Do Factor - Forma

Fausto Simões
arquitecologia.org

LISBOA e·nova
AGÊNCIA MUNICIPAL DE ENERGIA E AMBIENTE

Lisboa, 19 de Março de 2009

à vida no espaço entre os edifícios

$$\frac{\textcolor{red}{2\pi r}}{\textcolor{yellow}{\pi r^2}} = 2/r$$

Factor-Forma

Fausto Simões
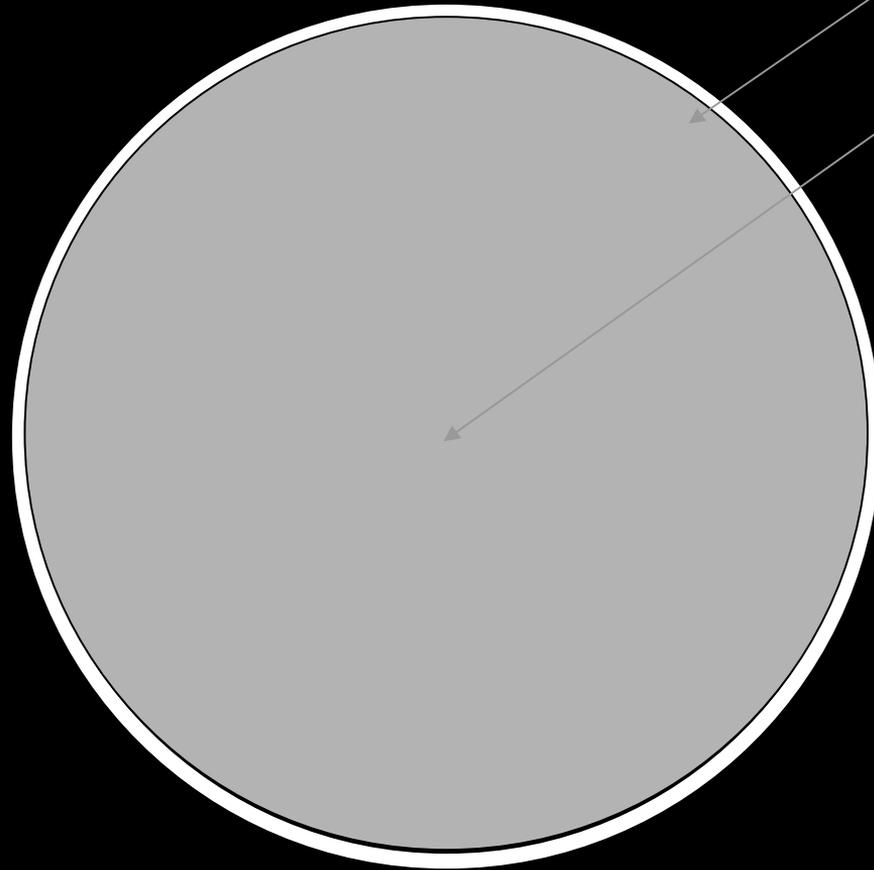
defined it), as any figure which, being added to any figure whatsoever, leaves the resultant figure similar to the original. Included in this important definition is the case of numbers, considered geometrically; that is to say, the εἰδητικοὶ ἀριθμοί, which can be translated into *form*, by means of rows of dots or other signs (cf. Arist. *Metaph.* 1092 b 12), or in the pattern of a tiled floor: all according to 'the mystical way of Pythagoras, and the secret magick of numbers'. For instance, the triangular numbers, 1, 3, 6, 10, etc., have the natural numbers for their 'differences'; and so the natural numbers may be called their gnomons, because they keep the triangular numbers still triangular. In like manner the square numbers have the successive odd numbers for their gnomons, as follows:

$$0+1 = 1^2$$
$$1^2 +3 = 2^2$$
$$2^2 +5 = 3^2$$
$$3^2+7 = 4^2 \text{ etc.}$$

And this gnomonic relation we may illustrate graphically (σχηματο- γραφεῖν) by the dots whose addition keeps the annexed figures perfect squares:[1]

There are other gnomonic figures more curious still. For example, if we make a rectangle (Fig. 77) such that the two sides are in the ratio of $1:\sqrt{2}$, it is obvious that, on doubling it, we obtain a similar figure; for $1:\sqrt{2}::\sqrt{2}:2$; and each half of the figure, accordingly, is now a gnomon to the other. Were we to make our paper of such a shape (say, roughly, 10 in. × 7 in.), we might fold and fold it, and the shape of folio, quarto and octavo pages would be all the same. For another elegant example, let us start with a rectangle (*A*) whose sides are in the proportion of the 'divine' or 'golden section'[2] that is to say as $1:\frac{1}{2} (\sqrt{5}-1)$, or, approximately, as $1:0.618\ldots$. The $\frac{\sqrt{5}+r}{2}$ gnomon to this rectangle is the square (*B*) erected on its longer side, and so on successively (Fig. 78).

