SILCHESTER, THE VITRUVIAN OCTAGONAL TOWN

Calleva Atrebatum, or Silchester today, is a good example of the literally application of the Vitruvius' theory in town planning.

According to Vitruvius, in F. Granger's translation, ... towns are not to be planned square ... but on the round, so that the enemy be seen from several sides. (L. I, C. V, 2). The towers are to be made round or polygonal. (L. I, C. V, 5.) Some have held that there are four winds ... But those who have inquired more diligently lay down that there are eight ... (L. I, C. VI, 4) ... both for the south wind and for the north wind we shall have marked out eighth part of the town's) circumference. The remaining part of the whole round, three on the right and three on the left, are to be distributen equally,. so that equal divisions of the eight winds are marked out in the figure. (L. I, C. VI, 7.) And so there will be eight equal spaces of winds in the (town's) circumference ... let the gnomon be set upon the angles of the octagon and let the division of the alleys be directed accordingly. (L. I, VI, 13.)

Vitruvius himself seems to be not quite sure of his utilitarian theory on octagonal form: Perhaps those who knew many names of the winds will wonder because only eight winds have been described by us to exist. (L. I, C. VI, 9.) Then Vitruvius goes on loquaciously asserting that there are indeed only eight winds, apparently more to convince himself than his readers.

Contrary to Vitruvius' teaching, Roman towns, palaces, and fortresses, are rectangles, unless the informal preexisting layout or topographical obstacles loosened their shape. The measurement with standard Roman sizes of some Roman rectangular settlements has made evident that octagon, or rather octagram, has been used as proportional key for town plans. (Illustration 1.).

Thus, the modular proportion of Diocletian palace in Split and of the atrium of the palace in Fishbourne, is a quadriagon, approximated by the Pell numbers 29:24. The
Fig. 1. Plans of Isca, or Caerleon today, and of Diocletian palace at Split are in the ratios of Pell numbers:
7 M (50 passus) : 6M (50 passus) and
29 M (5 passus) : 2424M (5 passus) respectively. Both ratios approximate the proportion, called quadriagon, which is geometrically generated by octagram.
form of the fortress *Isca*, under modern Caerleon in Wales, and of the fortress *Mogorjelo*, Dalmatia, is a quadriagon, approximated by the Pell numbers 7:6. Among the many towns in the form of quadriagon, the four cited examples will suffice to illustrate the function of octagram and Pell series. (John Pell, English mathematician, 1610—1685.)

Modular multiples 29 and 24 are terms of the first and double first Pell series:

\[
1 - 2 - 5 - 12 - 29 - 70 - \ldots \\
2 - 4 - 10 - 24 - 58 - 140 - \ldots
\]

Modular multiples 7 and 6 are terms of the second and double second Pell series:

\[
1 - 3 - 7 - 17 - \ldots \\
2 - 6 - 14 - 34 - \ldots
\]

Quotients 29:24 and 7:6 are close to quadriagon, the value of which is \((1 + \sqrt{2}) : 2\). Geometrically, this proportion and the related proportions, square, diagonal, dual diagonal, and double square, originate in the eight pointed star, or octagram. (See illustration 2.)

Vitruvius was whether not acquainted with the proportional role of octagram, and hence his inflated theory on octagonal towns, whether he was one of the illuminated and used winds only to hide the proportional technique of octagram. If this latter is true, Vitruvius borrowed as masks images of winds on the octagonal Tower of Winds in Athens: \(\ldots \text{Andronicus of Cyrhra} \ldots \text{ built at Athens an octagonal marble tower, and on the several sides of octagon, had representations of the winds} \ldots\) (L. I, C. VI, 4.) But it is more probable that Vitruvius' reference on Andronicus is only a support to his own not very strong belief that there are really the eight winds responsible for the towns' shape. Vitruvius seems to be ignorant of the secret know-how of proportioning with the aid of octagram. The allusion on a secret is a dangerous may of hiding.

The modular analysis shaws that Roman rectangular towns and palaces obey the rule of octagram. Only *Calleva Atrebatum* follows the Vitruvian precept on octagonal form. (Illustration 3.)

