THE THEORY OF CITY DESIGN.

By G. H. Knibbs, F.R.A.S.,
Lecturer in Surveying, University of Sydney.

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1. Introductory—The duty of designing and setting out an important city, is one which, in the near future and in the ordinary course of things, will be cast upon the Commonwealth of Australia. An elaboration of the principles which should govern the design of such a city, and a statement of the several matters which call for systematic consideration in connection therewith, is therefore not inopportune. Neither is it of small moment. Such an office as the creation of a capital city, practically unhampered by any conditions of existing settlement, and

1 The Federal Capital.
limited only by the topographical features of any selected site, is a unique one in the history of a country: the manner in which that office is discharged is of an importance which can hardly be overstated. A capital city, its general design, its utilitarian and aesthetic features, constitute an enduring index of the intelligence and foresight, the nobility of the sentiment, and the dignity of the artistic idea of the people creating it. The achievement must necessarily depend mainly upon two things, one the state of technical preparation, the other what may be defined as the moment of our aesthetic consciousness. Faultless technical knowledge is not in itself sufficient. It is, as it were, merely the instrument necessary for the proper realisation of the higher element; and if a city is to awaken in the beholder a distinct impression of its beauty, if it is to be in this respect one of the silent, subtle, but none the less high and powerful influences on the people who create it, and their descendants, then the artistic apperception, and the recognition of the dignity of the task, must be correspondingly vivid, and the outlook broader than would be dictated by mere utility.

The question of the normal elements of motivity I do not, of course, propose to discuss. The beauty and magnificence already realised in some cities are sufficient to remind us that no poverty of conception or present limitation should operate to make it forever impossible to create a beautiful city. It is therefore all-important that the city-designer shall take cognisance of what has already been attained, and further that as far as his instinct of prescience will allow, he shall anticipate the requirements and probable developments of the far distant future.

What I do propose to discuss, are those things that must necessarily command technical attention by way of preparation for what lies before a people when called upon to create a capital or other important city; and shall assume as given, a suitable site or sites, with its sine qua non, an abundant water-supply.

2. General idea of a city.—In order that the concentration of human activity, which is the essential feature of the aggregation
of human beings in a city, shall be of the highest efficiency, it is necessary that the lines of intercommunication between the buildings, forming as it were the real theatres of that activity, and also between them and the lesser centres of outlying territory, shall be the shortest possible, and therefore the most convenient. This is nothing more nor less than the affirmation that all systems of roads and streets should provide the greatest possible number of ‘short cuts’ from place to place, and thus economise as far as can be, human effort in the transaction of business, and in all other features of city life. The other element of importance is the appropriate localisation of the various types of industrial and other activity, so that the necessity for intercommunication itself, shall be reduced to a minimum. These two elements, viz., the street arrangement, and the determination of the purposes for which the blocks so formed shall be available, are the most fundamental in the development of a city-design. It is at once evident that both are greatly influenced by the topography of the site; a general disposition of streets and buildings which might be most suitable for one site, might be wholly unsuitable for another with different topographical features: any discussion of principles therefore can lead only to general results: these must, in any application, be taken as a general guide, to be modified as occasion demands. It is of course impossible to produce in detail an ideal design applicable to every site.

3. Radial street-system.—If one glances at any territorial map shewing towns and the roads leading therefrom to other similar aggregations of settlement, it becomes at once evident, that the lines of communication are on the whole radial, that is they tend to occupy the direct lines joining any one centre with those surrounding it: if diverted therefrom, it can be only because of topographical difficulties, or through the arbitrary interferences of the boundaries of real estate, or else from mere caprice. Any four centres forming, say a quadrilateral figure, would be united, not merely by the lines constituting the boundaries of the quadrilateral, but also by the lines forming its diagonals; at least unless
some element existed to hinder this. It is obvious from what has been said that the rectangular system of roads and streets so much in vogue in the States of Australia, is inconsistent with what may be properly called, not merely the natural position, but also the position of maximum efficiency; for to travel by any but the shortest way except for some adequate reason, is to waste effort.

Given a number of streets radiating from a centre, the shortest system of lines for connecting them one with another will be such as make equal angles with each radial pair: consequently the scheme of cross-streets, necessary to complete the radial system proper, will form a sort of ring-system, or else a polygonal system, like the lines on a geometrical spider's web.\(^1\) This is not identical with a diagonal system, properly so called, as a reference to the illustrative figures hereinafter, Figs. 1 to 5, will shew. A definite numerical comparison of the relative merits of the various systems in respect to shortness of path of travel from place to place, may be readily obtained, and will serve to fix our ideas. The two squares, Figs. 1 and 3, and the three circles, Figs. 2, 4, 5, have the same area, the length of the side of the square therefore being \(\frac{1}{2}\sqrt{\pi}\), when the diameter of the circle is unity. In each figure therefore the same area is commanded by the series of lines, which may be taken to represent streets. The two elements of importance are, (a) the total length of street to be provided, and (b) the

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E—Sept. 4, 1901.
mean distance of travel from all points to the centres, which are denoted by the letter C. The following table gives the results absolutely, and also in percentages.

I.—Mean distances of Travel and Total Length of Street.

<table>
<thead>
<tr>
<th>Fig.</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Distance</td>
<td>443</td>
<td>446</td>
<td>378</td>
<td>348</td>
<td>361</td>
</tr>
<tr>
<td>Total Length</td>
<td>5·317</td>
<td>5·142</td>
<td>7·824</td>
<td>7·142</td>
<td>6·142</td>
</tr>
<tr>
<td>Mean Distance %</td>
<td>100, say</td>
<td>100·7</td>
<td>85·4</td>
<td>78·6</td>
<td>86·0</td>
</tr>
<tr>
<td>Total Length %</td>
<td>100, say</td>
<td>96·7</td>
<td>147·1</td>
<td>134·3</td>
<td>115·5</td>
</tr>
</tbody>
</table>

On looking through this Table (I.) it is evident, first that (2) is better than (1), for while the mean distance of travel is increased only seven-tenths per cent., the total length of street is reduced about 3½ per cent. Hence for similar areas the ring form has an advantage over the rectangular, in respect of reducing the total length of street to be provided in a given area, and consequently any approximation to the ring form will exhibit the same feature.

In order to shew more clearly the relationship between mean distance and total length of street to be provided, Table (II.) is computed, shewing absolutely, and also in the form of a percentage as compared with the rectangular system, the ratio of the total length of street to the mean distance of travel to reach the centre C.

II.—Ratio of Total Length of Street to Mean Distance of Travel

<table>
<thead>
<tr>
<th>Fig.</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
<td>12·00</td>
<td>11·52</td>
<td>20·69</td>
<td>20·51</td>
<td>16·12</td>
</tr>
<tr>
<td>Percentage</td>
<td>100·0</td>
<td>96·0</td>
<td>172·4</td>
<td>170·9</td>
<td>134·4</td>
</tr>
</tbody>
</table>

A review of the figures in Table (II.) shews distinctly the advantage of (2) over (1); an angle of 90° is however too great between the radiating lines, so that any real consideration may be confined to (3), (4) and (5), that is to what may be called the 'diagonal' system, the octagonal-radial system, and the hexagonal-radial system. Comparing (4) with (3) it will be noticed first that there is a slight advantage for (4) in respect to the street.

1 The quantities are \( \frac{1}{4} \sqrt{\pi}, \frac{1}{2} + \frac{1}{10} \pi, (\frac{1}{2} + \sqrt{2} \sqrt{\pi}), \frac{1}{4} + \frac{1}{2} \sqrt{\pi}, \frac{1}{4} + \frac{1}{2} \pi. \)

2 Similarly \( 3 \sqrt{\pi}, 2 + \pi, (3 + \sqrt{2}) \sqrt{\pi}, 4 + \pi, 3 + \pi. \)
lengths: secondly that there is only half the number of acute angles (45°), so that the ‘octagonal-radial’ is distinctly preferable to the ‘rectangular-diagonal’ system. The most striking advantage is seen however in (5). Table (I.) shews that in respect of travel-distance it is practically equal to the diagonal system, and but little inferior to the octagonal-radial system; while in respect to street-length it is vastly superior to either: and still further, it gives altogether better angles, viz. 6 angles of 60° instead of 8 angles of 45°. We conclude therefore, that in order to secure the greatest advantage as to distance of travel, in a radial scheme of streets, the angles between the radiating lines should be approximately 60°, and that the cross-streets should be approximately symmetrical with respect to the centre: and further that such arrangement is to be preferred to the rectangular, so far at least as shortness of communication is concerned. This is very strikingly brought out on comparing (5) with (1). The total length of streets is increased only 15½%, while the mean distance of travel is reduced as much as 14%; in other words the reduction of distance of travel is practically identical with the increase of street-length! The radial system, pure and simple, has however some limitations which will be later considered, it is sufficiently clear that there should be points from which streets should radiate in all directions.

4. Position of Radial Centres.—The first point to be decided in elaborating a design for the streets of a city, is the position of what may be called its chief radial-centres, and its main lines of street. A concrete idea of what is meant by chief radial centres, would be reached by regarding such centres as the Capitol and the White House at Washington; or the Arc de Triomphe at Paris, between the Avenue de la Grande Armée and the Avenue des Champs Elysées. They may be defined as the centres round which either particular types of, or even general activity, will tend to concentrate, or they may be centres of aesthetic or intellectual interest, and it is obvious therefore that they should, as a rule, lie on the leading lines of communication between one place and
another: in fact the lines joining the centres, and the prolongations of such lines, ought to be the main arteries of traffic—the leading streets of the city. The position both of the centres and the main streets, are consequently dependent, partly on the topographical limitations of the site, partly on the position of outlying centres and the existing or potential roads and railways thereto, and partly also upon the suitableness of certain localities within the site for the special purposes or activities, for which provision must be made. The selection of the position of the chief radial-centres, requires therefore not only a comprehensive view of the administrative, educational, industrial, residential, military, and other needs of a capital city, not only a due regard for its communication with the outer world and for all the contingencies both in times of peace and war, which that communication involves, it requires also a nice appreciation of the topographical adaptabilities of the site, so that in the design the interdependence and mutual influence of every element shall be fully estimated and the general arrangement made the most convenient possible, and therefore the most economical; and further that it shall be such as will admit, without detriment, of that expansion which the future will certainly require. Upon an accurate perception of the best treatment of the site, the economy of the creation of the city will largely depend; and it is but proper that one should desire to have as perfect a result as possible for any given expenditure. This is a point to which we shall later return.

