The effects of block size and form in North American and Australian city centres

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Abstract. *The paper describes a comparative study of block size and form in twelve North American and Australian city centres. The purpose of the study was to analyse the effect of different initial block sizes and forms on the nature of subsequent urban development, in terms of land parcelling, building forms, circulation patterns, and partly also of land use. The study considered the evolution of the block and layout pattern since the initial layout was established, and its present form and performance. The findings demonstrate that certain block forms and dimensions perform better than others, in particular aspects and circumstances, and that the choice of initial block forms and sizes leads to predictable consequences and processes in subsequent development. The method used offers a systematic basis for other comparative studies of the influence of differing block forms and sizes in both historical and contemporary urban fabrics.*

Key Words: city centres, street blocks, North America, Australia

The city block is a fundamental element of the physical structure of urban areas. Throughout history, towns and cities have generally been laid out in relatively simple patterns of streets and blocks, both in planned and unplanned settlements. Therefore, it might be expected that the properties of different sizes, shapes and arrangements of blocks would be well known and documented. Surprisingly, this is not the case. Though some aspects have been studied, there is little consolidated knowledge about the properties and performance characteristics of different block sizes, shapes and arrangements in terms of circulation, land use, building forms and other aspects.

It would seem essential to have comparative factual information about the types, shapes, sizes and arrangements of blocks employed in different periods and places, and about their relative performance in meeting different urban purposes. Recent research (Siksna, 1990) has attempted to provide such comparative information by examining first, the block forms and sizes used in the main historical periods of new town foundation - Greek, Roman, medieval, and, in America and Australia, seventeenth to nineteenth century; and secondly, by examining the relative performance characteristics of selected North American and Australian city centres that have different block forms and sizes. This paper describes the methods and findings of the second part of the study.

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Nature and scope of study

A wide variety of layout patterns has been used for urban areas having a similar purpose. For example, the Central Business Districts (CBDs) of American and Australian cities are broadly similar in land use, built form and circulation requirements, yet they have very different block forms and sizes. Do they all work equally well? Do different block forms and sizes affect the subdivision or amalgamation of land parcels, the functioning of circulation patterns and the development of buildings? Do particular blocks forms and sizes create favourable or optimum conditions for one or more of these aspects? Are there any desirable or undesirable consequences which flow from the choice of certain block forms or sizes? Although some of these aspects have been addressed in studies of specific cities, there is no substantial comparative study which deals with the relative performance characteristics of different block forms and sizes in city centres.

To answer these questions more fully, a study of selected North American and Australian city centres was chosen for a number of reasons. First, the cities were founded at about the same time and developed major city centres of a similar nature in a similar time scale. Secondly, they have similar, rectilinear layouts but the forms, dimensions and geometric arrangement of their lots, blocks and streets vary considerably. Thirdly, their greatly changing requirements and rapid growth, allow the properties and relative performance characteristics of different block sizes and forms to be adequately revealed and tested. Finally, they enable cultural comparisons, yet are not so different that cultural differences cloud other factors.

The city centres of North American and Australian cities offer examples of initial layouts being subjected to immense and rapid changes in land use, building forms and transportation modes in a relatively short period of time. Although they have all managed to adapt to different requirements, it is possible that cities having certain block forms and sizes may have adapted more easily, and may perform better today, than others. Two hypotheses were advanced. First, that given their similar urban purposes and processes, layouts initially having different lot and block sizes and forms will tend, over time, towards similar patterns of land parcelling, building forms, and circulation routes. Secondly, that certain forms, sizes and arrangements of lots, blocks and streets have been more adaptable, and have performed better for past and present development requirements.

The block forms of ten of the twelve cities studied are shown in Figure 1. Three criteria were used in their selection. First, there should be equal numbers of North American and Australian cases. Secondly, a wide range of block sizes and forms should be covered, using at least two cases of each distinct block size and form; block sizes were classified as small (under 10 000m^2), medium (10 000 - 20 000m^2), and large (over 20 000m^2). Thirdly, each case should have unique traits, but also share some features with other cases.

The layout characteristics of the city centres are outlined below, with the year of the initial plan and 1980–81 metropolitan population stated in brackets.

Savannah (1733; 142 000) - small rectangular blocks - was included primarily as a point of reference, because it has much smaller blocks than are generally found in North American and Australian towns of this period, and offers a rare example of two types of blocks designed for different purposes - one for residential, the other for public uses. Its layout contains a number of central squares and the circulation pattern is hierarchical.

Portland (1845; 1 242 000) and Seattle (1853; 1 607 000) - small square and rectangular blocks - allow comparison with cities having larger square blocks. Individually, they can highlight differences caused by the slightly different sizes, forms and internal structures of their respective blocks.

