course, any system of design or morphology could recognise 'things at different scales'. What is distinctive about *A Pattern Language* is the way these are explicitly interpreted as interlocking and overlapping (Marshall, 2011). It is not just a matter of identifying such morphological units as streets, blocks, plots and buildings, all neatly nested within each other – although this is of course a convenient way of dividing up the urban fabric and abstracting topological relations (Conzen, 1960; Habraken, 1998; Marshall, 2009; Kropf, 2014). Nor is it simply that units of design *should* also be so hierarchically arranged – that is, the engineer laying out a superstructure of main roads, the planner laying out land parcels, the architect dealing with the design within individual plots. Or to use a more recent example, software such as City Engine creates morphologies based on the assumption that the streets are fixed then within the polygons created by a network of streets, design of the plots takes place, and within those polygons the building footprints are located, from which buildings are extruded (e.g. Parish and Müller, 2001).

Rather than such a neat nesting of elements, the interlocking, overlapping nature of the urban fabric means that, for example, a façade is both part of the design of the building and the design of the street, at the same time. Building and street are locked together. One cannot design (part of) one without designing (part of) the other (Marshall, 2011). This complexity has nuances of ambiguity (Kropf, 2014) and (post) post-Modernism (Turner, 1996), that implies that traditional processes are not so readily converted into algorithms or simple design procedures.

From a historical perspective, the complex interlock was an important aspect of the traditional urban fabric. Then along came Le Corbusier and swept this away – the corridor street and the courtyard block (Panerai *et al.*, 2004). This meant, in effect, that Modernist design and planning did not need to deal with these interlocking, overlapping aspects. The architect was free to design the buildings as they wished, and the roads could be designed separately according to their own geometry. The façade became simply part of the design of the building – no longer part of the street, because the street no longer existed (Marshall, 2005). The result was that there was in a sense no 'modern' theory of how to design these interlocking units of street-based urbanism. That is, there was no modern (formal, professional, systematic) way to design streets, since streets (as such) were not part of the Modernist canon (Marshall, 2011).

In a sense, *A Pattern Language* helps to fill this gap. In this respect, indeed, it could be argued that *A Pattern Language* is interpretable as a 'modern' approach in the sense that it is trying to make a conscious, progressive improvement on what would be done otherwise. *A Pattern*

Language as a whole, while inspired by traditional approaches, or even (as is claimed) part of a single 'timeless way', is arguably a dedicated, new package of elements and tactics for creating urbanism, that is not a direct codification of a single set of traditional practices (not least because of its inability to resist unprecedented innovations, whether INDEPENDENT REGIONS or systems of one way PARALLEL ROADS). As such, *A Pattern Language* can be interpreted as a self-consciously idealistic new artificial language – a sort of urban morphological 'Esperanto' – cobbled together from knowledge of existing linguistic traditions.

And, although Alexander's work is typically associated with gradualism – slow, incremental processes of design building on prior traditions – one could argue that what *A Pattern Language* supplies is an *accelerated* way of generating the kind of complexity found in traditional urban fabrics. In other words, use of *A Pattern Language* bypasses the actual (long-lost, laborious, non-linear, incremental) processes that created the 'traditional' (surviving accumulations of) urban fabric, whatever those were; and supplies instead a mechanism for someone coming along and creating a new, possibly traditional-style fabric from scratch – in a way that is not as simplistic as simply 'cutting and pasting' a traditional tissue and replicating *en masse* on a new site.[4]

Finally, *A Pattern Language* provides a way of interpreting complex morphology and turning it into complex urban design – where the medium of morphology and that of design can be regarded as equivalent (Marshall and Caliskan, 2011), hence why patterns can be both interpreted in existing fabrics (even if never used as building blocks for design) and used as building blocks for design (even if these were never found in existing fabrics). For example, concentric DENSITY RINGS can be interpreted in spontaneous settlement structures, even if there was never any strategic design or strategic control of density; but in *A Pattern Language* those DENSITY RINGS themselves become formative elements for creating new urban fabrics. Conversely, innovations such as grids of perpendicular pedestrian and vehicular streets can be proposed as building blocks for future urban layout, even if these were never found as conscious constructs of any extent on the ground. In effect, Alexander uses patterns as the fundamental building blocks of urbanism – rather than using more conventional elements such as neighbourhood units, land use zones, or morphological plots – unless those themselves are interpreted as patterns.

This issue of the building blocks of urbanism goes to the heart of the constructive prerogative of urban design and planning. For architecture, it seems clear enough what the elements or 'building blocks' are: these are physically solid things like walls, windows, doors, roof; as well as voids such as doorways, rooms and corridors. These are readily identified as morphological elements not least because these are typically deliberate and discrete products of design (though there are exceptions: in a cave dwelling, they might be undesigned natural features).