In any triangle, as Hero of Alexandria tells us, one part is always a gnomon to the other part. For instance, in the triangle *ABC* (Fig. 79), let us draw *BD*, so as to make the angle *CBD* equal to the angle *A*. Then the part *BCD* is a triangle similar to the whole triangle *ABC*, and *ABD* is a gnomon to *BCD*. A very elegant case is when

[1] Cf. Treutlein, *Z. Math. Phys.* 28 (1883), 209.   [2] Euclid, ɪɪ, 11.

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the original triangle *ABC* is an isosceles triangle having one angle of 36°, and the other two angles, therefore, each equal to 72° (Fig. 80). Then, by bisecting one of the angles of the base, we subdivide the large isosceles triangle into two isosceles triangles, of which one is similar to the whole figure and the other is its gnomon.[1] There is good reason to believe that this triangle was especially studied by the
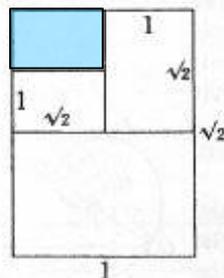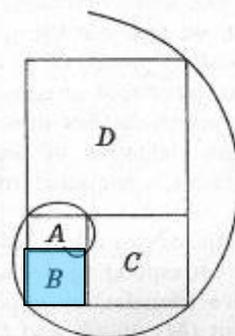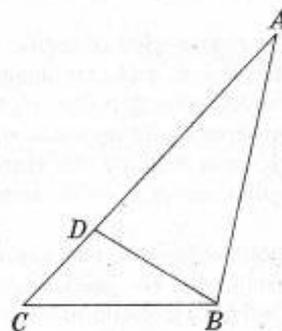
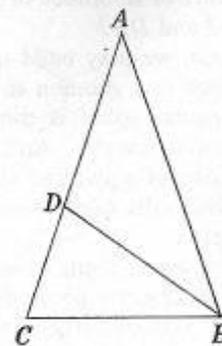Fig. 77.

Fig. 78.

Fig. 79.

Fig. 80.

Pythagoreans; for it lies at the root of many interesting geometrical constructions, such as the regular pentagon, and its mystical 'pent-alpha', and a whole range of other curious figures beloved of the ancient mathematicians:[2] culminating in the regular, or pentagonal,

[1] This is the so-called *Dreifachgleichschenkelige Dreieck*; cf. Naber, *op. cit. infra.* The ratio 1:0·618 is again not hard to find in this construction.
[2] See, on the mathematical history of the gnomon, Heath's *Euclid* (1908), ɪ, *passim*; Zeuthen, *Théorème de Pythagore* (Genève, 1904); also a curious and interesting book, *Das Theorem des Pythagoras*, by Dr H. A. Naber (Haarlem, 1908).
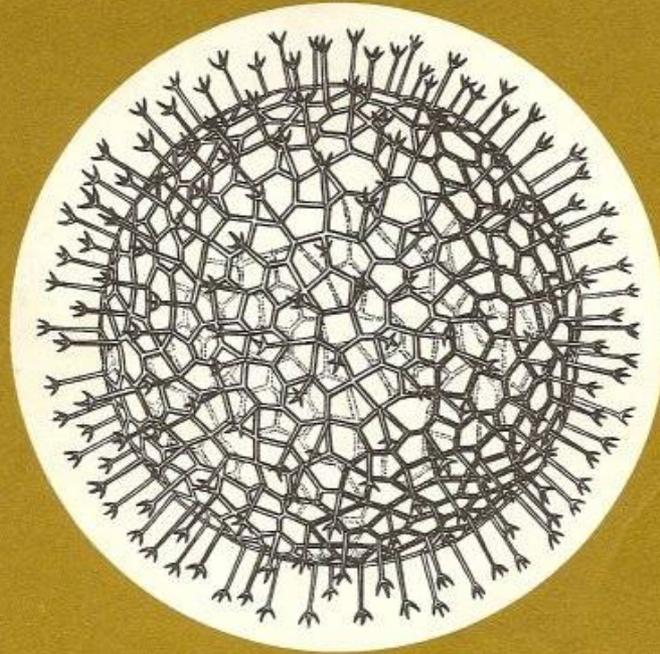
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CRESCIMENTO GNOMÓNICO (Thompson, D. W., 1917)