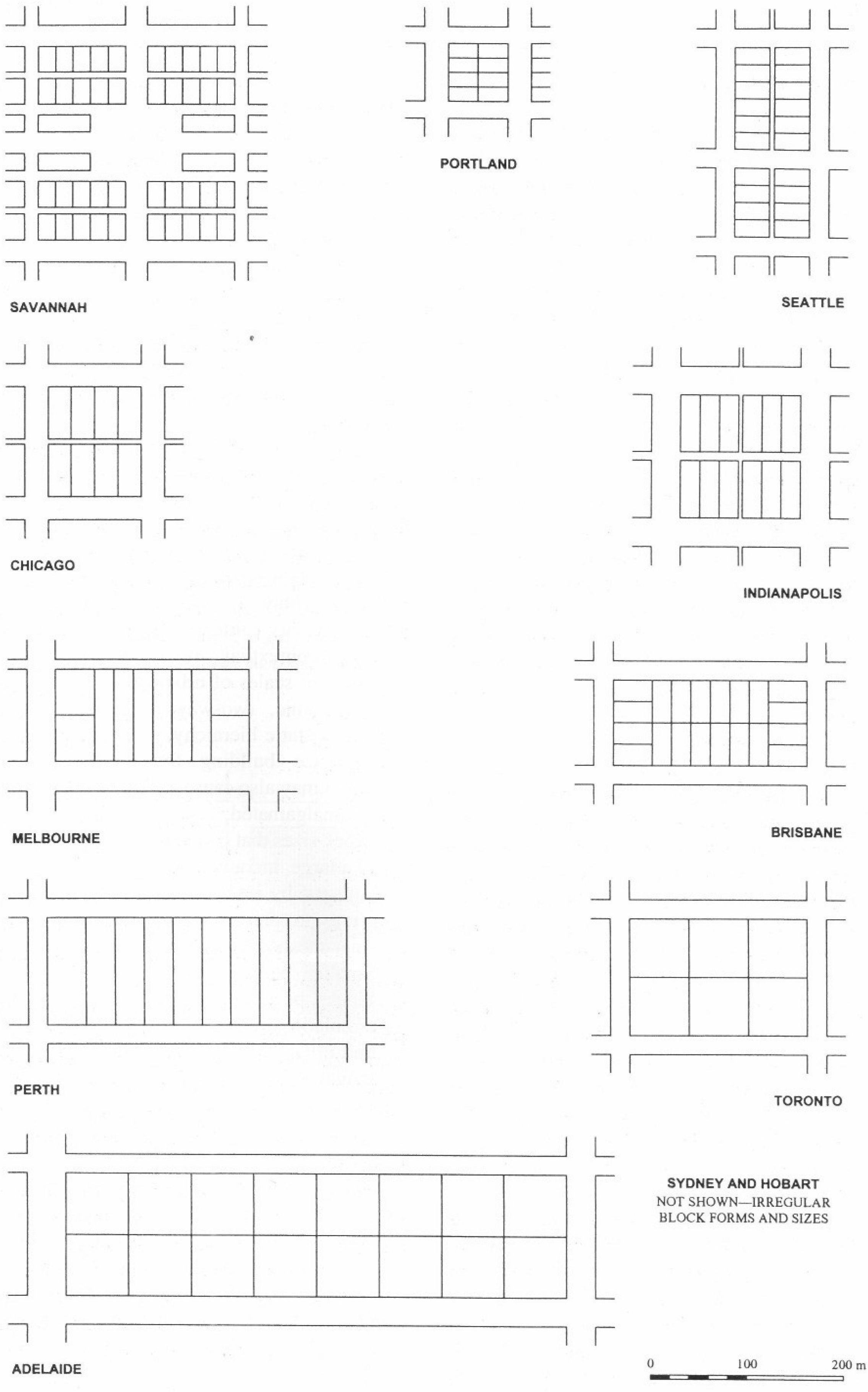

Figure 1. Block forms in selected towns.

Chicago (1830; 7 102 000) and Indianapolis (1821; 1 167 000) - medium square blocks - represent the upper end of American square block sizes. The internal block structures differ - Chicago has back alleys, whereas Indianapolis has cross alleys.

Melbourne (1837; 2 740 000) and Brisbane (1842; 1 015 000) - medium rectangular blocks - have blocks with almost identical dimensions. Melbourne's have ten through-lots extending between parallel streets; Brisbane's have 20 back-to-back lots. Thus any differences associated with the internal structure of blocks will be revealed.

Perth (1829; 884 000), Adelaide (1837; 933 000), and Toronto (1797; 2 865 000) - large rectangular blocks - as a group allow comparison with medium rectangular blocks, and individually they can highlight differences caused by different block lengths and lot types. Perth, like Melbourne, has narrow through-lots, whereas Adelaide has square lots arranged back-to-back. Toronto is included in this group because of its similar block form and size.

Sydney (1788; 3 193 000) and Hobart (1811; 170 000) - varied, irregular blocks - both have less regular layouts than the other cities. As a pair, they can reveal differences caused by irregular and varied block sizes and shapes, and individually they may highlight factors contributed by city size and the development intensity of the centre.

The twelve selected cities therefore allow comparative analyses of the following kinds:

(1) Within and between five different groups of block size and form, to which Savannah can be added as appropriate or used as a reference point;
(2) Within and between two sets of cities - five American ones, with relatively small square blocks; and six Australian ones, with relatively large rectangular blocks - to which Toronto, Canada can be added as appropriate, or used as an example of different cultural or evolutionary factors; and
(3) Selective examination of particular elements - the presence or absence of alleys; the effect of different types, shapes and sizes of lots.

In each case the study area is within the city's CBD, it has as its focus the retail core, and it contains a selection of the typical block forms and layout features of the particular city.

Rationale and method

Brown (1985), Brown and Johnson (1985), Moudon (1986), Maitland (1984, 1985) and Panerai *et al.* (1980) have made important contributions to the study of blocks with respect to three aspects: first, the processes governing the lot pattern within blocks; secondly, the adaptability and interaction of buildings, lots, blocks and urban form; and thirdly, the dimensions of the urban structure of streets and nodes (Figure 2). From their findings, the following rationale was adopted for the study of North American and Australian city centres:

- The contextual relationship between different scales of urban form elements is a dynamic, two-way interaction, rather than a static hierarchy. Thus lot size may influence building form, but building forms may also cause lots to be subdivided or amalgamated;
- Block sizes that create a circulation pattern of a large, inconvenient mesh size, may be adjusted by inserting additional streets or alleys to produce smaller blocks and a finer-meshed circulation network;
- Smaller blocks work better than larger blocks, because they produce a finer-mesh circulation pattern and finer-grained block and urban fabrics. The evolution of block structures and circulation patterns was therefore expected to demonstrate a clear trend for larger blocks to be broken down into smaller sub-blocks. This evolutionary process may also indicate the range of block dimensions that enables optimal performance of circulation patterns, of block fabrics (the pattern of lots, buildings and spaces within blocks) and of the urban fabric (the overall pattern made by block fabrics, streets and public spaces).