The grouping of activities having many points of contact, or common features, and the locating of one or more groups round a suitable point, as round a radial-centre, is so obviously desirable as to need no advocacy; and when a city can be designed without the embarrassments created by pre-existing occupation, there can be nothing to prevent such grouping, in any form conceived to be desirable.

Thus the housing of parliament, and of the great departments of official administration, might very properly be grouped around one centre, those having most frequent need of intercom-
munication being the nearest together: a university and its affiliated colleges might create another centre: technical and high schools still another: an aggregation of great commercial institutions yet another: and so on. Then again the industrial occupations which would develop, might with advantage be relegated to one quarter of the city, the large commercial houses to another, while the environs would normally constitute the residential sites, variously disposed according to the classes of residence allowed to be erected. The study, in the original design, should embrace all possibilities of extension for even remote periods, so far, at any rate, as they can be foreseen; and the control of settlement should also be sufficient to ensure the possibility of ultimate conformation to the first ideal, even if for any sufficient reasons it be temporarily abandoned.

5. Combination of radial and rectangular street-systems.—A rigid conformity to the hexagonal-radial system for the streets of a city, would constitute them three series of parallel lines, intersecting one another at an angle of 60°, and dividing the whole site into equal equilateral triangles, while the rectangular system consists of two sets of parallel lines intersecting at 90°, and dividing the area into squares. The greatest distance to be travelled in passing from any one point to any other, cannot in the former case be greater than the direct distance multiplied by the secant of 30°, nor in the latter than the direct distance multiplied by the secant of 45°. Calling the direct distance 100, the maximum distances of travel are

<table>
<thead>
<tr>
<th>System</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct distance</td>
<td>100.00</td>
</tr>
<tr>
<td>Hexagonal system</td>
<td>115.47</td>
</tr>
<tr>
<td>Rectangular system</td>
<td>141.42</td>
</tr>
</tbody>
</table>

It might be thought therefore that the advantage in favour of the hexagonal system is so pronounced as to exclude the adoption of the rectangular altogether. It has always been felt, however, that the rectangular system, has from the point of view of building construction much to commend it; it gives too, a better sense of orientation in regard to travelling through a city; hence it may
very well be combined with the hexagonal and other forms of the radial system. Again it may often happen that the convergence of only six roads upon one point is inadequate. For example, in Paris at the Arc de Triomphe there are no less than 14 avenues or streets converging, at the Place de la Bastille 10, at the Place de la Nation 9: in Washington at the Capitol there are 11 long convergent streets, and 8 and 10 in other places in the same city. When therefore a centre is of more than ordinary importance, it may be as the site of some great establishment or monument, or as the theatre of intense business activity, the number of convergent streets may be increased from say 6 to 12, and such a centre properly constitute a focus both of the radial and rectangular systems combined. The City of Washington is an illustration of the rectangular combined with the radial system, the former preponderating, see Fig. 6. (See Fig. 9 for polygonal radial system.)

![Fig. 6](image-url)

When it is considered that the importance of securing the full advantage of shortness in path of travel from point to point diminishes as the total amount of traffic in any street diminishes,
it will be realized that as long as the radial system is sufficiently employed for reducing the distance from all parts to the principal centres, and for bringing into prominence such aesthetic features as great public buildings and monuments, the substantial benefits of the system will have been secured. The adoption then of the rectangular system for the balance of the design, modified only under the compulsion of meeting topographical difficulties, will admit of the advantages of that system being also fully exploited.

6. Curved Streets.—On an undulating site, a strict adherence to any general and supposed ideal scheme for the system of streets is, as just indicated, often impracticable, because of the resulting severity in the gradient of some of the streets. Conformity to the fundamental design should therefore not be inflexible. If modifications of, or departures therefrom, will avoid the difficulty, there can be no valid reason for hesitating to make them, and such positions for the streets as would give uniform gradients might very properly be selected on conical hillsides, and round the heads of small valleys. This selection will involve the introduction of a curved form for the streets, and it may be occasionally, even the adoption of the zig-zag form. The use of curved streets is to be regarded not only as proper means for the alleviation of gradients, but also as an element in the design, capable of enhancing its merit as regards variety and artistic effect; especially in situations where traffic considerations are of less than average moment. The rigid adherence to straight streets and a rectangular system, characteristic of towns in the States of Australia, is a signal defect in the prevailing ideas of city-design: and its abandonment in favour of an independent treatment of each site, and an adoption of a radial-rectangular system would be distinctly beneficial even for villages. But to return to the question of curved streets. In situations where traffic is concentrated, where too, street rail and tramways are required, and where moreover the necessity of ameliorating the grade does not exist, curved streets are a disad vantage. Where a lengthy street view is effective, as bringing into prominence a great public building or monument, curved
streets should also be avoided. It may here be noted on the other hand, that in an hexagonal radial system, if "ring-streets," as they have been called, are used to connect the radial lines (e.g. Fig. 5), there is a distinct advantage over a system of hexagons of the same area, the mean distance of travel to the centre being 8·25% more for the latter. Ring and curved streets may consequently be advantageously introduced, at any rate occasionally; and there can be no doubt therefore that they should form, if not a marked, at least a minor feature of any future design for a city.

7. Cardinal direction of rectangular streets.—The cardinal direction of streets, and for the orientation of buildings, is a question which must be studied in relation to the latitude of a site, and to the particular purpose to which buildings are to be applied. Between the tropics, the sun will occupy at some time of the year and day all points of the compass; his northern aspect for the whole year preponderating for places south of the equator, and his southern for places north thereof. Since in that zone his meridian altitude is great, and the meridian shadows are therefore short, the merits of a particular aspect have to be decided on somewhat different grounds to those which apply in temperate regions, where, as we depart from the tropics, there is a great disproportion between the whole lengths of the midsummer meridian-shadow, and the similar shadow in midwinter, and where also the sun at noon is not at one time north of the place of the observer, and at another time south.

With a view to more clearly illustrating the nature of solar shadows on a horizontal tract of land, Fig. 7 has been prepared, for the nearest 5th degree of latitude to that of this city (Sydney), i.e., for latitude 35° S. The laws of position of the shadow of a vertical line may be thus defined for the temperate zone. For any one interval of time before or after apparent noon (i.e. the crossing of the sun over the meridian of a place) the terminals of the shadows on different days are points in a straight line which, produced, passes through a point defined by drawing a line from the elevated pole of the heavens through the top of the vertical line till it
meets the ground (supposed a horizontal plane at the bottom of the vertical line), the point P in the figure. For successive hours of the day, i.e., before or after noon, the terminals of the shadows lie on the corresponding straight line meeting at this point. At the equinoxes, the successive positions of the shadow-terminal during the day lie on a straight line running east and west.

Fig. 7.
through the point defined by the terminal at noon, the point $E$ in figure. At any other time, *i.e.*, between the equinoxes and the solstices, the shadow-terminals on any day lie on an hyperbolic curve, whose vertex is defined by the position at noon, and whose asymptotes intersect at the equinoctial point $E$.¹

In the frigid calottes, or zones as they are called, the curves may become ellipses. Turning to the diagram, suppose a vertical line or pole to stand at $O$, Fig. 7, of the length, equal to $OX$, (*i.e.*, 1 foot or metre, or 100 feet or metres, or any other unit length): this vertical will be perpendicular to the plane of the page. In latitude 35° S., let the line $OP$ be placed true north and south: then the shadow of the south celestial pole will be the point $P$; and the noon-shadow of the summit of the vertical, say of the length of 1000 units, will reach the following points on the days indicated:—

### III.—Length of shadows at noon of a vertical of 1000.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer solstice.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec. 22</td>
<td>$O - S$</td>
<td>204</td>
</tr>
<tr>
<td>Jan. 19, Nov. 24</td>
<td>$O - J$</td>
<td>262</td>
</tr>
<tr>
<td>Feb. 19, Oct. 24</td>
<td>$O - F$</td>
<td>433</td>
</tr>
<tr>
<td>Mar. 21, Sep. 23</td>
<td>$O - E$</td>
<td>700</td>
</tr>
<tr>
<td>Apl. 21, Aug. 23</td>
<td>$O - A$</td>
<td>1057</td>
</tr>
<tr>
<td>May 22, July 23</td>
<td>$O - M$</td>
<td>1446</td>
</tr>
<tr>
<td>Winter solstice.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June 22</td>
<td>$O - W$</td>
<td>1629</td>
</tr>
</tbody>
</table>

At the hours afternoon denoted by the lines radiating from the point $P$, the shadow will terminate at the intersection with the curves $SS$, $JJ$, etc.; that is to say, on the 22nd December the shadow of the top of the vertical line will move along the curve $SS$; on 19th January and 24th November along the curve $JJ$, and so on, the shadow reaching the intersection with the curve of the line radiating from $P$ at the hour marked on the latter. If now a straight line be drawn from the point $O$ to this intersection, it will shew the length and direction of the shadow at any particular hour after noon.² The morning shadow for the

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¹ The declination change being disregarded, at least for each day.
² Measured of course by the unit height $OX$. 
same number of hours before noon will be a similar line on the other side of the meridian line WOXP, that is to say, if $\theta_t$ is the angle of inclination between the south line and the shadow, for the hours before or after noon, then the shadows direction is, in the former case $180° + \theta_t$, in the latter $180° - \theta_t$. The shadows will never lie outside the curves SS and WW, which are, therefore, the limiting curves of the solar shadows.

Referring to the diagram it will be observed that there are northerly shadows in the morning and afternoon, in the summer interval between the equinoxes, i.e. between the 23rd September and 21st March, but none northerly in the winter interval. The shadows are respectively west and east at approximately the following hours of the day, for the different periods of the year opposite each.

IV.—Solar shadows east and west (approximate) lat. 35° S.