CRESCIMENTO GNOMÓNICO *(Nautilus Pompilius)*
http://en.wikipedia.org/wiki/Chambered_Nautilus

$$\frac{4\pi r^2}{4/3\pi r^3} = 3/r$$
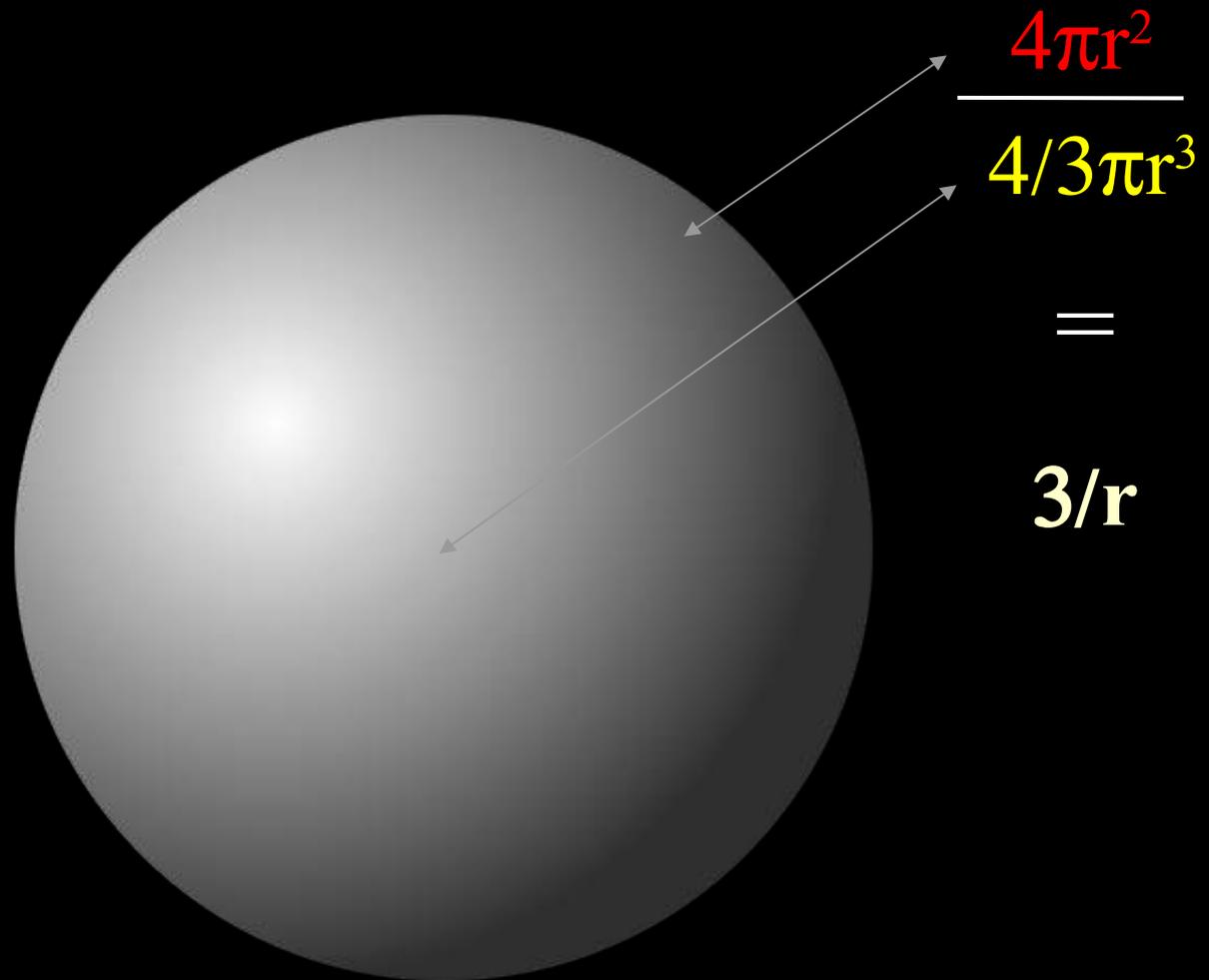
Do Factor-Forma ao Princípio da Similitude