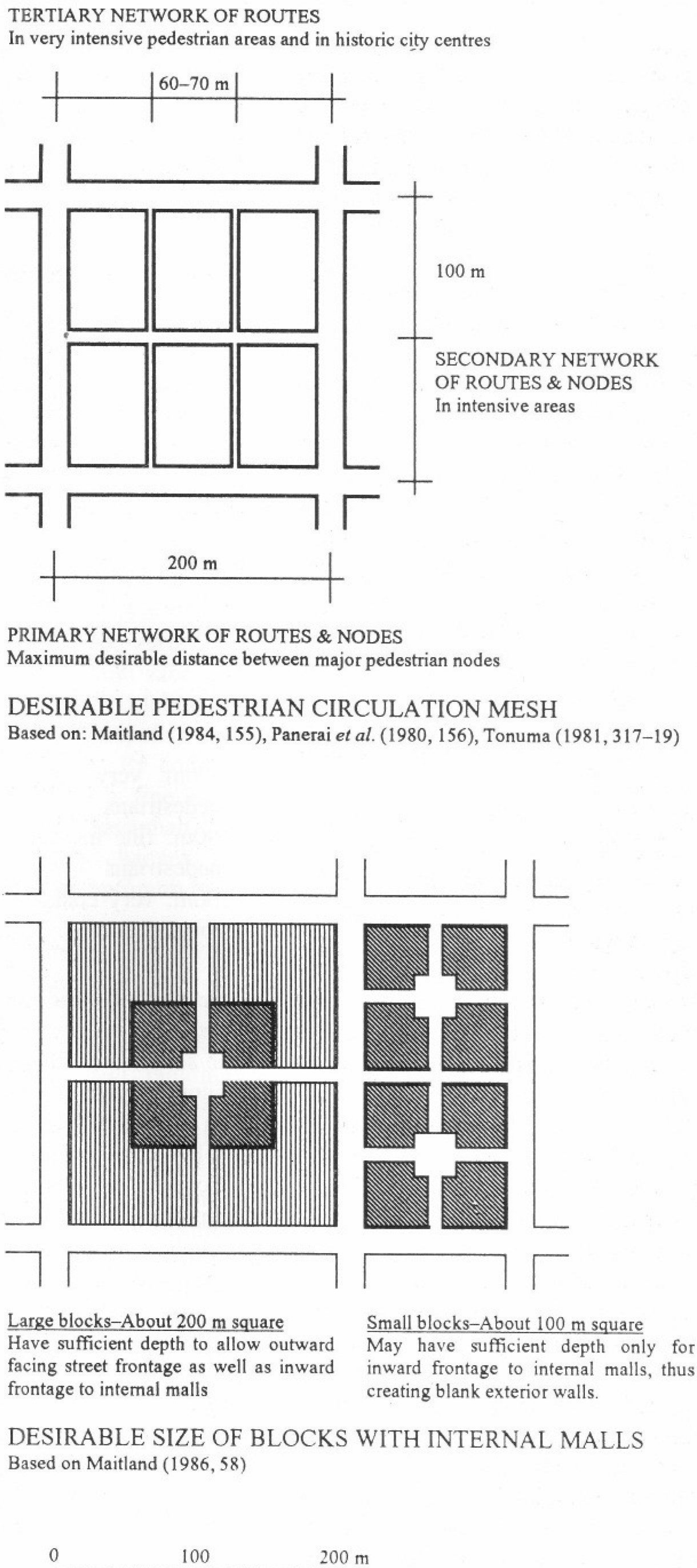

Figure 2. Factors influencing block size.

The study sought to examine the effect of different block sizes and forms on the nature of urban development in terms of land parcelling, building forms, circulation patterns, and partly also land-use patterns within the block. Both evolution and aspects of present form and performance were analysed. The four evolutionary aspects considered were: (1) addition or deletion of streets and public spaces, and the creation of sub-blocks or amalgamated blocks; (2) insertion or deletion of such features as alleys, arcades, and public spaces within blocks, and their effect on overall circulation patterns; (3) subdivision or amalgamation of lots, and their effect on block structure; and (4) compatibility of lot sizes and shapes with changing building forms, and the process of their mutual adjustment.

The four aspects of present form and performance that were considered were: (1) mesh size of the circulation networks for pedestrians and vehicles, as produced by the spacing of routes and their method of operation; (2) lot sizes and forms, and their suitability for development; (3) patterns of land use and activity within blocks; and (4) building forms and their collective effect on the block fabric and urban fabric.

All aspects were examined only in so far as they are affected by block form and size. Thus the analysis of circulation patterns is confined to the layout and spacing of the route network, and does not cover such matters as traffic volumes, capacities, and accident rates. To make the study manageable, certain aspects were not included; for example, solar access and microclimate considerations; detailed built form and site use implications; the perceived inconvenience by pedestrians and motorists using circulation networks; and the effect of planning regulations in assisting or preventing lot subdivision and/or amalgamation.

The changes made to the initial layout in the subsequent evolution of the city were obtained from historical maps, records, texts, illustrations and photographs. Historical maps, showing street and block layout, lots, and preferably also buildings, were the prime sources. The present form and performance of the block and town pattern were studied by using contemporary maps showing streets, blocks, lots and buildings; reports or articles describing past and present operation, performance and trends; and personal field observations, photographs and other illustrations of the study areas.

Qualitative and quantitative analyses of the individual and relative performance of the selected cities were undertaken to reveal common traits, 'cause-and-effect' relationships, and recurrent features and processes that demonstrate some general validity. It must be emphasized that the performance assessments are comparative and relative, rather than absolute. Wherever possible, firm theoretical criteria were used—for example, the desirable pedestrian mesh sizes stated in Figure 2 were used as yardsticks in evaluating performance as follows:

60–70m: very fine meshed - optimal for pedestrians
c.100m: fine meshed - very convenient for pedestrians
c.200m: very coarse meshed - inconvenient for pedestrians.

Indicators of good performance often only emerged from the case studies themselves, with some cases then serving as benchmarks for comparative observations. The use of the term 'optimum' also has relative rather than absolute connotations. Mostly, it was applied to conditions which represent the best compromise between opposing tendencies, for example between pedestrian and vehicular requirements in circulation mesh.