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[4] While Alexander himself may claim – via *The Timeless Way* and other publications – that he is in principle replicating actual, timeless vernacular processes, we can suppose that most users of *A Pattern Language* are more likely to be using it to create 'instant' contemporary solutions, oblivious to whatever earlier traditions may have informed or inspired the patterns.

For urbanism, however, it is much less clear-cut what the building blocks for design are should be. If we restricted ourselves to things that were routinely designed – such as buildings or street blocks or plats – then we would miss many of the things – such as central business district – that were never planned but emerged spontaneously; that could yet become onward building blocks for design. Neighbourhoods become formalised as 'neighbourhood units'; clusters of factories become the prototype of industrial estates. It remains an open question as to whether it is better to use macro elements such as neighbourhood units and land use zones, or micro elements like blocks and plots and buildings; or Lynchian elements (nodes, paths, landmarks, districts, edges; Lynch, 1960). Alexander's patterns provide a whole vocabulary of these, as well as rules for putting together in a language. (Patterns are not just 'things' but embedding 'rules for creating those things')

This also begs the question, why do we have building-blocks in the first place? While design implies conceiving as a whole, 'building blocks' implies modularity and breaking into separate parts. This modularity can serve to help manipulate physically (and mentally) elements that can be worked on by different hands (and minds).

A Pattern Language, significantly, follows a modular format; it is amenable to being worked on by 'many hands'; and it need not involve formal planning nor design. That said, an important caveat to the interpretation of modularity is that elements are incomplete of themselves but form part of an overlapping, interlocking continuum across scales (see also Salingaros, 2000). Hence, a door typically implies a doorway and some sort of wall that it is associated with. A door, outside the context of a wall, would be like a word isolated from the context of a sentence.

Overall, this combination of features makes *A Pattern Language* a useful teaching device, for assisting learning about how urban fabrics are put together or could be put together – quite apart from its value as a distinct planning philosophy or practical design aid.

Students' application of *A Pattern Language*

The author has used *A Pattern Language* as part of an undergraduate course, Urban Form and Formation – a part-lecture, part-studio course bridging from urban morphology to urban design – since 2008.[5] One of the aims of the course is for students to learn about the elements of urban form, and how these relate to the building blocks for urban design. *A Pattern Language* is considered a useful educational tool in inviting students to observe and analyse the urban fabric as it is – interpreted in terms of patterns – and then to undertake a design exercise using patterns as building blocks. This is in conscious contrast to using land use zones, neighbourhood units, or discrete elemental morphological units (such as streets, plots or blocks) as building blocks.

The course consciously encourages experimentation. A premise here is that students need to first learn about the basic elements of the urban fabric how they fit together – to play

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[5] The class is taken primarily by second year students of BSc Urban Planning, Design and Management and BSc Urban Studies, but is also an optional class that has been taken by students of Architectural Studies, Geography, and various engineering and social science degrees, over the years.

with them, to compose, to experiment, to get a feel for using them – before going on to undertake more formal planning or design exercises. This implies experimenting with both familiar and useful permutations of elements, and exploring what might turn out to be 'nonsensical' combinations or 'fabulous beasts' (Mitchell, 1990; Steadman, 1998) against which the logic and utility of familiar solutions can be better understood.

An analogy here would be with learning a new language, where it can help to experiment and play with the language, and compose sentences, write essays and make conversation – however trivial, anecdotal or fantastic – before settling down to create serious utilitarian prose. One has to experiment with, for example, being able to say 'the cat sat on the mat'[6], as opposed to 'the cat sat down on the mat' or 'the cat was sitting on the mat'; and also to explore different alternative permutations – even nonsensical combinations, in order to learn about the language – for example, 'the mat sat on the cat' or 'the sat cat on the mat', in order to understand viable combinations of vocabulary, syntax, grammar and meaning (and the different ways of being 'wrong'). When learning a language one also benefits from the joy of play and self-expression to encourage mastery of the language. (The 'cat sat on the mouse' implies another nuance of the meaning of 'sat on' – to immobilise – which implies something different from 'the mouse sat on the cat'). Without this sense of exploration, one would go straight to devising a master plan for an urban regeneration site, before one has even learned how roads and buildings are normally organised (or could be – abnormally – organised). This would be like the equivalent of learning a new language and suddenly being expected to compose a formal speech, without first having had an informal conversation.