<table>
<thead>
<tr>
<th></th>
<th>Dec. 22</th>
<th>Jan. 19</th>
<th>Feb. 19</th>
<th>Mar. 21</th>
<th>Sep. 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>h. m.</td>
<td>8:30</td>
<td>8:10</td>
<td>7:10</td>
<td>6:0</td>
<td></td>
</tr>
<tr>
<td>P.M.</td>
<td>3:30</td>
<td>3:50</td>
<td>4:50</td>
<td>6:0</td>
<td></td>
</tr>
</tbody>
</table>

If, therefore, a rectangular building have its sides directed to the cardinal points, then for six months of the year its southern wall will never have direct sunlight; so, also, the northern side of an east and west street. Table V, shewing the length of time the sun shines on the southern face of an E.—W. wall, brings this out more clearly.

V.—Length of time sun is south of east-west line, in either fore or afternoon. Lat 35° S.

<table>
<thead>
<tr>
<th></th>
<th>Dec. 22</th>
<th>Jan. 19</th>
<th>Feb. 19</th>
<th>Mar. 21</th>
<th>Sep. 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>h. m.</td>
<td>3:40</td>
<td>3:10</td>
<td>1:43</td>
<td>0:0</td>
<td></td>
</tr>
</tbody>
</table>

There is really no effective sunlight on the southern side of an E-W building for practically seven months of the year. Obviously the buildings and streets of a city should have as much direct
sunlight as any general arrangement will admit of, and the total absence of such for at least six months must be regarded as a serious defect. Nor is this fact modified by the necessity that may specially exist in some instances for deliberately avoiding direct sunlight. Evidently, therefore, the direction of the streets of a rectangular system should be placed in the N.E. and S.W., and N.W. and S.E. positions. The diagram will at once shew the effect of this, and the duration of direct sunlight on each face of a rectangular building, making angles of 45° with the principal cardinal points, will be as in the following table:

VI.—Duration of Direct Sunlight in Lat. 35° S., on each face of a rectangular building set S.E., N.E., N.W., S.W.

<table>
<thead>
<tr>
<th>Time of Year</th>
<th>Face of Building</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S.E.</td>
</tr>
<tr>
<td>December 22</td>
<td>4:50 - 11:10</td>
</tr>
<tr>
<td>Jan. 19, Nov. 24</td>
<td>5:0 - 11:0</td>
</tr>
<tr>
<td>Mar. 21, Sept. 23</td>
<td>6:0 - 10:0</td>
</tr>
<tr>
<td>May 22, July 23</td>
<td>7:0 - 9:0</td>
</tr>
<tr>
<td>June 22</td>
<td>7:10 - 8:50</td>
</tr>
</tbody>
</table>

The N.E. and N.W. faces have each eight hours of continuous sunlight; and the S.E. and S.W. faces have from 6½ to 1½ hours or a mean of four hours, which also is the duration of direct sunlight at the equinoxes. The signal advantage of this over the east-and-west and north-and-south positions needs no comment, and, since the case is similar in any part of the temperate zones, it may be affirmed that the cardinal directions of a rectangular system of streets should be inclined 45° to the meridian throughout that zone.

8. Width of streets.—The width of street desirable or necessary in different parts of a city is a question depending on various considerations. From the standpoint of economy of construction and maintenance, and from that of mere convenience in the conduct of business, the narrowest street that will serve the purpose, without intense congestion of vehicular and pedestrian...
traffic, is the best. From the sanitary and aesthetic standpoints, on the other hand, wide streets are to be preferred; these too, do not subject pedestrians to acute danger in crossing, and the risk of vehicular accident is correspondingly reduced. If provision is to be made for future means of mechanical locomotion, street rail and tramways, greater width will of course be required, a fact which argues the desirability of seeing that the necessities of the future in this respect are liberally anticipated.

It is evident at once, not only that the streets should as a whole be somewhat narrower both in the intense business centres, and in the less important parts of the city and its suburbs, but also that the general character of the city must affect the question. Therefore in a Capital city the aesthetic requirements are rightly regarded as of commanding importance, and utilitarian considerations as secondary, and properly subordinated to the last possible degree consistent with the fact that the general arrangements must of course be really practicable ones. Speaking broadly, the towns of the Commonwealth have been designed with small regard to aesthetic features, and the idea of avenues constituting an ordinary feature is practically foreign to us,¹ though not absolutely so. The magnificent example however of Paris suggests the propriety of the greater radial lines from the chief centres, forming boulevards. It may be questioned whether such examples as the Boulevarts Richard Lenoir, or de l’ Hôpital, or the Avenues des Champs Elysées, de la Grand Armée, or de Neuilly in Paris, the Boulevards du Midi, de Waterloo, du Régent, of Brussels, or the Unter den Linden in Berlin, can be lavishly followed. Still Australian experience has shewn that boulevards of considerable size² are appropriate and advantageous, and greatly enhance the beauty of a town.

Coming to actual dimensions, it may be said that lanes or streets of less width than say 10 metres or 33 feet (½ chain) are extremely undesirable. Unimportant roads and streets, so situated

¹ There are of course exceptions to this.
² E.g., Sturt Street, Ballarat.
that they can never become of importance, might be designed with widths of from 20 to 25 metres, or say from 66 to about 80 feet. Roads and streets of moderate importance, likely to require tramways, cycle paths, central footpaths, and so on, might be of still greater width, viz., of from 30 to 40 metres, or say of from 100 to 130 feet; while still wider streets, set out with avenues of trees, flower-beds, etc., might have any width of from 50 to 75 metres, or say from 160 to 240 feet.¹

With a suitable restriction as to height of buildings, such widths as have been suggested will not present any difficulties as to quantity of light, or as to suitable approach in cases of fire; while the abundant access of sunlight and the sufficiency of room for the planting of trees in the streets, makes it possible to ensure in the highest degree the fulfilling of the requirements of hygiene.

9. Localisation of the various types of streets.—Whatever care is taken, or however rigorous the control of occupation in the creation of a city, it is hardly practicable to ensure such a distribution as shall conform absolutely to that which might, having regard to the ultimate appearance of the city, be permanently sanctioned: to attempt it would, as a rule, involve excessive scattering of the population, or other injurious features. On the other hand any permitted departure from the distribution, deemed the best in the general interest, tends to establish itself, and there is the jeopardy that return to the original idea will be effectually resisted—a jeopardy that is by no means chimerical in a democratic community. This illustrates the signal importance of securing at the outset a disposition of the general settlement that shall practically accord with the ultimate intention, a result that involves not only the closest study of all the effects of the special localisation of the political, administrative, industrial, commercial, scientific, educational, residential, and military centres, but also an apperception of the reaction of each upon the other,

¹ The streets of Washington are from 80 to 120 feet, the avenues from 120 to 160 feet.
and a clear recognition of the possibilities of every practicable variation of the general design. Since the localisation of occupation involves localisation of the general characteristics of the traffic, and therefore of the particular type of street required, a methodical analysis of each possible variation of the design, in respect to its ultimate effect upon the health and appearance of the city, is essential in any attempt to guard against injury through the limitations of first or early occupation.

An important city is not mature even in a century; and the designer, if he is to leave a monument of the perfection of his work, in a general disposition which shall secure the possibility of it presenting permanently attractive features, must, while regarding everything from the standpoint of the remote future, regard it also in the light of present necessity, and only if his genius is equal to the task of harmonizing the two, will the result be satisfactory. During the first few decades it may be absolutely necessary, so as to suitably concentrate population, to allow development to proceed upon lines foreign to the ultimate intention, and to permit narrow streets to be substituted for wide ones. The design in such a case must contain an outline of such temporary modifications as cannot be avoided, in addition to the permanent features to which everything is finally to conform; and if settlement, on the lines of the temporary modification, be permitted only under clearly-defined and rigidly enforced conditions, ensuring return after a definite period to the original, no injury but on the contrary rather benefit will result, and one will not, as is so frequently the case, have to deplore the spoiling of the aesthetic possibilities of the site.

The interdependence of the types of occupation and of street, of settlement and of traffic, and the tendency of each to perpetuate itself without regard to the welfare of the city as a whole, involves, as we see, more than ordinary care in the arrangements of any city that is intended to be ideally beautiful, and no effort is wasted which has for its object the conservation of the higher
interests in such a way as to involve a minimum of alteration with its attendant expense and difficulty.

Outside such comprehensive considerations as the foregoing, the element of localising types of street depends solely upon their main function. For the leading lines of heavy traffic light grades are required, and widths proportionate to the ultimate magnitude of the traffic; special consideration is necessary to guard against inadequate provision at such points of congestion as depôts and freight-yards of all kinds, railway stations, and similar places. If the city is to possess a military centre, ample provision must also be made to facilitate the mobilisation and despatch of troops, war material, etc. The lighter traffic of merely residential streets involves less attention to gradient, their character depending solely upon their intended surroundings. For example, streets leading to each class of buildings would be designed in agreement therewith, those to be adorned on each side by palatial buildings possessing a collateral magnificence, whilst streets leading to localities populated by the poorer classes would be less pretentious; though they, too, might well be made picturesque with foliage trees.

10. Grade and cross-section of streets.—Ordinarily a grade of $\frac{1}{2}\%$ in the longitudinal section of a street will suffice for surface drainage; for localities subject to tropical downpour this might be slightly increased, and where the rate of fall is unusually light slightly diminished. For vehicular traffic a grade of 10 $\%$ may be treated as a maximum, and that design which avoids heavy grades on the main lines of traffic is of course the best in respect thereof. In commercial and industrial, and even in residential parts of the city, the level of the streets may, with advantage, be 1 or 1½ metres, say 3 to 5 feet, above the general level; on the other hand, in suburban residential localities, the street level ought to be the lower. The usual cross-section, viz., a carriage or roadway with raised footpaths, would, of course, in the case of the wider streets, be departed from. In the widest streets of all one part of the roadway might be devoted to heavy, and another
to light traffic, these being separated from the side walks by a row of trees on each side, while a central avenue or footwalk, with foliage trees on each side, would complete the section. Where there is little heavy vehicular traffic, strips forming garden or grass plots, lying between the footwalks and the roadway,¹ might constitute a feature. These could be graced also with shrubs of various kinds, and the centre of the street formed by a line or lines of ornamental trees, with or without footwalks. Roads and streets of less width would permit of a single row of trees on each side and next to the footwalks, or a single or double row in the middle. Cycle paths might well be introduced in many of the streets, in such positions as involve a minimum of interference with other forms of locomotion.