Relative and optimum performance: findings

The study revealed that block size and form have crucial and predictable effects on subsequent evolutionary patterns. Extensive alterations to the original layout can occur through successive modifications, often by unco-ordinated actions of individuals, fortuitously leading to optimal collective patterns over time.

In cities with small or medium initial blocks the street and block layout has remained intact, whereas in cities with large initial blocks the layout has been considerably modified by the addition of streets and alleys, creating smaller blocks and sub-blocks. For example, Adelaide's huge original blocks now contain four or five smaller blocks ($5200m^2$ to $19\,500m^2$); Perth's original blocks now contain two or three smaller blocks ($9600m^2$ to $19\,200m^2$); and several Toronto blocks have been split into sub-blocks ($3000m^2$ to $18\,000m^2$).

The addition of streets, alleys, arcades and pedestrian systems has altered the circulation mesh of the original layouts. Cities with large blocks (Perth, Adelaide, and Toronto) have considerably reduced their mesh size, and cities with medium blocks (Melbourne, Brisbane, Chicago, and Indianapolis) have partly reduced their mesh size. By contrast, cities with small blocks and a fine initial circulation mesh (Portland, Savannah, and Seattle) have undergone few changes, and can be regarded as having an optimum block size.

The findings on present form and performance are presented under four headings. These are: block size, form and layout pattern; circulation pattern and mesh; lot and land-use patterns; and buildings, block fabric and urban fabric. Under each heading two kinds of findings are identified: first, those block forms and dimensions whose performance has been optimum in certain aspects or circumstances of urban development; and secondly, the predictable consequences and processes caused for subsequent development by other block forms and dimensions.

Block size, form and layout pattern

Optimum performance:

- Small or medium blocks, in the range of $3600m^2$ to $20\,000m^2$, are more suitable for the general functioning of city centres than larger blocks;
- Layouts with rectangular blocks contain more block area in proportion to street space than layouts with square blocks, provided street widths are similar. Which of those forms is considered optimum depends on the desired balance between different aspects of performance - for example, layouts with square blocks will maximize circulation space, whereas rectangular blocks will maximize developable land.

Predictable consequences:

- Large blocks, over $20\,000m^2$, will be broken down, over time, into smaller blocks or sub-blocks, and will develop irregular patterns within the block (Figures 3 and 4).

Circulation pattern and mesh

Optimum performance:

- Layouts with small blocks produce finer-meshed circulation networks than layouts with large blocks. The number of intersections, affording change in travel direction, is a good indicator of the level of circulation convenience. Within a reference area of 800m x 800m, the initial layout of Portland had 110 intersections, Chicago 42, Melbourne 28, but Adelaide had only 12 (Figure 5);
- Street spacings of 80–110m offer a circulation mesh which is convenient both for pedestrian and vehicular movement, even with one-way traffic flows;
- Finer-mesh pedestrian networks, of 50–70m, are appropriate in areas of intense pedestrian activity, particularly in the retail core blocks.

Predictable consequences:

- Layouts with a coarse initial circulation mesh will develop finer-mesh networks by the addition of streets, alleys and arcades