In introducing *A Pattern Language* to the class – as a way of thinking and doing, not a 'bible' with 'all the answers' – it is always emphasised that what is important is the way that the elements and relations are structured, across different scales, their interlocking and overlapping nature, and their inter-relatedness. In a sense, a thing is not a thing except in relation to both its context (the things it contributes to), and the things it is made up of. So for example, a garage implies something with walls and a roof (otherwise it might be a carport or parking bay or something else); it also typically implies being associated with another building such as a house, and leading to the street perhaps via a driveway. As Alexander *et al.* point out (1977), the same physical structure, if it appeared in the context of a boat, would not be called a garage. Hence it is emphasised that one cannot simply design an element in isolation, but it must be thought through in terms of a context of other (supportive and supported) elements.

While the abstract morphological structure of *A Pattern Language* is emphasised, conversely, it is made clear to the students that they are not expected to necessarily agree with all of what Alexander and his co-authors say; it is not necessary to 'buy into' the whole *Timeless Way* philosophy; it is acknowledged that the patterns in the book are often outdated, and cannot necessarily be assumed to be universal. Critiques of *A Pattern Language* are identified (e.g. Saunders, 2002), and critical thinking encouraged. The point is that the students are free to use

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[6] Bill Hillier has used this phrase as an example of the difficulty of translating between languages (2003:17).

the *Pattern Language* as an exemplar or template for thinking about *any* patterns or urban form elements and processes of urban formation.

Each year a slightly different combination of exercises has been undertaken. These usually involve (1) some sort of writing a pattern (either an existing pattern updated with new research and/or case study, or a completely new pattern); (2) interpreting patterns – in clusters – on site; and (3) designing – collectively – a new piece of urban fabric using patterns.

In general, the students have no difficulty in identifying Alexandrian patterns *in situ*, interpreting new patterns *in situ*, and writing new patterns and creating urban form with them. Presented here are some examples of the design part of the exercise. The first examples are for a neighbourhood scale design on the Greenwich Peninsula; the second set of examples is a design for a courtyard development in the Camden area of London.

The concept map for Greenwich (Figure 1) is built up of a number of features which may be – but need not be – interpretable as 'patterns'. If one did not know this was an exercise building with patterns, one might not suspect it was. In fact, LOCAL SHOPS, PUBLIC ROOM and WEB OF GREEN SPACE are explicitly created as patterns, along with BUILDING DENSITY GRADIENT which can be inferred indirectly from the schematic arrows. Curiously, not all patterns that the student group used – such as WEB OF PEDESTRIAN SPACE – feature explicitly in this concept map. Conversely, all the other named features – e.g. 'government housing' and the 'linking bridge' – are not conceptualised as patterns as such.

The result looks as if these could be a succession of separate features. Their interlocking, overlapping nature is not explicitly apparent. To be fair to the students, *A Pattern Language* itself does not explicitly illustrate the interlocking overlapping nature of the patterns, either *in situ* or as designed assemblies (Saunders, 2002).

The students were nevertheless creative in attempting to capture the complexity of relations between patterns. Figure 2 looks less like a conventional 'land use plan'. This could be considered in a tradition of schematic / concept plans, not necessarily associated with patterns *per se*.

Now we turn to the second case, that of Camden Town. First, we have a plan of the development (Figure 3). This looks a bit like a conventional plan, that would not necessarily be recognisable as a pattern language exercise, out of context.