11. Engineering features of streets.—The necessity for some official control of the localisation of the different classes of occupation, which a regard for the general appearance and welfare of a capital city not only justifies but imperatively demands, permits its development to proceed on lines that obviate frequent changes in the constructional features of the streets; for these can all be thoroughly considered at the outset. The mains, conduits, tunnels, etc., required for water, gas, electric, or various forms of power-supply, for sewerage systems, for telephone and telegraphic services or for underground communication of any sort, can be located so as to involve the minimum disturbance of traffic, and the least expense for maintenance and repair; and the characteristic breaking up of, and injury to well-constructed streets, in order to reach such mains and conduits, can thereby be rendered an unknown element. Were it publicly realized how dearly we pay for our stolid ignorance and want of foresight in municipal arrangements generally, the constructional features of streets would perhaps be very different to what they are. In future city-design, the opportunity undoubtedly exists for avoiding that continual waste of resource, which, turned to advantage in more lavishly equipping

¹ Or, as in Washington strips may be left between the side walks and the property boundaries.

F—Sept. 4, 1901.
public institutions, and in making the city ornate, can be so much better expended. Similarly, an exhaustive consideration of the treatment of each street in regard to the necessity for tram or railways, will admit of the construction being developed on lines that avoid waste through the undertaking of various useless works, or injury to necessary ones. It will be a wise economy also to make the foundations of all streets thoroughly, and in no way to stint the means for so doing.

The scheme of lighting to be adopted, is an element in which decision antecedent to the development of the design is also requisite. Inasmuch as electric lighting does not involve, except at the generating station, any consumption of oxygen, and as the light itself does not produce those deleterious gases formed in the burning of coal gas, it is to be preferred wherever a start may be made *ab initio*.

More generally, it may be said that the predetermination of the whole of the engineering or constructional features for the streets is essential to the design being so elaborated as to reduce the expense to an absolute minimum, and it is only through the initial location of such features that everything dependent thereupon can be consistently and harmoniously adjusted and the best results attained.

12. *Sizes of blocks between streets.*—If in any site, the relation between the total area, and that to be occupied as streets, be antecedently assigned, the problem of ascertaining the size of blocks becomes numerically determinate, as soon as the general scheme for the streets is decided. In Paris the streets cover an area of about $\frac{1}{3}$ of the total: in Washington the ratio is still greater. With increase of street area, however, the construction and maintenance becomes correspondingly costly. The following suggestion as to suitable dimensions will sufficiently indicate the idea of general proportions:—

| Metres | Public institutions, large factories, and large establishments generally | ... | ... | ... | 100 × 200 |
Large suburban residences with grounds ... ... 80 × 160
Larger business sites, city residences, etc. ... 60 × 120 – 160
Smaller establishments... ... 40 × 80; 30 × 60 – 90; 20 × 60
Workmen's dwellings ... ... ... ... 10 × 30

If smaller areas than these last are admitted the elements of hygiene and beauty must be correspondingly sacrificed. The length of blocks may vary between say 100 and 200 metres, or say between 330 and 660 feet, and rear lanes be from 10 to 15 metres in width, say 33 to 50 feet.

13. Height of buildings.—Apart from the impossibility of adequately dealing with fires breaking out in very high buildings, and the consequent jeopardy to property generally, and apart also from any consideration of the aesthetic defects of such buildings; a certain height may be regarded as injurious, as unduly limiting the sky-line, and as preventing sufficient access of direct and diffused sunlight to the properties in the neighbourhood. The following table shewing the lengths of shadow when the direction of the sun is 45° off the meridian, and the directions and lengths when it is three hours off the meridian, will afford the data from which a judgment may be formed as to the limits that may be considered reasonable, in restricting the height of buildings.

![Fig. 8.](image-url)

VII.—Lengths of shadows 45° and at 3 hours off the meridian, Lat. 35° S. vertical 100.

<table>
<thead>
<tr>
<th>Date</th>
<th>Jan. 19</th>
<th>Feb. 19</th>
<th>Mar. 21</th>
<th>Apr. 21</th>
<th>May 22</th>
<th>June 22</th>
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<tr>
<td>Dec. 22</td>
<td></td>
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<tr>
<td>Nov. 24</td>
<td>27(a)</td>
<td>35(b)</td>
<td>59(e)</td>
<td>100(d)</td>
<td>166(e)</td>
<td>276(f)</td>
</tr>
<tr>
<td>Oct. 24</td>
<td>86</td>
<td>90</td>
<td>107</td>
<td>141</td>
<td>197</td>
<td>273</td>
</tr>
<tr>
<td>Sep. 23</td>
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<tr>
<td>Aug. 23</td>
<td>2hrs.</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Mar. 21</td>
<td></td>
<td>3hrs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr. 21</td>
<td>2hrs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>May 22</td>
<td>2hrs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>June 22</td>
<td>2hrs.</td>
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</tbody>
</table>

Direction 86° 81° 71° 60° 51° 45° 43°
Fig. 8 shews the position of the solar-shadows when the sun lies N.E. or N.W. for the different months of the year; the shadow reaches the point a, b...g at the dates specified in table. The positions of the shadows on buildings, with streets of various widths, is also shewn.

If a street have buildings immediately abutting on it, equal in height to its width, the maximum angle of sky transversely to the street is 53° 8', and the minimum 45°. A skyline higher than 45° is clearly too high, hence as a maximum limit, the façade of any building abutting on the street should not be of greater height than the width of the street. The façades will be better seen with a less angle, a two-thirds limit would, therefore, be preferable, i.e., the height to be not more than two-thirds of the street width. Buildings standing back from the street frontage could be correspondingly increased in height. This element will be further considered in dealing with the aesthetic elements of city design.

14. Theory of aspect.—The most favorable form for picturesque effect in a site would be a gently undulating surface, surrounded by commanding hills, constituting a sort of semi-amphitheatre. The desirable aspect in relation to the cardinal points will depend very much on local peculiarities, such as the climate, the prevailing direction and character of the winds, and similar meteorological factors. Consequently it is hardly possible to generalise in respect thereof.

So far as mere sunlight is concerned, eastern slopes are cooler than western, and northern than southern; consequently north-western slopes are to be preferred where heat is desired, and south-eastern when the opposite is the case. These effects may, however, be greatly modified by other factors.

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1 Max. = Observer in middle of street. Angle = $2 \tan^{-1} \frac{1}{2}$, i.e., 53° 8'.

2 Min. = Observer at side of street. Angle = $\tan^{-1} 1$, i.e., 45°.

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In a city set out on the rectangular-radial system almost every possible orientation in respect of individual blocks exists, and if the site be also undulating, choice of aspect in such a system can offer no difficulty, because of its multitudinous variety. So that whether industrial or other requirements demand the presence or absence of direct sunlight, those requirements are easily met. Buildings in which it is necessary to secure the maximum penetration of solar rays, so as to benefit by their heat in winter, and the minimum penetration so as to avoid the heat in summer, should so far as the geometry of solar shadows is concerned, have their long axes east and west in southern latitudes and their windows on the north face of the building. Since, however, the temperature reaches a maximum after noon through the cumulative effects of the sun's heat rays, the axis should, theoretically, be rotated slightly, so as to turn a little to the north on the east side, therefore a little to the south on the west side. The amount of this rotation can be ascertained by taking account of the difference between the apparent noon and the times of maximum temperature; the differences between the noon and maximum temperatures, and the latitude of the place considered, the discussion extending over the changes for an entire year, so as to properly integrate the effects, and hence deduce their mean. The necessary rotation will, however, not greatly modify the E.—W. position for the axis. The designer must, it is evident, take account of these necessities, and for buildings of a large size, and requiring spacious grounds, where aspect is important—as for example hospitals, sanatoria, etc.—provide suitable blocks.

15. The aesthetics of design.—A study of those examples of architecture which impress the human consciousness with a sense of beauty, has revealed the fact that their general proportions, and the mutual relationship of their details, conform to simple numerical ratios and to an harmonious scheme. These ratios, spatially realized in the cube, square, the plane or circular equilateral triangle, the 3, 4, 5 triangle, the sphere, cube, pyramid, etc., are geometrical forms that constitute, as it were, a skeleton
on which architectural features are developed, in symmetrical grouping, with however such relief in detail as to obviate too cold and severe an effect, or what may perhaps be called an appearance of excessive symmetry. The proper subordination in the various parts of structures of their mass effects is also essential to awaken that impression of stability and repose which, together with grandeur of form and beauty of outline, and the grace of harmonious ornament, constitute the ideal of architectural design. Although these matters require the immediate and intense attention rather of those charged with erecting the buildings of a city, than of those whose function it is to design its streets and general arrangements, the latter can by no means neglect them. A knowledge of, and attention to aesthetic laws are absolutely necessary in studying a design, for as the eye passes over the contoured plan of a proposed site, the artistic possibilities of every feature must array themselves before the consciousness of the designer, if his work is in any way to exhaust them.

Outside the aesthetics of Architecture proper, the designer requires moreover to consider, in general, the picturesque effect of masses of foliage, the perspective appearance of monumental buildings and monuments from the points of view where they will be prominently seen, the grouping of buildings and classes of buildings, the effective position for parks, gardens, etc., the spatial provision necessary for the proper viewing of all features of interest, and so on; for it is by attention to such elements of city design that the possibility of beauty is created, and the picturesque capabilities of a site are exploited. Thus eminences and concave surfaces, both of which lend themselves to striking effects, should be exhaustively studied in relation to the general scheme.