Fausto Simões

D'ARCY THOMPSON

On Growth and Form

ABRIDGED EDITION
Edited by J.T.Bonner

CAMBRIDGE UNIVERSITY PRESS

PROJECTAR COM O CLIMA

O *factor-forma* no RCCTE

Nec. Nom. de Aquec. Máximas - Ni (kWh/m².ano)

$Ni = 4,5 + 0,0395\ GD$ para FF < 0,5

$Ni = 4,5 + (0,021 + 0,037\ FF)\ GD$ para 0,5 < FF < 1

$Ni = [4,5 + (0,021 + 0,037\ FF)\ GD]\ (1,2 - 0,2\ FF)$ para 1 < FF < 1,5

$Ni = 4,05 + 0,06885\ GD$ para FF > 1,5

PROJECTAR COM O CLIMA

Expressão matemática da "conservação do calor" no Inverno combinando o *factor-forma*, o isolamento térmico e o número de renovações por hora

$$Q_{(kWh)} = (\Sigma A\,U + 1/3\,n\,V)\,\Delta t$$

$$Q_{(kWh/m^3k)} = \frac{(\Sigma A\,U + 1/3\,n\,V)\,\Delta t}{V\,\Delta t}$$

$$Q_{(kWh/m^3k)} = (\Sigma A/V)\,U + n/3 = F\,U + n/3$$

Fausto Simões

PROJECTAR COM O CLIMA

Expressão matemática da "conservação do calor" no Inverno combinando o *factor-forma*, o isolamento térmico e o número de renovações por hora
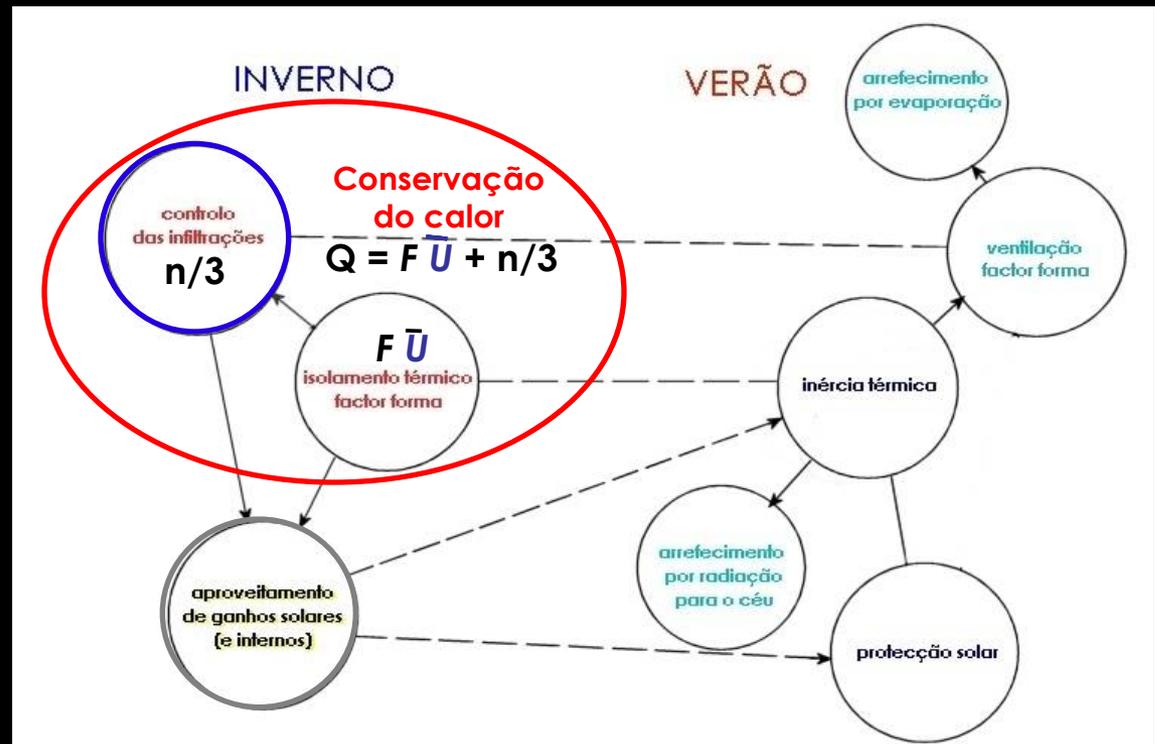
Q Wh/m^3k
F *factor-forma*
U W/m^2k
n *renovações/h*