Next, we see a series of images showing the development of the courtyard over time (Figure 4). This is accompanied by a narrative (paraphrased here for simplicity to the right of each image) explaining the appearance or emergence of the different patterns at each stage. Finally, we see two ways of visualising the linkages between patterns. The first shows a graph (nodes and links) superimposed on a sketch (Figure 5). The final image (Figure 6) is an abstracted graph which shows the patterns as nodes and the pattern relations as links.
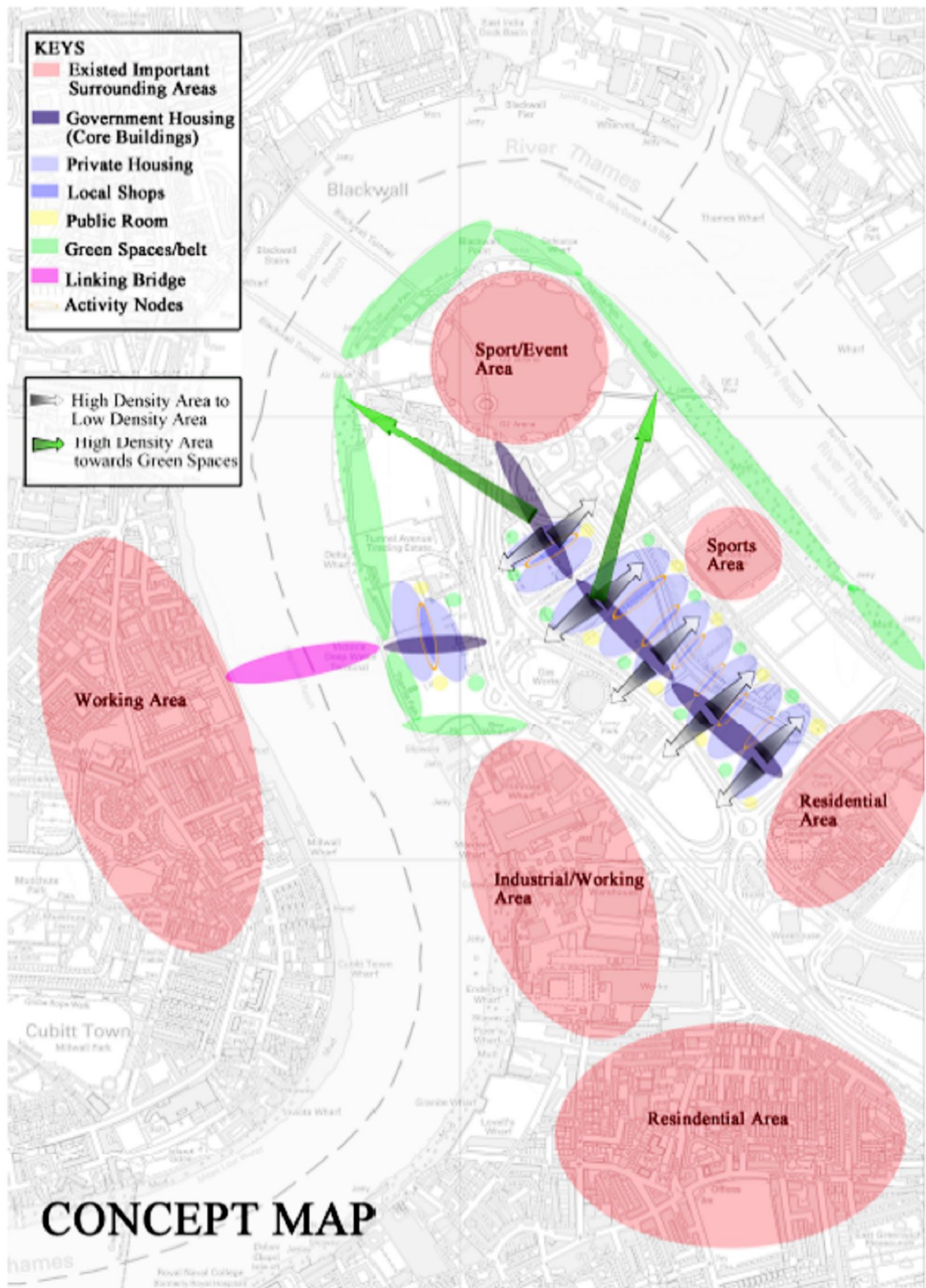
Figure 1. Concept Map. This shows various building blocks of urban form. One would not necessarily guess that the named elements are 'patterns' as such.
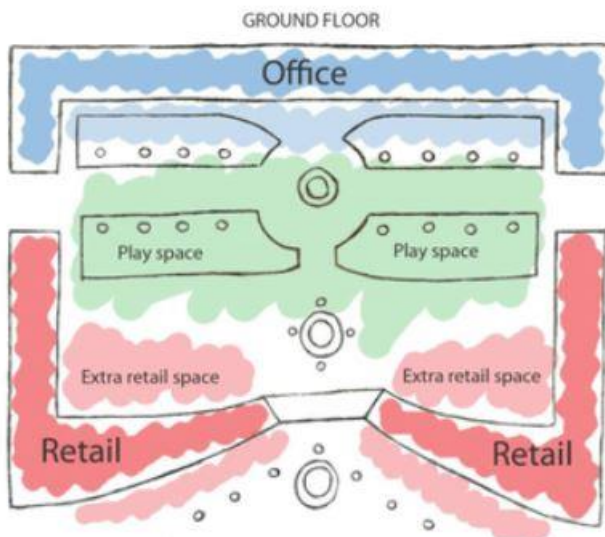
Figure 2. Sketch plan.

Figure 3. Camden courtyard development. This could be a conventional master plan.

A would-be COURTYARD THAT LIVES – but awaits other patterns for fulfilment

A WEB OF SHOPPING emerges, helping to create and POSITIVE OUTDOOR SPACE and a COURTYARD THAT LIVES

An IDENTIFIABLE NEIGHBORHOOD emerges…

…and finally DEGREES OF PUBLICNESS and a STRUCTURE WHICH FOLLOWS SOCIAL SPACES

Figure 4. Sequential development of the courtyard over time.