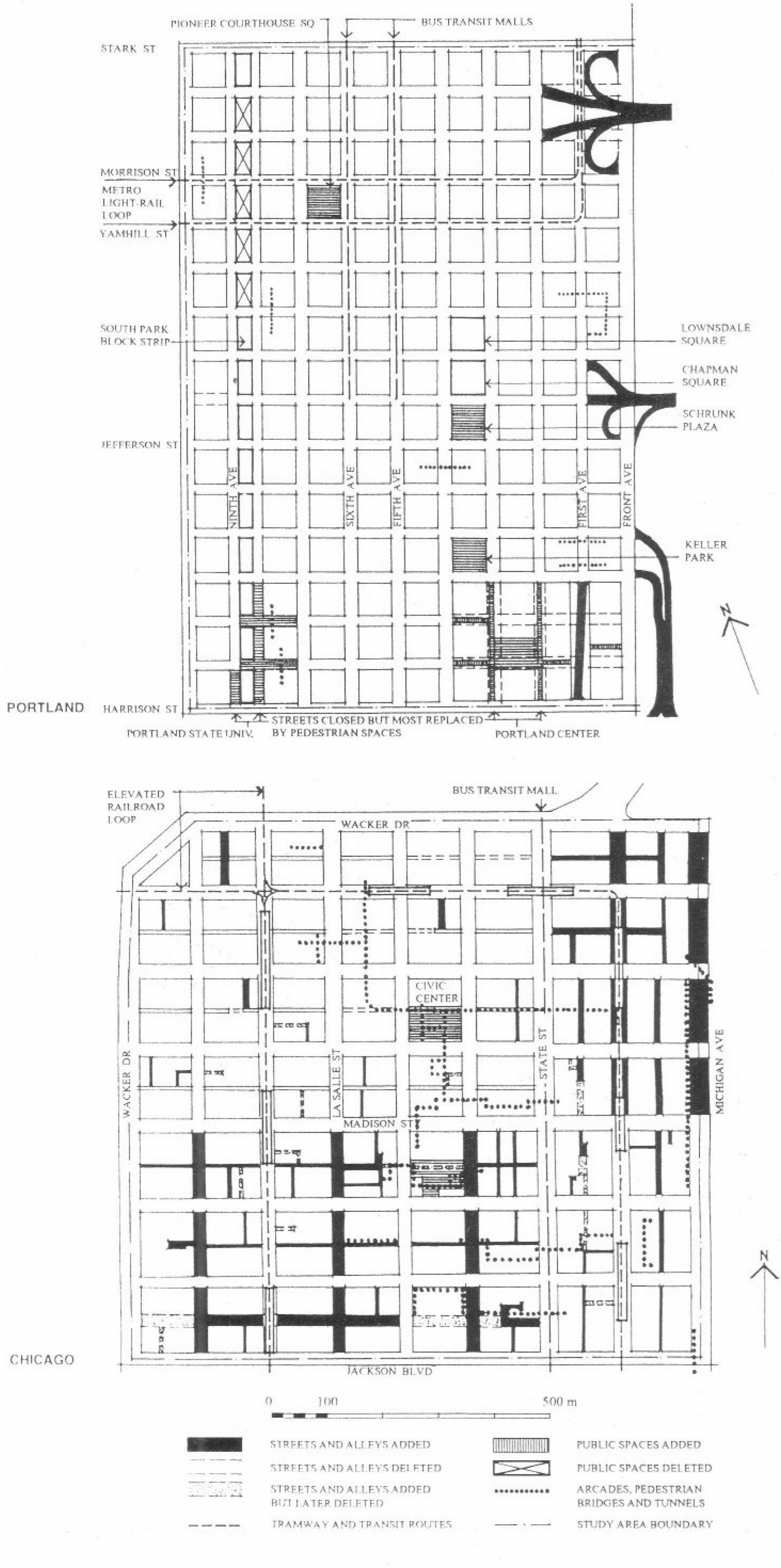

Figure 3. Modifications to original layout in cities with small and medium square blocks.

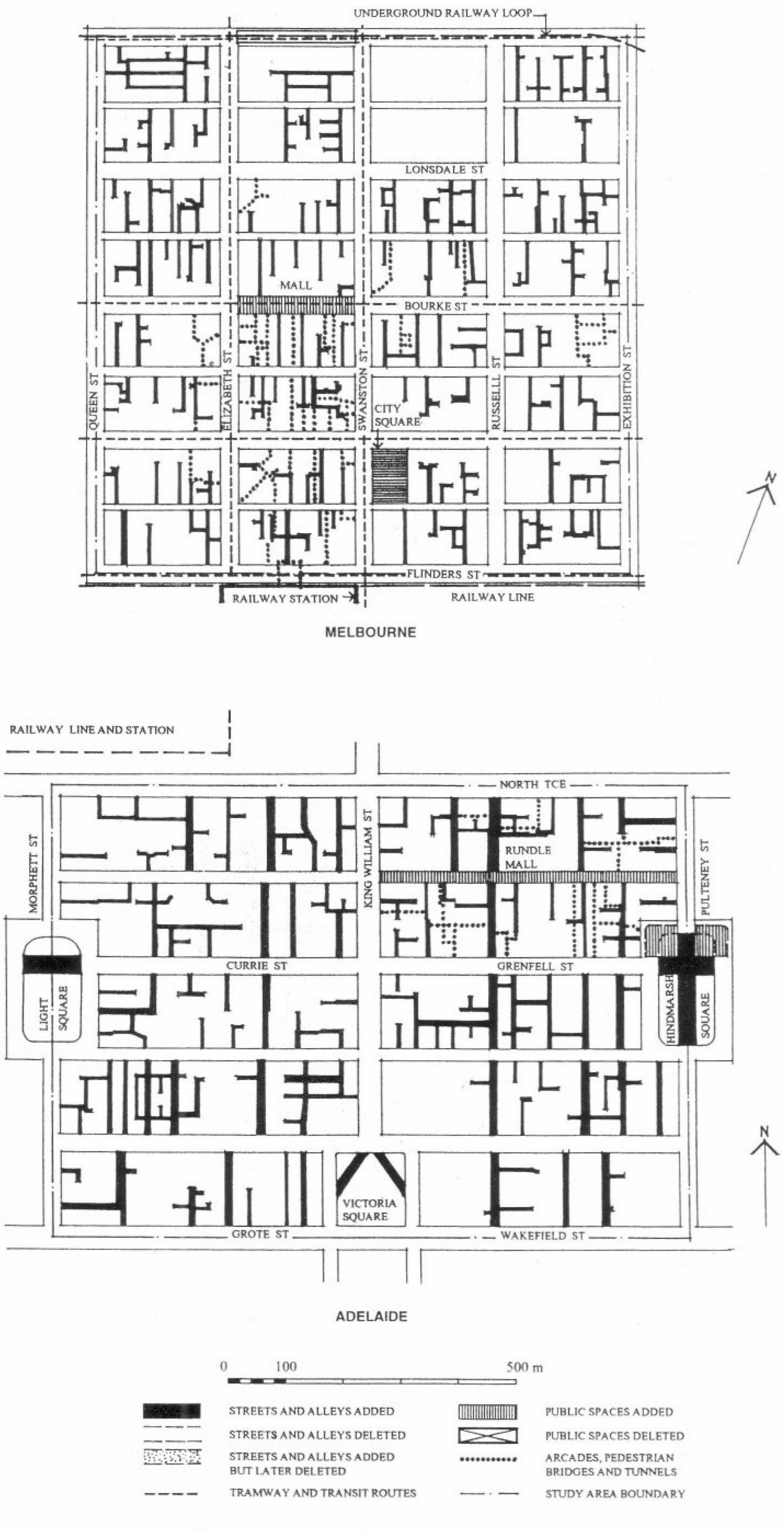

Figure 4. Modifications to original layout in cities with medium and large rectangular blocks.