Fausto Simões
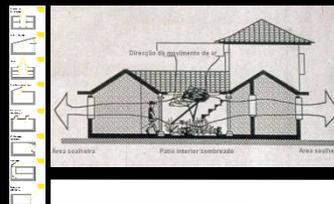
PROJECTAR COM O CLIMA

A importância da FORMA

factor forma

$$F = 2/a \cdot f$$

$$f = [(1+b)/ab]+1$$
$$a=p/a; \quad b=c/p$$

Área de Pavimento Volume Bruto	100.0m2 300.0m3	200.0m2 600.0m3	1000.0m2 3000.0m3
3/r	0.72	0.57	0.33
6/a	0.89	0.71	0.41
a.2a.6a 10/3a	1.14	0.91	0.53

Fausto Simões

PROJECTAR COM O CLIMA

Edifícios comandados pela envolvente

A importância da FORMA

factor forma

$$F = 2/a \cdot f$$

$$f = [(1+b)/ab]+1$$
$$a=p/a; \quad b=c/p$$

Área de Pavimento Volume Bruto	100.0m2 300.0m3	200.0m2 600.0m3	1000.0m2 3000.0m3
3/r	0.72	0.57	0.33
6/a	0.89	0.71	0.41
a.2a.6a 10/3a	1.14	0.91	0.53

Fausto Simões

PROJECTAR COM O CLIMA

A importância da **FORMA**

Edifícios comandados pelas cargas térmicas interiores

factor forma

$$F = 2/a \cdot f$$

$$f = [(1+b)/ab]+1$$
$$a=p/a; \quad b=c/p$$

Área de Pavimento Volume Bruto	100.0m2 300.0m3	200.0m2 600.0m3	1000.0m2 3000.0m3
3/r	0.72	0.57	0.33
6/a	0.89	0.71	0.41
a.2a.6a 10/3a	1.14	0.91	0.53

Fausto Simões

O acesso ao sol dos edifícios e espaços exteriores em ruas Este-Oeste
Av. João XXI (E-W; 29/35°) 22 Janeiro 98 12H00 (31°/167°)

O acesso ao sol dos edifícios e espaços exteriores em ruas Norte-Sul
Av de Roma (340°-160°; 32°)   Jun 2004 16H00 aprox.

O solar-passivo, sendo menos imperativo nos grandes edifícios devido ao menor factor-forma, facilita a compatibilização entre o conforto interior e o exterior e este a animação do espaço público
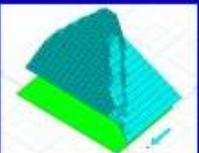

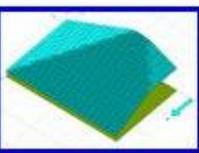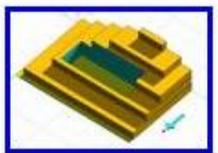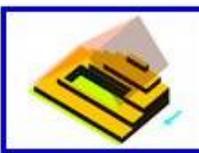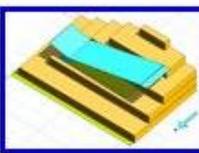Avenida Guerra Junqueiro (325º-145º; 34-44º) 20 Dez 2006 12H30

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Avenida Guerra Junqueiro (325°-145°; 34-44°) Jun 2004 17H00