Legend:
- (19) WEB OF SHOPPING
- (205) STRUCTURE FOLLOWS SOCIAL SPACES
- (106) POSITIVE OUTDOOR SPACE
- (115) COURTYARDS WHICH LIVE
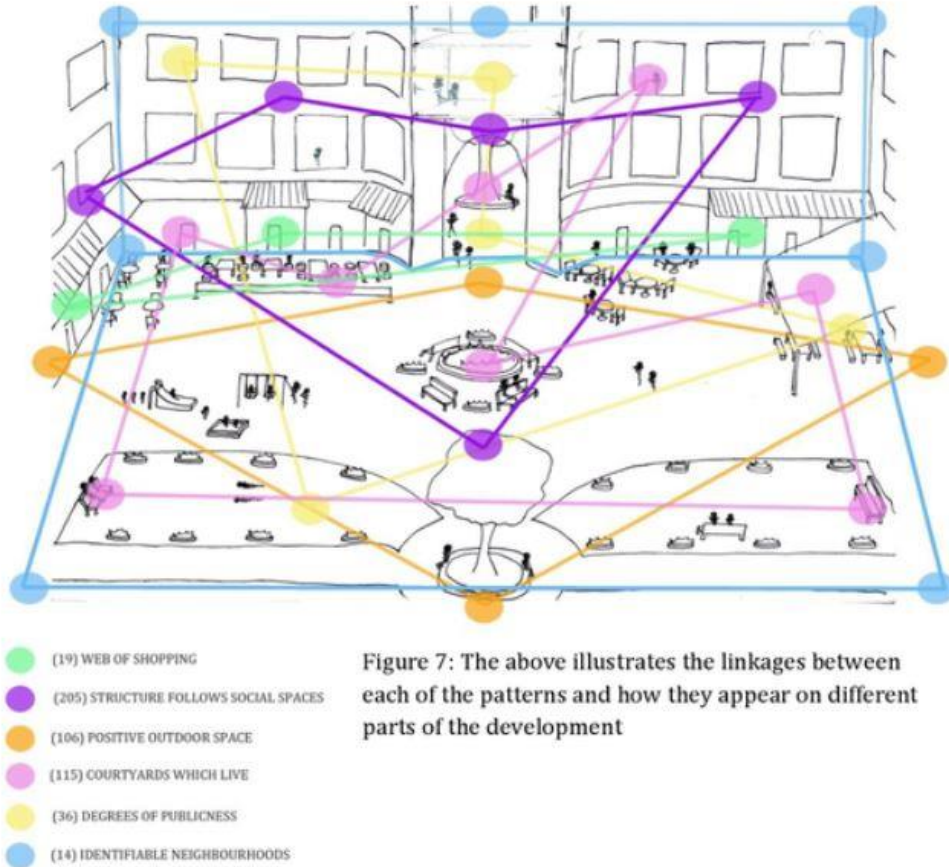- (36) DEGREES OF PUBLICNESS
- (14) IDENTIFIABLE NEIGHBOURHOODS

Figure 7: The above illustrates the linkages between each of the patterns and how they appear on different parts of the development

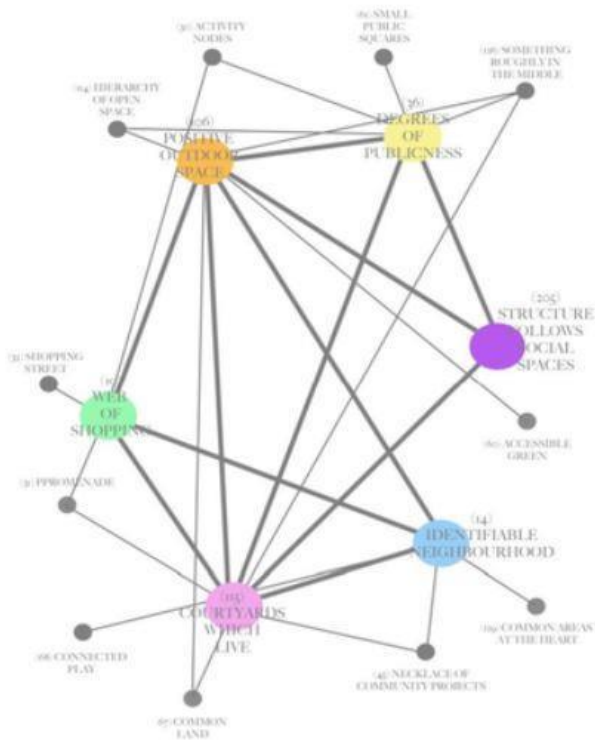Figure 5. Abstract linkages between patterns overlain on sketch.