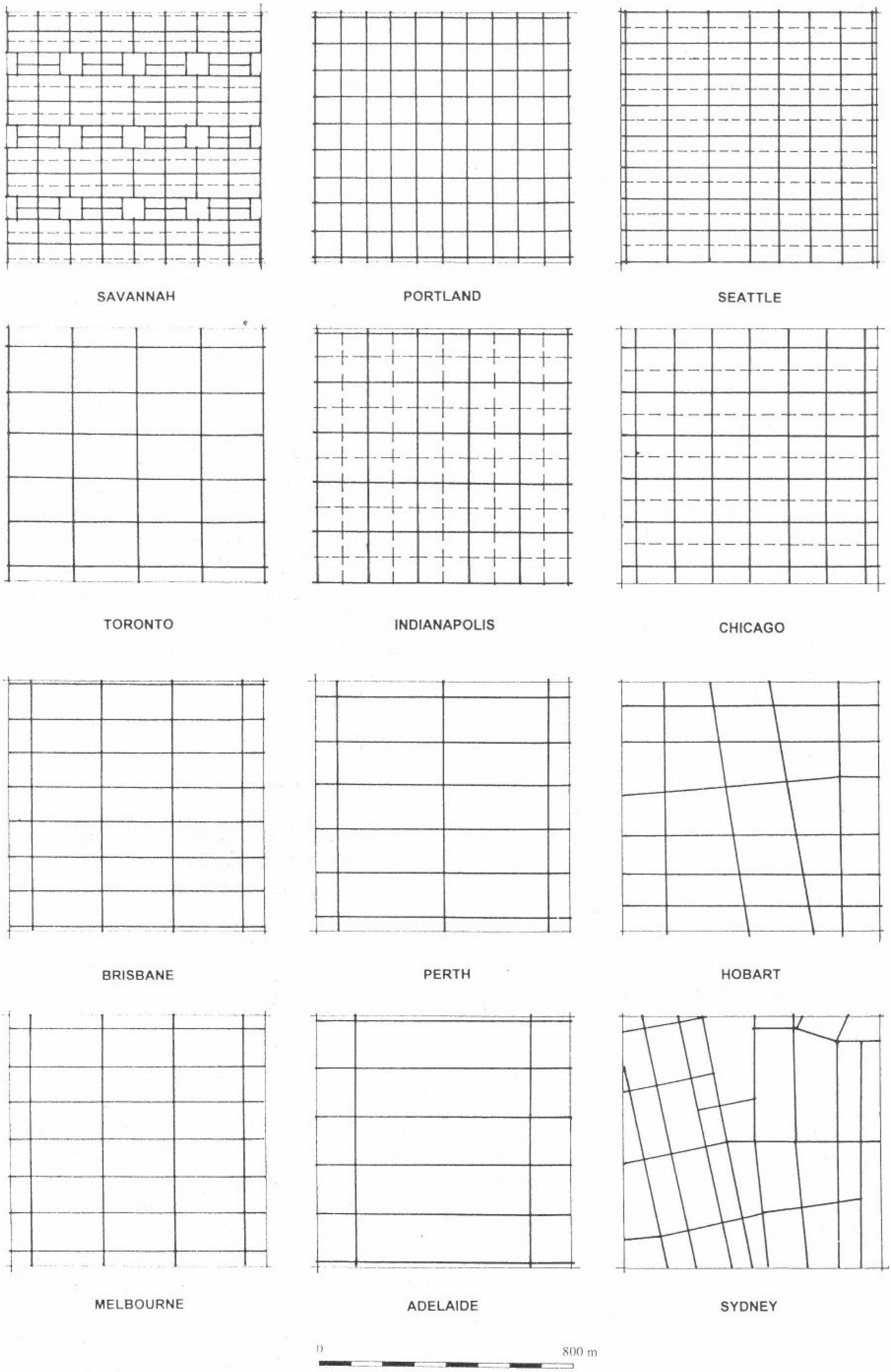

Figure 5. Comparison of original layouts.

within the initial street network. Thus Adelaide's coarse initial mesh (554m x 154m) has been reduced to a finer mesh of 60m x 70m in its retail core, and about 220m x 154m generally. Through-lots facilitate the insertion of lateral alleys and arcades - within Perth's blocks of over 300m in length, and Melbourne's blocks of 200m in length, the mesh in the retail cores is now as fine as 46–80m (Figures 3 and 4, Table 1).

Lot and land-use patterns

Optimum performance:

- Layouts with small blocks provide a greater total length of block perimeters within the same area than large blocks;
- Square blocks that have 4 or 8 lots produce more orderly lot amalgamation patterns than rectangular or square blocks that have more than 8 lots, because they encourage lot amalgamations into regular quarter-block and half-block parcels (Figures 6 and 7);
- Back alleys assist subdivision of deep lots by providing access to new back lots, and help to maintain distinct half-block units, when lots are subdivided or amalgamated.

Predictable consequences:

- If the whole perimeter of the block is not divided into equal lot frontages initially, subdivision will occur along the wider lot frontages;
- Through-lots assist subdivision into two back-to-back lots using both street frontages;
- Wide lots are usually subdivided into two, three or four fractional lots, but deep lots require the insertion of alleys to open up the land for more intensive development;
- Blocks with different lot widths along their sides, and/or fronting streets and public places with markedly different character, may become differentiated in their land-use pattern. Such differentiation is reinforced by the presence of alleys and sloping land.

Buildings, block fabric and urban fabric

Optimum performance:

- Lots 15–20m wide and 30–40m deep constitute good modular units for most city centre developments. As individual sites, they suit most small-scale traditional and contemporary building forms, and two lots can be amalgamated to form squarish parcels, with 30–40m sides, which suit extensive and medium-rise buildings;
- Site amalgamations of 3600–6400m^2, equivalent to the square blocks in Portland and Seattle, are satisfactory for most large or high-rise buildings (Figure 6);
- Small square blocks, with lot patterns amenable to the creation of quarter- or half-block parcels, tend to produce more regular patterns in their block fabrics than larger rectangular blocks, particularly where tall buildings occur (Figures 6 and 7).

Predictable consequences:

- Incompatibilities between lot size and building forms are resolved by developing new building forms in response to constraints posed by lots, or by creating new lots through subdivision or amalgamation in response to required building forms.