	1. solar envelope	2. building mass	3. interstitium	4. toldo	5. wind patterns
case a					
case b					
case c					
case d					
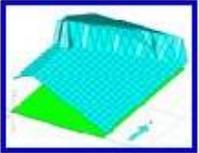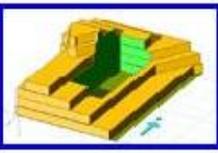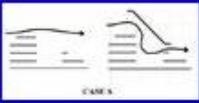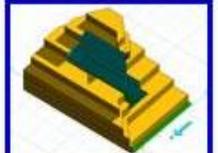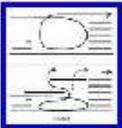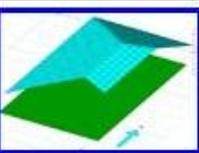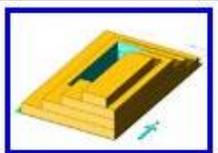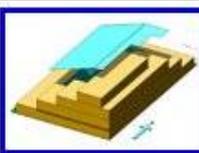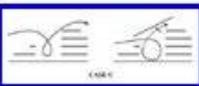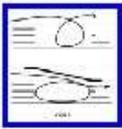
**Direito ao sol
controlo do sol e
do vento
nos edifícios e
espaços exteriores**
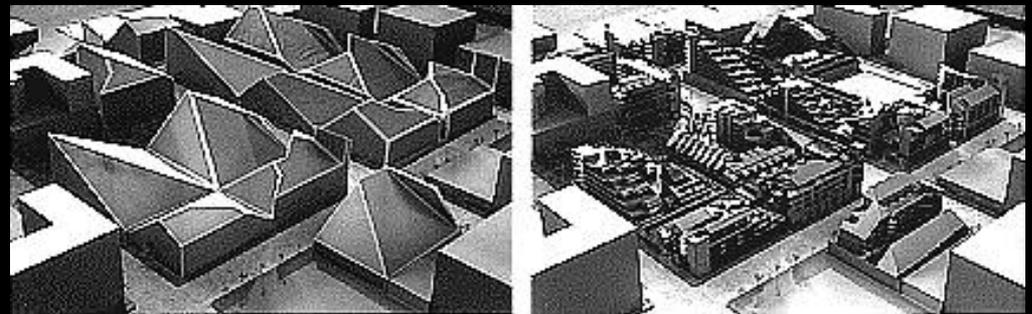
Ralph Knowles (1999), *The Solar Envelope*
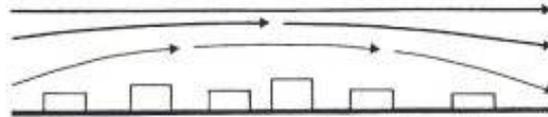
CLIMATE IN THE CITY CENTER

Located in a part of the world with low sun angles and lots of wind, central Copenhagen is well equipped to make the best of these conditions.

The dense, homogenous mass of buildings directs the wind to pass over the city, and the small spaces and crooked streets assist further in this task. Whatever wind is left in the spaces between the buildings becomes much gentler than in areas outside the city center.

The relatively low building heights also give good sun access to the streets and squares.

These factors give the center of Copenhagen a milder and more pleasant climate than in the rest of the city. A fortunate situation indeed.

The wind tends to pass over low and rather dense built-up areas.


Very few high-rise buildings have been built in Copenhagen, and none in the old city. On windy days – of which Copenhagen has many – pedestrians have to hang on to their hats near existing high-rises. The photo below is taken on Vesterbrogade, in front of the SAS high-rise hotel.
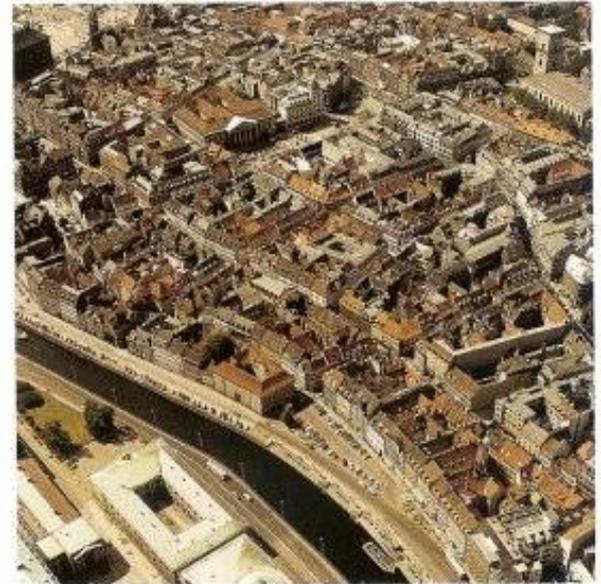
Right: Copenhagen's medieval structure and homogenous low building mass help make the most of climate conditions. The physical structure reduces wind and shade and provides good sun access. (The cars parked on the two city squares show that this photo was taken before the 1990's.)
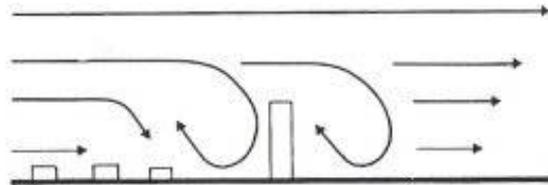
High, free-standing buildings catch fast high winds and create turbulence. The wind can be as much as four times stronger around high buildings than in the surrounding landscape.
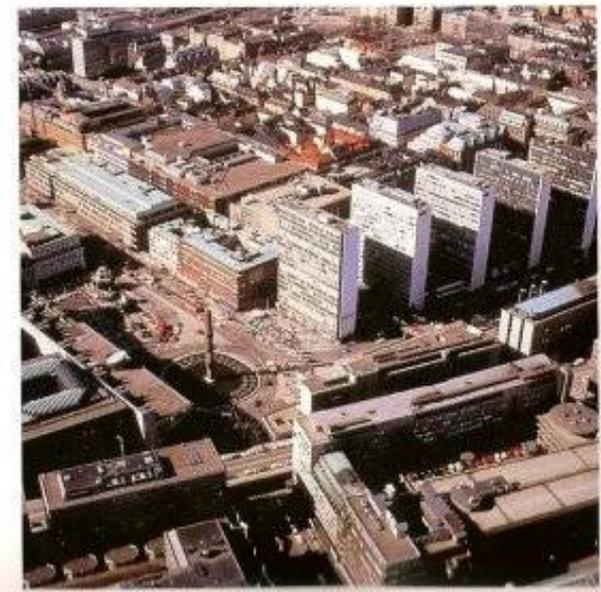
Right: Stockholm city center was radically reconstructed in the 1950's and 1960's. One of the byproducts of this reconstruction, with its wider streets and taller buildings, is more wind, more shade, and less sunshine in many places. All in all, a much colder city climate than desirable in this region.