Figure 8: this illustrates how the six chosen patterns link together but also how they link to less significant external patterns which will have influence on the growth of the development

Figure 6. Linkages abstracted as a graph representation.

From observing classes over several years, it seems that while most designs are duly annotated with patterns, it was not always clear to what extent patterns were the most fundamental formative elements. In some cases, it seemed that the students could not help thinking in terms of conventional land use plans and units. For example, if devising a new town, a group would typically instinctively start with sketching out a town in a conventional way – for example with main roads, a centre, and neighbourhoods or districts of various kinds, and adding in distinct features (e.g. university campus, library, etc.) with no reference to patterns. When the overall structure was created, the patterns might later be identified as such. In other words, it seemed that the students (in these cases) were not truly 'thinking in patterns'; but first thinking in terms of conventional building-blocks, and then converting them into patterns, or retrospectively labelling them as patterns. This could be the equivalent of thinking not in a foreign language, but thinking in one's native language and then translating everything into the target foreign language (i.e. where here the pattern language is the foreign language).

This raises the question as to why this might be so; and hence the stimulus to ask students to reflect on their own work.

Students' interpretations of using *A Pattern Language*

For a recent year's class, students were asked individually to reflect on the strengths and weaknesses of using an Alexander-style pattern language for creating development today. This reveals both attitudes to *A Pattern Language* in general, and the challenges to using it for complex design in particular.

From their narratives, it is evident that the students typically perceive *A Pattern Language* to be of its place and time (so, not so 'timeless' after all); and restricted in applicability to a western cultural context. Additionally, typical comments were that many of the ideas were unrealistic – too utopian or not reflecting actual reality. This was often specifically related to how applicable some patterns would be in a market economy, or current planning context. The specificity/prescriptiveness or flexibility/vagueness of patterns was interpreted as either a strength or a weakness (or sometimes both, as identified by particular individuals). The potential to deal with complex forms and for participative contributions was noted by some, as were the relative lack of attention to actors and instruments (i.e., who would implement the patterns, and how).

Overall, nevertheless, the students were able to produce designs using the patterns in some way (not necessarily strictly as envisaged by Alexander), and were therefore able to demonstrate to some extent the viability of patterns as a way of generating urban development – at least as a paper exercise. However, as noted earlier, the students did not always seem to 'think in patterns', and did not necessarily use the patterns in the way intended by Alexander, but would sometimes tend to use them like more conventional building-blocks.

There are several hypotheses as to why this might be so (summarised in Table 1).

Table 1. Hypotheses about the difficulties in using *A Pattern Language*

Hypothesis	Experience
1. Patterns are not real, or difficult to identify *in situ*	Not borne out
2. Patterns are real *in situ*, but not suitable as building blocks	Compatible with student experience
3. Patterns would be suitable as building blocks, but	
(a) Students pre-conditioned to thinking instead of other building blocks (zones, neighbourhood units, etc.)	May be partly true, but not thought significant
(b) It is mentally difficult to do so (cognitive constraint)	Compatible with student experience
(c) Less able students found it difficult	Not borne out

1. It could be that patterns are figments of the authors' imaginations (Alexander *et al.,* 1977); or artificial constructs (like Esperanto) not found naturally *in situ*; or otherwise arbitrary or capricious interpretations of the urban fabric, that have to be consciously learned, both as ways of interpreting the built environment, and for designing it.

This does not seem to be borne out by the student experience. It is easy enough to interpret MAIN GATEWAYS or PATHS AND GOALS or QUIET BACKS; these are (for the most part) not contrivances but are in some way a natural way of interpreting the built environment that any lay person could recognise.

2. The urban fabric really is made up of patterns or pattern-like elements and relationships; these are readily identifiable as such, when interpreting existing sites; but when it comes to design, they are not the most intuitive 'building blocks', to design with, for creating interlocking wholes 'at once'. This could imply it is natural to understand with patterns, but difficult to intervene using them. This hypothesis is compatible with the student work. It would also seem to tally with the experience of Modernist planning, many of whose advocates such as Hilberseimer (1944), Le Corbusier (1964) and Bacon (1975) drew explicitly inspiration from traditional urban formats, but when it came to design, the designs always seemed to be more simple and less rich – and actually likely to be less functional than the traditional exemplars (Marshall, 2009).

3. Patterns could be a valid and viable way for both interpreting *and* building the built environment, but the users of the book (in this case, students) for whatever reason, sometimes find it difficult to get the hang of using.

(a) This could be in principle because the students were somehow 'preconditioned' to think in terms of conventional building-blocks such as land use zones or neighbourhood units, and that if only those things could be 'unlearned' we could be better off.