Conclusions

The comparative analysis of North American and Australian city centres that have different block forms and sizes in their initial layouts, has demonstrated that certain block forms and dimensions are better suited to particular aspects or circumstances of urban development. Small square blocks, of about 60–80m, perform better than larger blocks because they produce finer-mesh circulation patterns, more potential lot frontages, more coherent block fabrics and finer-grained, continuous urban fabrics, both with low-rise

Table 1. Comparison of street spacing in original and modified circulation mesh sizes. Dimensions are in metres between centre lines

City	Original mesh		Present pedestrian mesh			
	Street spacing		Generally		In retail areas	
	N-S	E-W	N-S	E-W	N-S	E-W
Portland	85	79	85	79		
Savannah	110	79	91-110	35-79		
Seattle*	93 -130	98	93-130	98	65	49
Chicago	122	140	122-140	140-141	61	70
Indianapolis	158	158	158	158	79	79
Brisbane*	221	111	221	111	73-110	55
Melbourne	231	116	77-116	116	46-58	116
Toronto	201	140	201-282	87-150	100-140	75
Perth	332	141	150-201	131-141	50-80	131-141
Adelaide	554	155	60-380	155	60-160	70-155
Sydney	51-127	151-360	51-127	151-281	51-127	60-94
Hobart*	98-157	128-224	98-157	128-224		

* Grid angled to cardinal directions

and high-rise buildings. Circulation meshes with a spacing of about 80–110m constitute an optimum network for both pedestrian and vehicular needs, and finer-mesh networks, with a spacing of about 50–70m, are the optimum in areas of intensive pedestrian activity.

The study has identified certain factors and processes which enable layouts of lots, blocks and streets to be modified over time. First, the intensification of development within large blocks, and the creation of optimum blocks and circulation meshes, occurs by the insertion of streets, alleys and arcades. Secondly, large lots are subdivided into orderly patterns of fractional lots, but the subsequent amalgamation of lots occurs in less orderly patterns. Thirdly, lot location and topographical conditions can create differentiated land-use patterns within the block. Fourthly, particular lot, block and street forms and configurations can assist, or prevent, certain types of development of block and layout patterns.

The study has also confirmed and refined the findings and theories of previous research studies. The findings of Moudon (1986) for residential blocks - for example, that small lots produce more predictable building forms and fine-grain block fabrics, and that large, deep blocks are intensified by inserting alleys and subdividing the block interior - have been shown to be generally valid also for city centre blocks.

The expectation of Brown and Johnson (1985) that certain patterns of land division produce similar urban forms, and that for this reason different cultures might generate similar urban forms, was also confirmed. For example, similar block and lot forms have evolved in similar ways in Toronto, Canada and Adelaide, Australia.

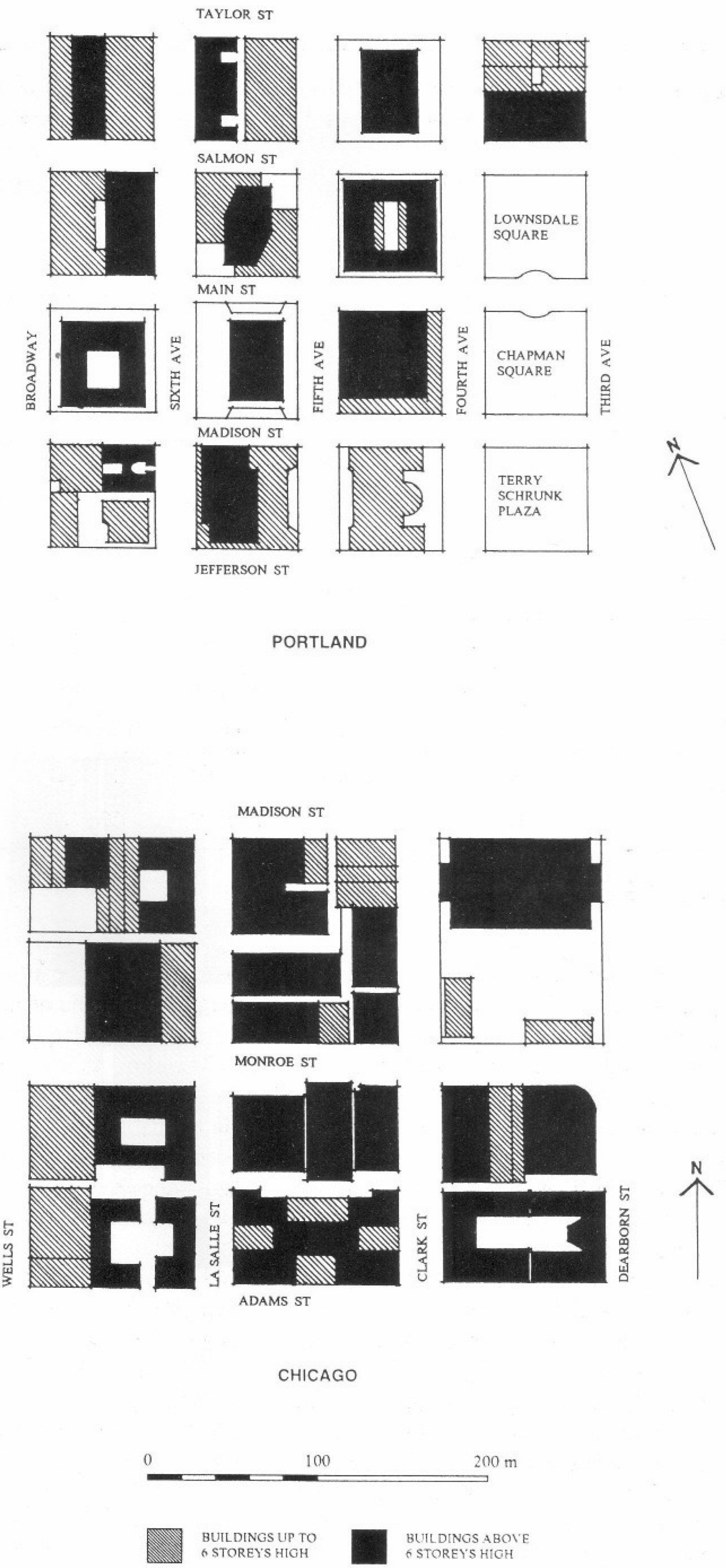

Figure 6. Typical block fabrics in American cities with square blocks.