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PROJECTAR COM O CLIMA

A importância da FORMA
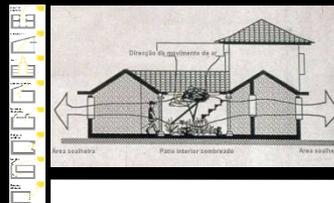
A variação do Factor-Forma com a forma e a magnitude em simultaneo favorece a "porosidade" urbana

factor -forma

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$f = [(1+b)/ab]+1$
$a=p/a; b=c/p$

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a.2a.6a 10/3a	1.14	0.91	0.53

Fausto Simões

Diogo de Torralva, 1554 (inic.)
Convento de Cristo
"Claustro dos Filipes"
Tomar, Pt

..."Torralva aumentou a espessura dos pares
de colunas[...] Ao mesmo tempo,abriu passagens
nos pilares e rasgou-os de frestas e quebra-luzes
atingindo assim a característica
nitidamente portuguesa da **parede "habitada"**[...]
As solicitações tactil e visual são constantemente
reforçadas pelo encontro entre
ambas a sensações."
(G. Kubler, *A Arquitectura Portuguesa Chã*,
Vega Lda, 1988)

Acolhedor "camarote" à sombra de um arco entre pátios murados.

A sensação de frescura é reforçada pela presença da água ao alcance da mão e pela vegetação

Reales Alcázares de Sevilla

A temperatura em Portugal poderá subir de 3º a 5ºC até 2100 devido ao aquecimento global (SIAM 2001);

Agravando-se a instabilidade climática e as ondas de calor em Verões mais quentes, ganham importância as estratégias de arrefecimento e os "espaços intermédios"
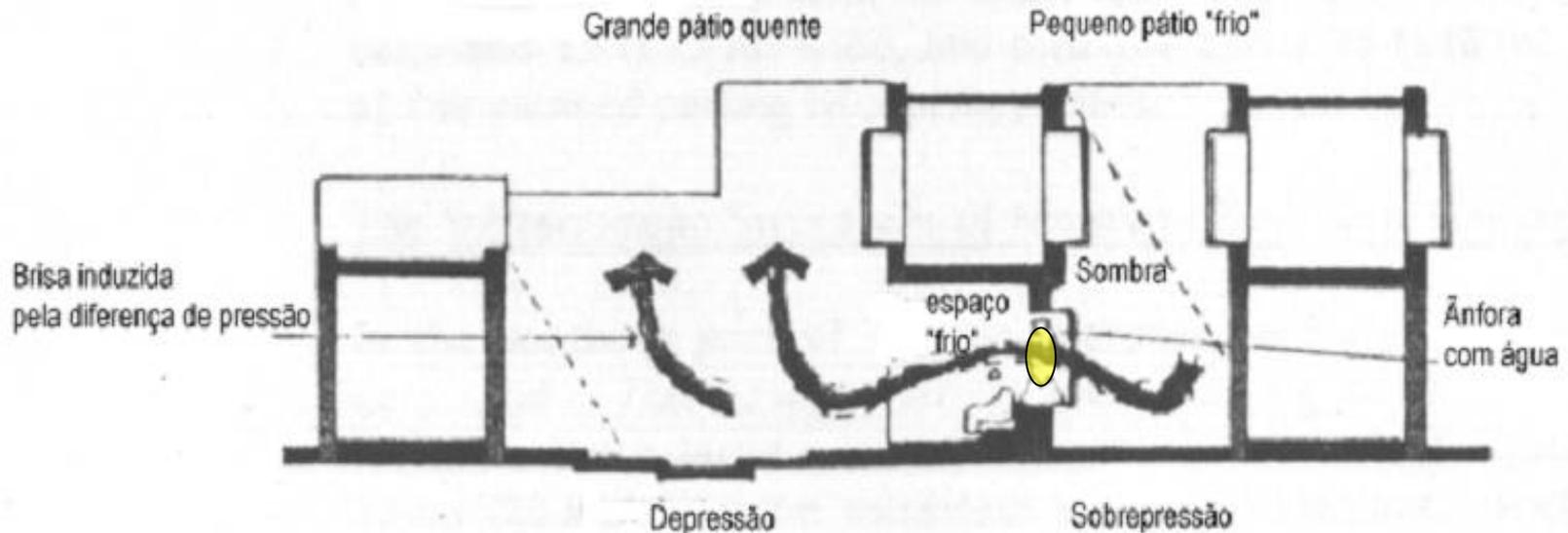
Fardeheb Fewazi. *Passive Solar Journal,* 4(4), 377-417 (1987)