16. Sites for monumental buildings and monuments.—The two classes of site that give the necessary prominence to monumental buildings are the summit of hills and the centres of amphitheatres: the one bringing a building into relief against the sky, the other shewing it in relation to its surroundings. In both cases the preservation of space about the building greatly enhances its
effect, by ensuring for it a sufficient distinctness. Remembering that a considerable time must elapse before any great city can be completed,\(^1\) the reservation of sites for future public buildings and requirements generally, and for extension of buildings as the necessity arises, should always be on a most liberal scale, as this not only avoids the need for costly resumptions of land, but also enables the aesthetic effects to receive that adequate consideration which they rarely do if the element of cost is serious.\(^2\)

The spatial provision for monuments, intended to be of noble proportions, therefore, would be appropriately located at prominent radial centres, while that for those of lesser size would be relegated to more unpretentious positions. It is, of course, important that the magnitude of monuments should harmonize with their surroundings; and as the form they may be expected to take depends very largely upon the contingencies of the future, the spatial provision should be liberal. The essence of the whole matter is that all conspicuous or prominent sites should be appropriated for those great public buildings and monuments upon which a people may be expected to lavish its wealth and artistically express its national feeling.

In order that monuments of all kinds may be properly seen, an unobstructed area must be preserved immediately round about them. For viewing detail, an onlooker would stand at a distance from the monument about equal to its height; to see it as a whole, at a distance about twice its height; to see it with its background and immediate surroundings, at say three times its height;\(^3\) and to see it with its general surroundings at a still greater distance.

\(^1\) It will, for example, be many years before Australia will be wealthy enough to erect truly monumental buildings. It would be well to commence, however, on permanent lines, whenever we do start the substantial buildings.

\(^2\) The penalty paid, over and over again, in the States of the Commonwealth, for want of foresight in the matter of public requirements, is not merely a most serious financial loss: the possibility of adequately meeting those requirements has practically vanished.

\(^3\) Angles 45°, 26° 34', and 18° 26' respectively.
It is necessary, therefore, that about every monument the unobstructed space should be between a distance equal to its height, and that equal to at least three times its height. Similar monumental buildings of noble proportions should stand back a sufficient distance from the street to admit of their being favourably seen.

17. Treatment of streets from the standpoint of aesthetics.—Owing to the fact that great lengths of street, especially when unvarying in width, of similar section, and fairly level, produce on the beholder a sense of wearisome regularity, the introduction of spaces for monuments, large street fountains, water-jets, foliage squares, etc., at such points as relieve the view, is a desirable corrective. It is hardly possible to lay down any rule as to the length which may be unrelieved, because so much depends upon grade, width, and general treatment in other respects; a length of from 15 to 25 times the width might be taken as a general indication. Tiresome uniformity can also be avoided by subjecting each street to independent treatment, so that each may possess some characteristic. Even alteration of width is preferable to excessive symmetry, and may be introduced to counteract its unesthetic effect.

The undisguised presence of telegraph wires, telephone cables, etc., besides being unsightly, is a menace to public safety in cases of fire. Overhead electric wires in a tram-system although perhaps less unsightly, are inconsistent with a fine effect, and might well be transferred to underground conduits, as has already been done in some instances.

It has been said that monuments, so too, foliage masses, may be employed as a relief to street uniformity: they may also be introduced to obviate the ugly effect which arises from the disappearance of buildings etc., over the summit of streets crossing a ridge, for in no case should such effect be unrelieved: their proper situation is of course central, the traffic passing on either side, on a sufficient space provided therefor.

If monuments be erected in curved streets, the concave\(^1\) is the proper side, forasmuch as it has the greater area of visibility, and

\(^1\) That is the side of greater radius.
moreover the concave side forms an effective background, as is evident on viewing figures in niches. The convex is less effective than even a flat background, to say nothing of the reduction of the area of visibility. Hence spaces for monuments are desirable on the concave side in effective localities.

The lighting arrangements of a city are also susceptible of artistic treatment, and lamp-posts or candelabra could be so designed and arranged as to greatly enhance the beauty of streets. The necessity of occasional illumination might, with advantage, be systematically considered, and such permanent installations made as would admit of its more frequent use. This applies no less to the illumination of buildings than to streets, and the expense of permanent constructions would be scarcely greater than the cost of individual illuminations. In streets planted with trees, the effect could be made very pleasing, and the somewhat wanton injury to this formation, common on such occasions, wholly avoided. All these matters may easily be taken account of in the development of the design; they should not be an afterthought, however. The same remark applies to the form and position of drinking stands, pillar boxes for letters, telephone fire alarms, conveniences, letter-boxes, and other furniture of modern streets; all need to be considered in the design, so as to be made harmonious with their surroundings.

Among places admitting of decided improvement as regards the usual treatment, may be mentioned street intersections. Where the blocks have acute angles, a sufficient cut-off to form a façade, or a suitable rounding off, greatly enhances the appearance, and even the intersections of rectangular streets are markedly benefited by similar treatment. The customary right angle is far from satisfactory aesthetically. The cutting off of corners increases of course the diagonals at the intersection, and since the sidewalks or footpaths follow the outlines of the blocks (i.e., are equidistant from the building lines) increases diagonally, also, the roadway proper. This enlargement leaves room for street ornamentation at the intersections of the centre lines. By making
the cut off of corners adequate, provision may be made for a small square, a monument, clump of foliage, or small garden. A still greater cut-off will permit of a central square, circle or ellipse of finer proportions, with roadways round it, and which may be utilized for a more pretentious central feature, and the independent treatment of every intersection will produce a gratifying result.

In addition to those at street intersections, spaces are also desirable in front of, and in some cases even on three sides of, certain types of public buildings, especially those in which the architectural elaboration would not normally be restricted to the front, as, for example, museums, theatres, churches, etc. Arcades and approaches thereto are features which, since they can be made very effective in appearance, ought to be provided for in the design; and further, sites should be indicated for those fine pieces of sculpture or architectural art which the artistic sentiment of any cultured people will eventually require. Since all artistic elements must stand in harmonious relationship to one another, and their distribution be such as to give them a maximum efficiency in relation to their influence in beautifying the city, they ought all to be considered in the original design, so that the necessary provision may be made. The usual practice of either entirely neglecting, or inadequately regarding these matters, and then doing the best possible with the sites that chance to be available, can never be satisfactory, as is obvious when one contemplates the all too common hopeless disfigurement of what were originally ideally perfect sites.

18. Public parks and gardens.—Public parks and gardens are not only an ornament to a city but a necessity to its people, if their health is to be regarded, and considerations of health and beauty may at least have weight in important cities.¹ Hence we are justified in making liberal provision for public gardens,

¹ The antagonism of interest between the estate vendor and the public good should be guarded against. The price paid for cupidity on the one hand and ignorance on the other is serious!
irregular surfaces are to be preferred, as giving the landscape gardener greater scope for displaying his art, and as possessing intrinsically greater charm. In selecting areas for public gardens therefore, the irregular tracts would always be chosen, provided other parts of the design could be made to accord therewith, and provided also that the positions lent themselves to good effects from every point of view. Whole blocks, or even double, triple, or quadruple blocks, containing suitable features might therefore be devoted to the purpose, the distribution over the entire site being made fairly uniform, but adapted to the general character of the surroundings.

Besides these gardens and smaller parks, in the city proper, large parks also are necessary for its environs. The Bois de Boulogne, and the Bois de Vincennes of Paris have each an area of over 2,000 acres, and similarly liberal provision for every important city is to be desired. Parks like these would constitute recreation or picnicking grounds for the peoples of the cities and their areas ought to be ample for the probable ultimate population of the city. The creation of artificial, if there be no natural, lakes, especially for cities not on the sea-shore, would be advantageous, and if the water supplied to them were, on its passage, passed through large fountains of many jets, not only would the feature be very attractive, but the water itself would also be well aerated. By suitably selecting the path for the conduits conveying this water, it could in some cases be made to serve either all or most of the fountains of the city, passing by gravitation from one to the other, subject only to the loss by evaporation at each fountain.

I may be here excused for repeating a suggestion made to me in conversation by the Commissioner appointed to report on the sites for the Federal Capital. If the parks were thickly planted with trees whose foliage was beautiful, and whose timber at the same time was of value, then when the demand for the fuller use of the parks arose, necessitating clearing, the trees would have become a valuable asset, and the income from the timber available for removal might be made to materially assist in the more
elaborate development of the parks. Another suggestion made by the same gentleman is that the parks might to some extent illustrate the types of timber to be found scattered over the face of the earth, not by individual specimens, but by creating small forests of such type.

19. Hygienic elements of design.—It is not only in the choice of a site that the elements conducing to health need to be studied. However wisely the choice may have been made in respect of climate, of the nature of the surface and subsoil, of the condition of the discharge of surface waters, and the position of the groundwaters, of the possibilities of adequate water-supply and efficient drainage, there still remains a need for a hygienic as well as aesthetic control of the localisation of settlement. And since this reacts upon the whole question, it is not possible to omit the hygienic elements in elaborating a design that is to be as perfect as our knowledge will allow.

The first great requisite to general health is the prevention of all settlement on those parts of a site where undesirable hygienic conditions prevail. For example, neither residences nor factories should be allowed to be built or established in depressions or other places where the moisture is excessive, or where water is liable to accumulate in heavy storms. A complete defence against the liability to misapplication of such areas is the converting of them into parks, and planting with types of vegetation that make a maximum demand upon the available moisture. By planting and draining, an area can be quite transformed, both in character and appearance, as the history of the city of Washington, U.S.A., so well demonstrates, and an unsightly feature may be converted into one of beauty.

A second requisite is that so far as possible variations in the design permit, those should have weight which lend themselves to convenient and efficient drainage systems, both for storm waters, and domestic, industrial, and other polluted drainage; and the

1 Alexander Oliver, Esq., M.A., President of the Land Appeal Court, State of N.S.W.
outlines of the scheme for this should therefore be fully considered when the design is being developed, and not afterwards.

The third requisite is that the total quantity of breathing space provided in the design should be large, the vegetation made abundant; and when the building stage is reached, the necessary sanitary provision enforced for every structure, overcrowding being prohibited by requiring a sufficient number of cubic metres of space to each inhabitant.

And among the most important of the hygienic elements, I would place that of ample provision for play or recreation grounds in connection with every school, college, or other educational establishment; i.e., a complete abandonment of the present niggardly notion of what is a reasonable provision in this respect. That the recreation of a people should be under pleasant and healthy conditions is always important, and never more so than in the case of the young, so that the school-grounds of a beautiful city should in themselves be a source of attraction, and exhilarant in their reaction upon those who use them.