This could be partly true, but it is considered unlikely to be a crucial factor. The students are not strongly indoctrinated into planning in this way, and there are many students who come to the course from outside planning. It is possible they learned about town planning elements in

school – for example, central business districts or concentric rings in urban geography. But in any case, it is surely the case that any observation of a modern urban or suburban landscape, one is more likely to come across things such as 'shopping centres' and 'industrial estates' than 'DEGREES OF PUBLICNESS' or 'SCATTERED WORK'. Even in traditional urban fabrics, things like 'suburban high streets' are readily observable though they are not found among Alexander's patterns; and therefore, if using these as the building blocks for a planned town or town extension, it is almost inevitable that a first stab at a town plan (or design of an urban quarter) would include those 'not in the book' features.

(b) Another possibility is that patterns are simply too difficult to think with; either by faithfully reflecting the difficult complexity of reality, or by being in some way counter-intuitive. In this hypothesis, students find it difficult to conceive of the interlocking, overlapping nature of the urban fabric. This would correspond with Alexander's hypothesis in *A City is Not a Tree*. In this case, *A Pattern Language* is providing an explicit way of 'forcing' the users to try to think in terms of what links to what, what overlaps with what. These connections are dutifully documented, but they are not always easily grasped as a whole or expressed on plan. It may be difficult to express the overlap and interlock, because the more successfully a place or design is seamlessly constituted, perhaps, the less visible the join, as it were. In other words, patterns could in principle be a viable way of creating complex environments, but it is still difficult for users to do so (i.e. overcomes the creative challenge even if there remains a cognitive constraint). From the student experience, this is inferred to be at least partly true.

(c) Finally, it could simply be that the more able students are able to apply patterns successfully, and the less able, not. This could be a straightforward case like that of ability equating with dexterity in drawing, or handling numbers. The most able students not only 'get it' (what they should be doing and why) but are able to 'achieve it' (express themselves through patterns, as the exercise demands). In this case, the fact that some students do not do it so well is simply a matter of variation in ability. But it could also be that the students who 'get it' contrive their designs so as to look as if designed using patterns, even if the patterns are retrofitted[7]. From the evidence so far, this hypothesis is not borne out. The students who were most articulate in their reflections were also the most articulate in pinpointing the challenges of working with patterns.

The nuances of difference or linkage between hypotheses 2 and 3 (a) and (b) could be further tested – the degree to which any cognitive constraints affected the usability of patterns as building blocks for design.

Turning to the students' own reflections on the strengths and weaknesses of using pattern languages, we find some clues as to what was going on, in the students' minds (Table 2).

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[7] Also, one is tempted to ask: do students continue to use patterns later on in their studies, or do they revert to conventional design elements (neighbourhood, park, car park, etc.). Even if so, students might nevertheless benefit from the insights they have gained through using patterns, including the experimentation, and alternative ways of thinking about the urban fabric; some anecdotal evidence suggests this is the case.

Taking these points together, we can say, first, that in some sense, the use of patterns did allow creation of complexity, but that that complexity was, after all, difficult to conceive and visualise to some extent. That is, *A Pattern Language* could be successful in helping address the creative challenge of *A City is not a Tree*, but in doing so, the resulting structure was yet still difficult sometimes to conceive and visualise. This could yet be a successful outcome (allowing for the cognitive constraint).

Secondly, in some sense, the patterns were not necessarily the most useful 'building blocks' to design with. This could be because focusing on patterns as 'building blocks' (to use this metaphor in particular) – breaking down the urban fabric into discrete elements – somehow led to a loss of the seamless interlocking complexity. This could be an inevitable consequence of 'designing with discrete things'.

Table 2. Student reflection on strengths and weaknesses of patterns

Student	Comment	Interpretation
A	"It was very difficult to draw patterns on a map with boundaries"	While this statement contains some ambiguity, the phrase 'very difficult' is unambiguous and telling. It must be interpretable as some sort of barrier to visualising or conceiving of patterns. This would include patterns at different scales (a NETWORK OF LEARNING could be city-wide or boundless).
B	"Using patterns, …on numerous occasions restricted our efforts. Oftentimes the vision became subservient to the pattern framework".	This implies that the patterns were almost mechanistically dictating what the vision could be expressed as, rather than the vision being 'naturally' dreamed up in the language of patterns – like a 'native language'.
B	"Though a 'language' describes a consummate whole, it is difficult to envision the final product without being slavish to its constituent parts"	This is as if somehow because the overall vision (something site-specific) was itself not a pattern, the patterns only featured as parts of the whole. For example, if one had a SMALL PUBLIC SQUARE that was also an ACTIVITY NODE, perhaps it was difficult to conceive of this as anything other than the sum of those two patterns
B	Noted, as a strength, that the pattern method taps into 'subconscious formations'.	This statement was not elaborated, but could have been a generic statement about the attributes of patterns in general (e.g. reproducing received wisdom on strengths and weaknesses)
C	"By carving things into patterns… users…focusing too much on the actual patterns rather than their linkages".	This implies that patterns-with-linkages is the important thing, rather than 'building blocks' as implying discrete separable elements.