The plan of Silchester is far from a perfect octagon, but the layout of its streets follows exactly the directions and distances of lines, generated by the three successive octagrams. The directions of Silchester's alleys are north to south and east to west, which is the consequence of the octagram oriented so, that \(\ldots \text{both for the south wind and} \ldots\)
Fig. 2. Proportions, generated geometrically by the octagram and rationally approximated by the ratios of Pell numbers, are square, diagonal, quadrilateral, dual diagonal, double square, and double quadrilateral.
Fig. 3. Calleva Atrebatum, or Silchester, on the grid of the town planning octagram. The dimensions of insulae, measured between the borders of streets, are expressible with terms of Pell series multiplied by the town-planning module M (decempeda).

for the north wind we shall have marked out eighth part of the circumference. (L. I, C. VI, 7.) The distances between borders of the streets (axial rhythm is used in Roman planning only for colonnades, but not for spacing walls and alleys) are modular multiples. Their module equals one
pertica, the roman measuring rod, which is one decempeda long; their multiples are terms of the first, second, and third, Pell series:

— first Pell series  
  \[1-2-5-12-29-70-169-\ldots\]
— second Pell series  
  \[1-3-7-17-41-99-239-\ldots\]
— third Pell series  
  \[1-4-9-22-53-128-309-\ldots\]
— double third Pell series  
  \[2-8-18-44-106-256-618-\ldots\]

Dimensions of insulae (minus the street's width) are standard sizes, formed by terms of Pell series, acting as multiples, and of decempeda, acting as town-planning module. Owing to the preferred dimensions in Pell numbers, insulae in Calleva Atrebatum approximate related proportions of octagram:

<table>
<thead>
<tr>
<th>INSULA</th>
<th>PROPORTION</th>
<th>DIMENSIONS (in decempedae)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>quadratum</td>
<td>(41 \times 41)</td>
</tr>
<tr>
<td>II</td>
<td></td>
<td>(29 \times 29)</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>(29 \times 29)</td>
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<tr>
<td>V</td>
<td></td>
<td>(29 \times 29)</td>
</tr>
<tr>
<td>VI</td>
<td></td>
<td>(29 \times 29)</td>
</tr>
<tr>
<td>VII</td>
<td>diagon</td>
<td>(41 \times 29)</td>
</tr>
<tr>
<td>IX</td>
<td></td>
<td>(29 \times 41)</td>
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<tr>
<td>X</td>
<td></td>
<td>(29 \times 41)</td>
</tr>
<tr>
<td>XIII</td>
<td></td>
<td>(41 \times 29)</td>
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<tr>
<td>XIV</td>
<td>quadratum</td>
<td>(29 \times 29)</td>
</tr>
<tr>
<td>XV</td>
<td>diagon</td>
<td>(41 \times 29)</td>
</tr>
<tr>
<td>XVI</td>
<td>quadratum</td>
<td>(29 \times 29)</td>
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<td>XVII</td>
<td>diagon</td>
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<td>XIX</td>
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<td>(29 \times 41)</td>
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<tr>
<td>XXI</td>
<td></td>
<td>(29 \times 41)</td>
</tr>
<tr>
<td>XXIII</td>
<td>quadratum</td>
<td>(41 \times 41)</td>
</tr>
<tr>
<td>XXVI</td>
<td>diagon</td>
<td>(29 \times 41)</td>
</tr>
<tr>
<td>XXXV</td>
<td></td>
<td>(29 \times 41)</td>
</tr>
</tbody>
</table>

Even the deformed octagon of town's shape has sizes chosen from the Pell numbers. Its north to south and its southeast to northwest dimension is 256 decempedae.

The layout of Silchester obeys strictly the two inner octagrams, but deviates from the outer octagon. Perhaps some military or political authority interfered with their lay demands to include or exclude a particular plot. Or, a possibly preexisting ditch (the one on the northeast?) didn't follow the orientation as suggested by Vitruvius, which made the scheme to be adapted. Or the winds didn't blow from the prescribed directions, which caused the dislocation of some walls to stop them. But the deformity of the circumferential
octagon is certainly not to be attributed to the inability of Roman gromaticus.

Though Vitruvius usually illustrates his theories with existing building, he has no example to offer for his octagonal town, which, compared to the multitude of rectangular octagrammatic settlements, is a sufficient proof that his knowledge of the contemporary town-planning was only superficial. The only example of his theory put inconsistently into practice in a remote province is an exception proving that his praeceptum was only subjective and not universal.

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