Similarly hospitals and sanitoria should have bright surroundings and pleasant aspects, for the cheery and tonic effect of these is by no means the least potent of the remedies available to those charged with the care of our health.

The suitable location of industrial occupations which are either noxious or unpleasant, even in a minor degree, is a matter of importance in enhancing the merits of a city, and in dealing with those occupations as they arise, all provisions for diminishing their mischief should be enforced. For example, since a smoky cannot be a beautiful city, at any rate in the highest sense, all smoke in factories ought to be consumed. Where industries are such that they cannot be ameliorated, they can be excluded from the city proper. Therefore provision for abattoirs, and similar establishments are preferably omitted. These and similar malodorous occupations, can be concentrated at some convenient but sufficiently distant point, for though they may not directly create
sanitary mischief, their reaction upon human beings is unfavourable, and they are therefore undesirable.

20. The preliminaries of design.—Imperfect as is the statement given of the elements to be considered in any real attempt to properly design an important city, it will nevertheless be sufficient to indicate that a preliminary topographical and contour survey of the whole of the site is an essential. Such a plan perfectly represents the surface, and if supplemented with geological information as to the depth at which rock is found, the nature of the rock and of the material from the surface down thereto, it would constitute the necessary prerequisite for thoroughly discussing the design. Obvious as this seems, (and it must be equally evident that even in regard to the engineering details alone, the cost of obtaining such information would be far more than compensated by the aid it would lend to economy of construction) it has not been the practice in the Australian States to obtain it. The time lost in so doing is gained in the end, and it is only by such systematic procedure that satisfactory results can be achieved. I am well aware that those who have not thoroughly studied this question, are under the impression that what is called the common sense of well educated people is sufficient for the task of designing. That is not the opinion of those who have seriously given the matter their professional attention. If evidence were wanted of the calamity of indifferent design, it is to be had in our own city and suburbs. The topographical features of Sydney would have permitted it to be, if not the most, at least one of the most beautiful cities of the world. No word-painting could too vividly, or with too high a colour, express the magnificent opportunity that once existed for the people of this land to create a city of almost unparalleled beauty: that opportunity has been hopelessly lost through the ignorance, and want of apperception of those whose duty it was to avail themselves of it, leaving at the same time a monument of the dignity of their ideas. And the reason of failure is that no great scheme for the creation of the city was ever heartily entertained. Like Topsy it has 'growed.' And any
other city that grows by chance will equally exhibit great imperfections, and fail of its possibilities.

21. **Conclusion.**—The treatment of the subject of this paper, is by no means exhaustive, and may be taken rather as a general indication of its scope, than as a systematic and complete presentation. In concluding I may be permitted to express my indebtedness to the paper by Herr J. Stübben (Baurath, and Assistant Burgomaster of Cologne) on the same subject, and to that by Mr. J. Sulman, read at the Melbourne meeting of the Australasian Association for the Advancement of Science, more than ten years ago (1890). Both advocate the radial-ring system. As to the adoption of the radial element there can I think be no question; and I have shewn the great advantage of the ring system. This system may in my opinion well form a feature relieving the uniformity of the rectangular, but since all three can be employed with advantage, it ought not to be dominant. A complete and final abandonment of the present practice of lightly regarding the matter of city design, and a really exhaustive study from every possible point of view of any selected site, as a preliminary qualification, is what is desired. Given this, we shall have in each case a noble and far-seeing design, and the cities of the Commonwealth will bid fair to be all that we could wish, so far as the art of city building is concerned. And unique among them should be that which will be known as the Capital of Australia.¹

[Added 12th Sept.] Since writing the above my attention has been called² to an article on “City Plans” by Horace Bushnell, d.b. Essay V. in his “Work and Play.”³ He affirms that there can be no absolute plan for cities, each must be designed by itself. The essay is an exposition of the subject from the standpoints of convenience, health, and artistic development. Although the

¹ May I add that it would be easy to introduce and familiarise the people with the metric system, which must inevitably be adopted, if all the measurements, dimensions, etc., are given for the Federal Capital in that system.

² By Mr. J. H. Knibbs.

³ Lond., Alex. Strahan & Co., 1864.
scheme of treatment greatly differs from that just given, and although on minor matters there is some slight difference of opinion the fundamental ideas are as nearly as possible identical, making allowance for the fact that certain elements now require attention, which did not exist when the essay was written (1864), and that experience has accumulated since then. I am reminded also\(^1\) that Karlsruhe might have been quoted as affording an example of the radial-ring system of streets. Lastly, I wish to make it absolutely clear that the ideal design must be founded on the radial element, the rectangular, and ring systems, and curved or zigzag streets being combined therewith, so as not merely to suitably conform to the topographical features, but to do so in such a way that in respect of convenience and of imposing effects, the city will be as perfect as possible. In Fig. 9 above, I have given an existing example of ring or polygonal streets; it is part of New Orleans.—G.H.K.

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\(^1\) By J. Marden, M.A., LL.D.
Mr. H. G. McKinney, M. Inst. C.E.—The paper is very comprehensive in its character and bears every evidence of careful thought and skilful preparation. Any criticism therefore which I have to offer relates to matters of detail and to the order in which action should be taken.

The first point to which I feel disposed to take exception is the place given to the paragraph devoted to the preliminaries of design. I concur in Mr. Knibbs' opinion that "a preliminary topographical and contour survey of the whole of the site is essential," but I should have preferred to see this point brought in near the beginning of the paper and greater prominence given to it. The site selected for the Federal Capital is almost certain to be in hilly country, and the contour of the ground will be a factor of the first importance in settling the character of the street system or systems, which should be adopted. Examination merely of the headings under which Mr. Knibbs has discussed the subject shows how much depends on the contour plan. For instance the important question of the positions of radial centres is one which will depend in a very large measure on the natural outlines of the ground, as will also the question of the advantage or propriety of adopting curved streets.

As the immediate object in view in establishing the Federal Capital is to provide Houses of Parliament and offices for the use of the Federal Government, it appears to me that all other objects should be subordinated to this. I quite concur in Mr. Knibbs' opinion that all possibilities of extension should be provided for, but I think that in attempting to make definite provision for various possible developments there would be some risk of losing sight of the main object which should be kept in view.

In his statement regarding the fixing of radial centres, I think more stress might be laid on facilities for water supply and drainage, and on the location of railways and main roads, but Mr. Knibbs may very justly say in regard to this, that the magnitude of the subject compelled him to condense his remarks.

G—Oct. 2, 1901.
Mr. Knibbs very justly condemns what may be termed the so-called "Practical Man" principle in regard to laying out the Federal City. There can be no doubt that the best professional advice should at the outset be obtained regarding the surveying, engineering, architectural, sanitary, and horticultural questions which have to be dealt with in founding a model city.

Mr. Herbert E. Ross, B.sc.—Mr. Knibbs certainly seems to have assembled all the general elements which should determine the design of an ideal city. The consummation of such a design is, however, so beset by the dangers of democratic interference that if only a major part of the theory outlined could be carried into effect the result might well be regarded as a distinct milestone in the march of civilization. Of the difficulties of realization, the greatest would of course be an impatience leading to amendments of the conceived design, sacrificing future perfection to more obvious present expediency, so that continuity of purpose should be an important element in the theory.

The radial-ring arrangement of streets is doubtless the best possible economically, and perhaps even aesthetically, it has a minor objection however, it would tend to a sense of confusion of locality in the ideas of an average citizen; a common instance in our own city is afforded by the irregular system of streets surrounding our Government administrative buildings. Of course the radial-ring arrangement, with rectangular subsections, could be systematised to avoid this difficulty to a certain extent, by the streets being named according to consecutive numbers, or other series, and referred to centres or to some popular meridian, thus establishing relative location throughout. The principle of concentration of allied interests is good only to a limited extent. Thus, for instance, the association of administrative systems, and again commercial activities, would be desirable and necessary, but the principle would fail if applied, for instance, to educative institutions, except those which claim the whole attention of their votaries. Thus museums, libraries, and the representative collections of art and industry, should be conveniently scattered in the centres of greatest
activity, and not set apart where the work-a-day world would gain least from their civilizing influences.

In the adoption of curved streets or indirect routes to avoid heavy grades there must be some mean condition, a compromise, as it were, between the direct route of the steep gradient, and the devious route of the easier grade. The author’s proposal that the maximum grade under these circumstances should be 10% is considered quite excessive; a maximum of 7\(\frac{1}{2}\)% under the most unfavourable topographical conditions would entail no special difficulties, and certainly should not be exceeded. The economy of low gradients extends far beyond the immediate section of road considered, and may sometimes determine the load at a distance.

Any plan having been duly decided upon, I consider it would be highly dangerous to the satisfactory final completion of that design, if any allegedly temporary amendment be permitted, especially where the building line is concerned. It would be quite in the economy of a design that streets be wide and yet not wholly in use. A central strip for instance, not paved and treated as a shrubbery, would entail no great cost, and even if subject to neglect would be better than some other excuse for permanently crippling the design.

Of the broad question of aesthetics there is much to be said, and the general principles should never be lost sight of, as they are independent of all accidental features which form only the framework for their application. Starting, de novo, it would be possible to introduce principles impossible and unknown to the cities of the past, which have, as Mr. Knibbs graphically puts it—like Topsy—grewed. Of these, to my mind, one of the greatest possible aesthetic importance is the question of the weather protection of footpaths. There is nothing associated with the habitations of man so fatal to beauty in design, so hideously excrescent and foreign to every canon of architectural proportion, as the street awning. It is necessary to every climate and is disowned by every style of architecture. The architect excludes it from his drawings, knowing the while, that parasite-like it will attach itself
to his building before it leaves his hands. The street awning can have no place whatsoever in a beautiful city; and yet under the special conditions under which a new city may come into existence it would be an easy matter to supply its place, and at the same time add new possibilities to the beauty of our street architecture. To this end I would so regulate the conditions of land tenure that there would be two building lines to the side of each street, one line would lie, say, one-third the width of the footpath from the kerb thereof, and the other or near line would be back at the full distance of the footpath. An invariable condition of building in certain streets would result in two-thirds of the footpath being under cover and one-third open. Instances of this class of construction in this city, though not so applied, are afforded by Victoria House in Pitt Street, and the General Post Office. Such construction is conformable to every recognised style of architecture and would undoubtedly lend itself to fine effects hitherto impossible.