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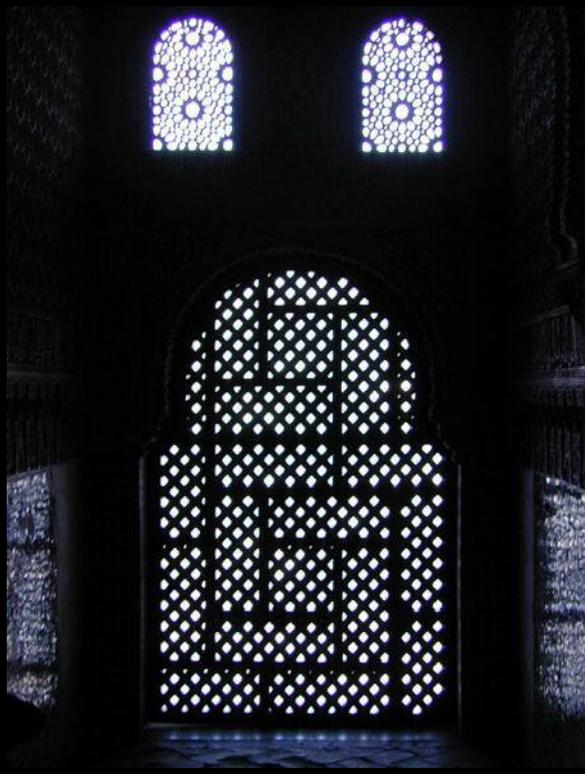

Espaços intermédios pesados e públicos em Beja

A temperatura em Portugal poderá subir de 3º a 5ºC até 2100 devido ao aquecimento global (SIAM 2001);

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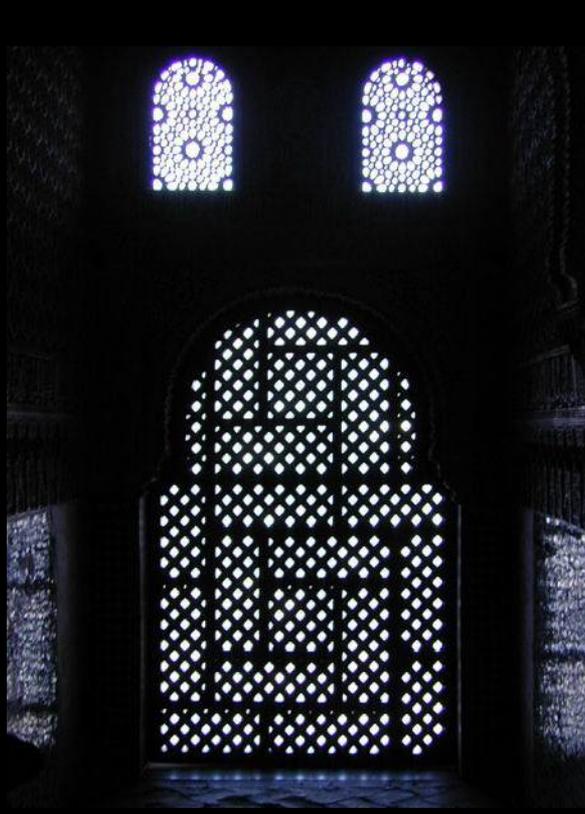
Espaços intermédios leves e privados

FIM

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