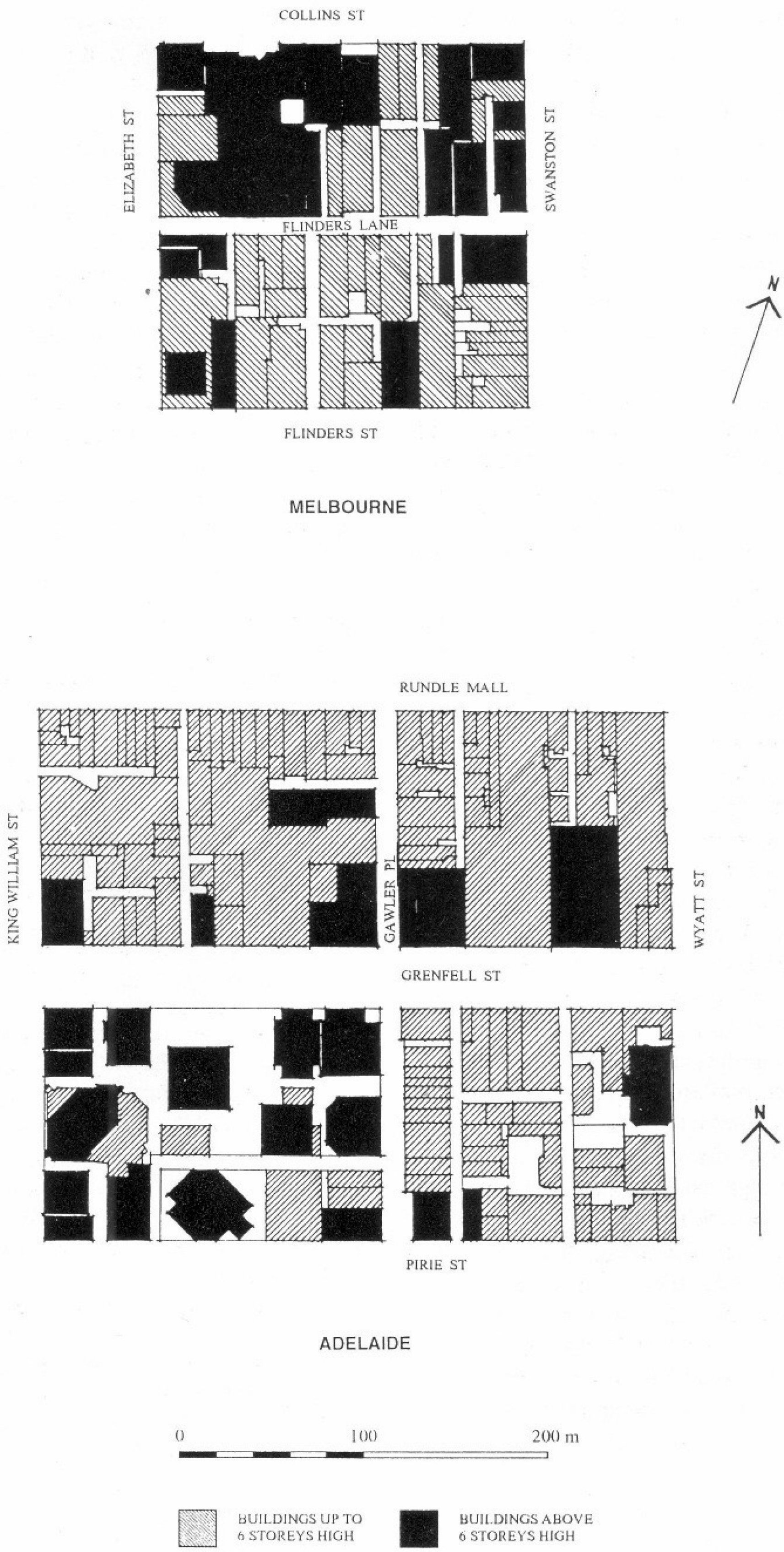

Figure 7. Typical block fabrics in Australian cities with rectangular blocks.

The compatibility with the findings of Maitland (1984, 1985) on pedestrian route mesh, and his theory of 'minimal urban structure', is more problematic. While several American and Australian city centres (Savannah, Seattle, Brisbane, and Melbourne) conform to the 200m spacing of primary pedestrian routes and the 100m spacing of secondary routes postulated by Maitland (Figure 2), others (Chicago, Indianapolis, Adelaide, Perth, and Toronto) significantly depart from these dimensions. However, Maitland's suggestion that, in areas of high-density development, pedestrian routes and nodes should be closer than 100m, was confirmed and refined by the study's finding that some city centre retail cores had pedestrian networks at average spacings of 50–70m.

The study findings support the initial hypotheses. Given similar urban purposes and processes, layouts initially having different lot and block sizes and forms have tended, over time, towards similar patterns of land parcelling, building forms, and circulation routes. Furthermore, certain forms, sizes and arrangements of lots, blocks and streets have been more adaptable, and have performed better for both past and present development requirements. The tendency towards similar patterns is more marked in cities which share some aspect of initial block form, size or structure. For example, the presence of through-lots in Melbourne and Perth produces similar arcade patterns. Some tendencies are apparent in several cities - those with large or medium blocks have all developed finer pedestrian circulation meshes, approximating those initially provided in cities with smaller blocks. Others are found in all cities - for example, the amalgamation of land parcels, and the coarsening of vehicular circulation mesh due to one-way traffic systems.

The main value of this study is its comparative nature. It could pave the way for similar investigations covering city centres with similar or different block sizes and forms, particular city centres in more depth (cf. Moudon, 1986), and centres with different layout, cultural and performance characteristics - for example, centres planned on a super-block pattern, or primarily used by pedestrians and cyclists. Another related line of investigation would be the simulation of the future evolution of block sizes and forms in centres. The identification of optimum forms also suggests that they might be used as 'models' for the laying out of new centres and for improving existing centres. If certain block forms have worked well, or have produced particular effects in the past, there is a reasonable expectation that they will perform similarly in other cases in the future.

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