C	The book presents a series of patterns, rather than 'vivisecting' an existing fabric (as Jane Jacobs did) which would emphasise the whole including the connections.	In presenting a series of separable entities, the *Pattern Language* book may itself be part of the problem.
D	"A denser or more complex structure of patterns would be difficult to present in raw form to the layman"	This seems to allude to the visual complexity of presenting design solutions.
E	Patterns could 'constrain thinking'	This is interpreted to mean constraining by presenting a limited range of solutions.
F	Patterns helped 'expand the mind'.	This implies patterns do not constrain thinking.
G	Patterns encouraged thinking in a 'piecemeal' way to create 'holistic' vision.	This could be interpreted as paradoxical, or alternatively, part of the quixotic appeal of Alexander's broader quest.
H	Pattern making is complicated and patterns can't be put together 'in one second'.	This reflects the traditional processes it is inspired by; it may be the price to be paid for any benefits of 'better urbanism' resulting.
I	Patterns did not fit well what they were trying to do.	This is interpreted to include fitting with existing site.
J	'We refer to it now and then'	This implies that the pattern language was only partly used; or allude to the periodic departure from the pattern-based approach, by using non-pattern elements in the design.

Alternatively, and contrariwise, it could be that patterns might be the 'wrong kind of thing to design with' precisely because they deal with entities that are not 'things' as such, but more elusive entities that are not as concretely designable as more conventional units.

In other words, it is possible that some students, in most faithfully following the Alexandrian definition of a pattern, found those patterns unintuitive to design with, while those that 'converted' patterns into 'handy things to design with' (discrete building blocks) gained on designability but led to 'clunkier' products (For example, the pattern PATHS AND GOALS is less tangible than the things 'footpath' or 'door'.) This is an issue that could be further tested.

As it stands, we can see why Alexander's system, at once traditionalist yet revolutionary, gradualist yet 'accelerative', could appear so promising in principle yet remain underutilised in practice: because the system as a whole would need a revolution to allow it to work. The

implementation of a single pattern implies bringing into play several others, and perhaps rethinking the whole system of how the built environment is designed and managed. In this sense, the most ordinary pattern could be more difficult to achieve in practice than the most radical, innovative conventional object to the extent that the latter can effectively be accommodated in the conventional system without changing it. (An iconoclastic avant-garde chair, for example, can still fit perfectly within the system of furniture design, production and furniture retail markets, whereas a physically prosaic public bench built into the wall of a private building could imply a complex renegotiation of physical, social and legal boundaries). To the extent that *A Pattern Language* upsets distinctions between conventional morphological objects and modes of production, this is hence why, in a sense, Alexander's way is cognitively challenging or could 'mess with your head'.

Ironically, then, patterns – while potentially offering a solution to complex design – seem themselves to suffer from the cognitive constraint. This difficulty in application is partly why, even though it has been applied successfully by individual designers, patterns have yet to become a new order, usurping conventional planning – we still have city Departments of Planning, after all, rather than Departments of Pattern-Making. That pattern languages have not become the new mainstream also lends support of sorts to the cognitive constraint hypothesis: in effect, the limitations of Alexandrian methods in practice help support Alexandrian theory.

Conclusion

This chapter has reported on a case of using *A Pattern Language* in teaching student projects. In doing so, it has drawn attention to some of the challenges in using patterns to generate complex urban form. This provides some evidence lending some support to Alexander's 'cognitive constraint' hypothesis – that people have difficulty in holding interlocking, overlapping structures in their heads – and therefore partly explaining the 'creative challenge' – the difficulty in recreating the complex traditional urban fabrics by an act of design or planning. It suggests more research is needed to demonstrate more systematically the relation between these aspects: further interrogation of designs and designers could help establish these emerging results more strongly.

Ultimately, further procedural development would be required to help make the design of complex fabrics more intuitive; or else, the need to create them in a way that is not 'by design', but some sort of collective, incremental way perhaps controlled by codes. Perhaps, indeed, codes could be devised to handle the complex overlapping, interlocking aspect, while the modular elements were themselves more conventional. In such a way, the complex part is embedded in and mediated by the relationships, not the elements themselves. By this means it could yet be possible for different people to design parts of the fabric in a controlled but piecemeal, not-too-challenging fashion – in a way that allows creativity while avoiding any cognitive constraints. ●

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