Mr. Norman Selfe, M. Inst. C.E.—To discuss within reasonable limits such a lengthy and masterly paper as that which Mr. Knibbs has contributed to this important subject, is very difficult. I therefore propose to supplement rather than to criticise; and to make a few prosaic remarks on some of the commonplace aspects of the question, hardly touched by Mr. Knibbs, but which naturally occur to those who are in daily contact with the practical rather than the theoretical side of such matters.

It seems to me to be entirely premature for any one to dogmatise on the subject of the Federal Capital, before certain definite and important premises have been thoroughly settled. As a result of having looked upon fifty or sixty of the principal cities of the world—from Stockholm to Naples, and from Boston to St. Louis, it has been forced upon me that those cities are all the results of special series of combinations of conditions—unique in every case. Prague and Chicago, London and Christiania, what have they in common? Philadelphia, one of the largest cities of the world, appears to be one of the least self-assertive;
but, like its brother Chicago, it owes much of its stateliness and beauty to conditions that, so far, have not arisen in Australia.

If the Americans are the sharpest business people in the world, they have also developed patriotic instincts to an extent and in a way totally unknown in this southern land. There speculators and capitalists have purchased and subdivided immense areas around their cities. They have laid out broad avenues, with promenades and intervening parks; the latter containing winter gardens when necessary, to preserve their flowers and delicate plants through an inclement season. This has been done by means of Trusts, whose object was not mere vulgar money making, but the more noble one of securing for all time to its members, faultless residential districts, in combination with the most beautiful and healthful surroundings. Few if any such works have yet been undertaken here, even if such a spirit is animating the wealthy public men of the Australian States. If there is such a desire abroad among us there is some doubt as to the scope for its operations in connection with the Federal City.

Before we can deal very much with the site of the Federal City we require to know:—First as to Official Buildings—

(a) Legislative Buildings and Vice-Regal Residence.

(b) Public Offices of State: as Mint, Treasury, Customs and Internal Revenue, Patents, Military and Naval Departments, etc.

(c) Supreme Court and Law Departments.

(d) The residences of the principal Officers of the Commonwealth, whether such are to be simply private homes or State mansions to serve as foci for ceremonial functions.

(e) The shops and magazines of trade required to supply the wants of the official staff and its servants.

(f) The homes of the various grades and classes of servants other than those housed in the public buildings; and every accommodation that appertains to the machinery of government.
Secondly, Non-Official Buildings.—Prior to taking any steps with regard to colleges, art galleries, museums or libraries, and before any provision can be made for a non-official population, some determination must be arrived at as to the likelihood of others than the Members of the Senate and House of Representatives—(a) taking up a permanent residence in the district, or (b) paying occasional visit to the city. A permanent non-official population can only grow under one or both of two heads. In the first case the mineral, agricultural or forest resources of the district may be of a character to warrant and favour the establishment of manufactories, and the position of the city as a centre of trade may favor the economical distribution of its goods; then an industrial population may be reckoned on. Or the site may have such beautiful salubrious and economical attractions as to lead to the city becoming a resort for families of means.

It is necessary to consider in any selected site whether any of its natural features should be emphasised or suppressed. For example, a foreground of water, whether river, lake, or creek, although insignificant in the original landscape, might be so altered by embanking and terracing as to become a characteristic feature of the city.

As regards the relative merits of a rectangular hexagonal or radial and circumferential street system; nothing could possibly be settled beforehand, about a site that will in all probability be in hilly country. The only safe rule is that which provides that there should be the shortest practicable routes between the most important centres. In old cities we find straight cuts being continually made, with such an object, through slum districts. If there is only one prominent elevation on the site, it should no doubt be crowned either by the Citadel (if there is to be one) or by the Capitol buildings without the Citadel. There should be plenty of park and garden surroundings, and if the main centre is too elevated for direct radial roads of approach, then spiral avenues may be necessary. If there are lesser or subordinate elevations, then other State or prominent buildings should crown.
them; and every endeavour should be made to prevent concentra-
tion into too narrow a focus for a commencement.

While on the subject of parks, greens and open spaces, a custom
which obtains in many cities of the United States may be referred
to. It is no unusual thing in that great country to see public
parks, the domains enclosing State Capitols, the grounds surround-
ing the mansions of the wealthy, and even the gardens bordering
the stately rows of villa residences, on their tree lined avenues,
all entirely without gates or enclosures of any kind. A great
deal has been said about Washington, D.C., and it is certain that
any authorities that may be appointed, will not forget the lessons
to be drawn from it; but the great difficulty will be to design a
nucleus, with all the possibilities for expansion and extension,
which will not be what—"the city of magnificent distances" was
—a ragged and disjointed one for a generation or two at least.
When however, the positions of the streets are once settled on,
their borders planted and their roadways formed, then no other
authority than that charged with their maintenance, should be
allowed to pull them up again. We should insist that subways
should be imperative in the principal streets of the Capitol.

Mr. J. H. MAIDEN.—Having had no time to make a set report
on the subject I can only offer a few remarks at present on my
colleague's valuable paper. I trust that the Federal City will not,
at an early stage (or indeed at any other), be overloaded with too
many fine buildings. A beautiful building need not necessarily
be a costly one and it is to be hoped that free use will be made of
bricks of various tints and colours, of tiled and shingled roofs, of
wooden outside beams, and other architectural features of wood.
In our sunny climate we particularly want lightness, brightness,
and colour, particularly in our domestic architecture; any excess
of brightness can be toned down by creepers or by judicious plant-
ings. The presence of large quantities of building stone does not
commend itself to me, in this connection, so much as abundant
supplies of first-class brick clays.
Some of the fine buildings that have been suggested by various writers should be looked upon as ideals, perhaps not to be reached before the lapse of many years. It will be found, when the work of forming the city is set about in earnest, that the inevitable expenditure will be enormous, and therefore we should carefully discriminate between the essentials (as laid down in Mr. Knibbs' paper) and those suggestions which have been made without due consideration of ways and means. We must remember the vicissitudes of national finance, that the good ship of State at irregular intervals strikes a rock, and then retrenchment is the watchword. Retrenchment is often carried out in a more or less empirical way, and we should guard against the sacrifice of essentials in such a contingency. Washington is a city often quoted to us as an example, but we should not lose sight of the fact that it has a far wealthier and more densely populated territory at its back than we have.

I would suggest that the whole of the Federal territory be looked upon somewhat in the light of a gigantic park, the streets and the buildings to be inserted as details and when required. By this I mean that one grand scheme should be kept in view, that all our energies should not be entirely devoted to the official and residential part of the Federal City to the neglect of its suburbs and of its adjacent territory. In planning the roads and other means of access to the Federal territory we should not lose sight of the fact that the design of the city itself, which is of course of supreme importance, should not exclude rational treatment of the federal non-urban territory.

Design your streets and squares and gardens as soon as you can, and then let the planting begin. You will get more evident results from an artistic and hygienic point of view from planting than by any other means, and planting, amongst other advantages, will give definiteness to the ground plan of the city. There is an old proverb "Trees grow while we sleep"; while other details are being worked out our plants are increasing in size and usefulness. I trust that the crescent will be adopted to some extent, as it is
capable of very artistic treatment. The crescents should have segmental plantations between them and the busy highways. Crescents in London, Edinburgh, Leeds and other cities, small and great, will readily occur to members.

Then there should be a supervising architect to pass all plans of buildings before erection. I do not mean merely as regards compliance with sanitary bye-laws and safety of construction, but in regard to taste. The supervising architect should be an arbiter of taste, and while his ideals would not be too high, they should be high enough to prevent any gross offence against taste.

Coming to matters more particularly within my own province, let preparation be deliberately made for the planting of trees by the sides of streets. Is there a street in Sydney where this has been done? Or a noble avenue in New South Wales? The planting of a tree is not the careless making of a shallow hole and the off-hand putting of a tree therein. We must have good soil and good drainage. If the former is not there already, we must obtain it. No trenching or planting of the permanent avenues or plantations should be done by contract. When we plant a tree we do it for all time and therefore no inducement should be offered to do anything which would contend against success in this direction. Everyone has experience of irremediable loss,—perhaps of money, certainly of valuable time, inflicted on citizens who have only discovered bad planting by its after effects in wasted years.

Amongst public bodies often a labourer is told off either to plant or to tend trees,—a policy that shows that the gardening profession has not attained proper recognition in New South Wales. As a very general rule the citizen calls in the services of a skilled tradesman to satisfy his requirements, as he knows that such a policy is wise, and the truest economy, but the exception he commonly makes is in regard to his garden. If a man has tried everything else he can still be a gardener; this is an economic heresy which is very widespread in Australia. A good gardener is a trained man and one who has frequently undergone a long and severe apprenticeship, and it will be in the truest interests
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of this State and of the Federal territory when public opinion is so educated that the value of a gardener is properly appraised. Much useful work can be done by the garden-labourer or the navvy, under skilled supervision, but the technical skill of the gardener must be employed for planting and its attendant operations, for pruning (some people think that fruit-trees alone require to be pruned), for prevention of disease and for the application of sprays and other technical methods for the arrest of disease. These may seem details, but they are essential, and I invite attention to them with all the earnestness of which I am capable.

The prospect of noble avenues of trees in the Federal City is very pleasing, and I trust that nothing will prevent their extensive adoption. As compared with the results, the expenditure is certainly most justifiable. The value of the avenue, whether along streets, along approaches to buildings or as promenades in parks, has been but little realized in Australia, although common enough in Europe. And let me enunciate an axiom "One avenue one kind of tree." The finest avenues in the world consist of one kind of tree, as by that means uniformity of growth and general appearance, which gives the main charm to an avenue, can be alone secured. The pernicious misplaced hankering after variety which causes so many avenues to be spoiled because they are of two or more kinds of trees is responsible for the disreputable appearance of so many avenues and boulevards. Such remind one irresistibly of the "awkward squad."

I would extensively plant fruit-trees (which might be the property of the hospital) along the boulevards, and then the eye would be delighted with the prospect of a magnificent display of blossom in the spring. In the fruit season the public could be educated to respect the crop; this has been done in France. If the work were properly done it should be at least self-supporting.

Then clumps of trees and shelter belts from the west and south should be extensively planted, or, if they are there already, very stringent regulations should be adopted in regard to the felling of trees by irresponsible persons.
We have no grand Arboretum in Australia, and the foundation of the Federal City gives us the opportunity of establishing one that should be fully availed of. This would be of ornamental appearance and of great interest to the average citizen; it would also be of high value from an educational point of view. The growth of timber trees here would be a matter of deep interest to the Forest Departments of the different States, which would probably join to partly or entirely support it.

Mr. Alexander Oliver has suggested a geographical arrangement of trees in the large urban or suburban plantations, an excellent idea that has much to commend it. But I am very anxious to see the trees, in such plantations, arranged in Natural Orders also. For example, what a grand and useful thing a Pinetum would be—when we could get every species of Pine (with other Conifers adjacent) we could secure and compare their growth. The Oak plantations, collected from species indigenous to the United States and Mexico, from Europe, from the Himalayan region and from China and Japan, could become a feature in the Federal City that would attract many pilgrims. The cost would not be great and the economic lessons would be important, and we must let these two points always be with us in regard to the city, otherwise the Federal expenditure will be unduly inflated.

Personally I only plant young trees,—so, if my advice were followed special lines of trees could be raised from seeds or cuttings while the surveyors were putting in their pegs.

I was much struck with the model village of Port Sunlight¹ in England, where there are allotment gardens at the backs of blocks, the houses being arranged in a more or less quadrangular method for the purpose. Here is a hint for such gardens at the backs of blocks in the town lots for workmen in the Federal City. Incidentally let me commend the neat, pretty and various domestic architecture at Port Sunlight, much of which could be introduced, with but little alteration into the Federal or other Australian city. I show you photographs in order that you may see how light and

¹ The creation of Lever Brothers and Company.
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bright it is. At Port Sunlight, as you will see, great use has been made of lawns from the houses and other buildings to the roads, the lawns or gardens being protected by light iron railings where necessary.

And finally, let us encourage hedge planting in lieu of railings wherever possible. The Federal site will be not less than 2,000 feet above the level of the sea and the selection of approved hedge plants for that elevation is very great. Hedges can be made most artistic adjuncts to buildings, and, what is very much to the point, they are inexpensive.

JUDGE DOCKER—When the discussion upon Mr. Knibbs' paper was adjourned I also resolved to take part in the debate, as the subject is one in which I have taken a great interest, and as I have already expressed some views upon it in a letter published in one of the Sydney newspapers during the latter part of last year. But having read Mr. Knibbs' paper, I find myself in the same difficulty as Mr. McKinney. I find that the author has taken up and discussed every point, in a far more forcible manner than I could hope to accomplish, inasmuch as he possesses the technical knowledge which I do not. So it only remains for me to reiterate, and if possible, emphasise one or two of the points already insisted upon.

1. After the site for the Federal Capital has been selected and a contour survey made, an ideal of the city as complete must be evolved before a stone or a brick is placed in position. It ought not to be left to a single mind, however gifted, to create this ideal city, but a large commission should be appointed, including, not only the most distinguished engineers and architects of the Commonwealth, but also artists and other specialists, whose contributions towards elaborating the general ideal might be valuable. It is difficult to conceive of a higher honour than to be a member of such a commission and to share in the task of evolving the ideal of a Capital City as clear and distinct as was the vision of the "New Jerusalem" to the inspired Seer, but which will take decades perhaps centuries to realise.
2. I approve of the combination of different systems, the rectangular, the radial, the crescent; modified of course, by the contour of the surface. I think the nucleus should be rectangular and of considerable extent; and the transition to radial streets could be conveniently made by taking the diagonals of squares for the sides of a series of larger outer squares, the half-squares left by this transition should be reserved for such public or semi-public buildings as ought to be detached from other buildings and surrounded by plantations or open spaces. I wish to insist particularly on the necessity for leaving ample open spaces for recreation etc., not confined to one locality, but distributed uniformly through the occupied area. In fact, my idea of the general plan of the city may be illustrated by a chess board. Building should be permitted only on the alternate squares, the others being occupied by gardens and plantations, such as outlined by Mr. Maiden, artificial lakes and numerous recreation grounds for cricket and other sports.

I should like to touch upon many other points, but I do not wish to occupy the time of the meeting by going over matter which has been already so thoroughly and so ably discussed by Mr. Knibbs in his paper, and I will conclude by complimenting him upon the admirable manner in which he has accomplished the task he has undertaken, and by expressing the hope that he may be a member of the commission which I trust will be appointed to evolve the ideal of the Federal Capital.

Professor W. H. Warren, M. Inst. C.E.—I congratulate my friend Mr. Knibbs on having produced a very complete and thoughtful paper. I am sure the various subjects which he has dealt with at some length will be of great value to those whose duty it will be to arrange for the proper laying out of the Federal City. I am acquainted with all the important cities in America and Great Britain, as well as those of France, Germany, Austria, Italy and Hungary, and I am thus able to fully realize and appreciate the value of the various matters brought forward in the paper.

Mr. Knibbs assumes that a suitable site is available, and he places first the fact that an abundant source of water supply is
available, to which I should add, of suitable quality, within a moderate distance so that the cost of the necessary works, whether by gravitation, pumping, or a combination of these will not be unreasonable, or at least fairly economical. With an abundant supply of water available at a reasonable cost, a system of sewerage and drainage can be readily designed.

As to the relative merits of the rectangular and radial systems of laying out the principal lines of communication: these have been clearly dealt with, but it is impossible to deal with this matter more definitely until the site of the proposed city is actually selected. When this is done, I consider that the physical features of the country will indicate the most suitable sites for the main public buildings, and the most desirable combinations of the rectangular and radial systems of streets connecting these important buildings with the remainder of the city. Such cities as Washington, Paris, Berlin, Vienna, and Budapest give valuable suggestions on this head.

The cardinal direction of rectangular streets in regard to the latitude of the site has been very fully considered, and I do not propose to add anything to this part of the paper, but in regard to the width of the principal streets, I consider that there should be ample room for a double line of tramway with a thoroughfare on each side for vehicular traffic, and ample width for footpaths. In the main street of the city leading up to the principal Government buildings, I consider the plan adopted in the Unter-den-Linden of Berlin would be most suitable, as it provides completely for all kinds of traffic, and the rows of trees would be most useful in summer, and add to the beauty of the street. Even George Street near the Town Hall is not wide enough for the principal street of a city such as Sydney.

It must always however, be considered that very wide streets, such as King William Street, Adelaide, involve considerable expenditure in construction and maintenance, where the traffic is heavy. There is a practical economical width which should be obtained in every case wherever possible, which depends upon the
nature of the street, the height of buildings, and the amount and kind of traffic. The tendency to construct increasingly lofty buildings and the necessity for electric tramways, both involve the construction of wider streets than were formerly required. I consider that a single row of trees should be planted next to footwalks or a double row in the middle of all the principal streets.

**Engineering feature of streets.**—The chief point to be kept in view is to avoid divided authority and as much as possible the construction and maintenance of the streets of our Federal City should be concentrated in one authority, which should control and maintain whatever tunnels and subways were required for telephone service, water supply, gas, sewerage and electrical conductors for power and light, so that there would be no possibility of the traffic of the street being interfered with to an unnecessary extent, and the various disturbing elements of this nature, which we are all so familiar with in Sydney, would be avoided, with all their unnecessary expenses and inconveniences to the public.

Again, I see no reason why electricity should not be exclusively used for tramway traction, light, and power, so that there would be no real necessity for gas, or for the hydraulic system of transmitting power such as we have in Sydney, as all the various matters dealt with under this head could be more efficiently and economically provided for by electricity, and the smoke nuisance would be minimised. Incidentally I consider that measures should be taken to stamp out the smoke nuisance, now that its prevention is better understood. I quite agree with the necessity of public parks and gardens, from the utilitarian, hygienic, and aesthetic aspects of the question. The discussion cannot well be carried much further until the site of the city is selected, and then the real work may be commenced in which the principles dealt with by Mr. Knibbs and brought out in the discussion, may be applied in a practical manner.

**Mr. James Taylor, B.Sc., Wh. S., etc.**—The paper we have heard from Mr. Knibbs is so well prepared that very little room is left for criticism. One little matter has occurred to me in reading it
through since last meeting. Mention is made of the establishment of manufactories in the city. No doubt such establishments must arise sooner or later in connection with a large city, and in grouping them as suggested in the paper, attention should be paid to prevailing winds, so that the manufactories would be placed as far as possible, towards the lee side of the city.

There is another matter I would just like to notice, although it does not perhaps, strictly speaking, come within the limits of Mr. Knibbs' paper, i.e., the location of the site. We are hearing a great deal about this subject just now and I have made a calculation on the subject as follows:—If we suppose the population of each of the Federated States to be concentrated in its capital city and consider each capital to be a heavy point having a weight proportional to the concentrated population, the heavy points being rigidly connected: then the centre of gravity of the system of heavy points thus formed should give the position of the Federal City. Or, other things being equal, the suitable site nearest the point thus determined should be adopted. The site thus indicated would be situated about Lat. 35° 30' S., Long. 147° 20' E., say about thirty miles south of Wagga Wagga.

Mr. Henry Deane, M.A., M. Inst. C.E.—Referring to the recommendation of a previous speaker, that an area should be set apart for manufactures, Mr. Knibbs had not included this as a necessary provision; and rightly, too. Manufactures, if possible, should be rigidly excluded from the Federal City area. They were not wanted there and there was plenty of room elsewhere for them.

With regard to the remarks of one speaker, that the city should be under one control so as to avoid the evils that had arisen in Sydney through different authorities breaking up the streets at different times, to lay pipes and make other improvements; the City Council would probably not have done any better had they had full charge of affairs. The Federal City would have chances that Sydney never had. It would of course be under one central control, either the Federal Government itself or a suitably selected Commission, and it could be laid out with subways for pipes, etc., and all modern improvements from the start.

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