

In search of the best city measures: ten propositions

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ABSTRACT

There is a remarkable tradition that stands for a close relationship between good architecture or good city form, and the precise dimension of their elements. It defends the existence of well-defined rules that link the parts with the whole city, smart rules that were applied from ancient times until present. In this paper I would like to discuss some of these arguments, checking how designers have long sought for measures that assure the good shape of the city, its best performance, hygiene, safety and beauty. Among these rules density has quite recently become one of the most relevant attributes to describe the form and characteristics of a city. Therefore Vertical Cities Asia has proposed a project set on a main parameter, a density of 100.000 people per square kilometre. It is certainly a remarkable high density.

But is it too much?

And until what extent a given density may determine the urban form?
I would like to share with you ten propositions regarding these questions.

Key words: density, urban parameters, and good city form

1. Discovering the most suitable proportions between the parts of a building or a city has been a continuous aim in the history of architecture and urbanism

Diverse proposals defend a close relationship, a confidence on an accurate mathematical and geometric connection, between the parts and the whole city, following specific guidelines to guarantee good architecture or a good city form.

This aim is quite common in classical studies, but also in the most recent ones by Lionel March and Leslie Martin, or using the powerful Spacematrix.¹ The goal to find the best measures runs along many rich cultures from the field of architecture to the construction of towns. You may recognise it in Plato Dialogues, or in his book about the Republic;² in different medieval treaties; and in the background of all the extensive colonisation processes in France or Spain.

It implies a theoretical desire, but also a rich field of experimentation. I am not going to discuss who was the first searching these magic measures, or designing regular cities,

¹ See Leslie Martin, Lionel March and Marcial Echenique, "Urban space and structures", Cambridge University Press, London 1972 or Meta Berghauer Pont and Per Haupt, "Space, Density and Urban Form". PhD dissertation, Technische Universiteit Delft. Delft 2009.

² See among Plato writings, "The Republic" or the series of Dialogues.

whether China or Mesopotamia. In fact the most ancient cities tried to be quite regular in shape, based on precise grid patterns, and many of them searched ideal measures.

Regular geometric patterns become quite common features in classical Greece, where the concept of Hippodamian layout appeared;³ but also in the Roman camps; in some Middle Eastern Arabian cities; in the fortified French *bastides* in the 13th century;⁴ in the cities along the *Camino de Santiago*; in the Spanish villages after the Christians Reconquest, and obviously in the great epic of the) foundation of cities in Latin America from the sixteenth to eighteenth centuries.

With the great European Town Extensions of the nineteenth century the discussion about the best measures of streets and blocks spreads again at a broader scale.

2. Soon these projects relate to the most appropriate street, block and building parameters with some desired urban attributes, like hygiene, safety or beauty

Maybe the engineer Ildefons Cerdà with his broad scientific studies to support the Town Extension project for Barcelona was one of the first to show this concern.

The reasons for his 20, 30 and 50 meter streets, 113 by 113 meter octagonal blocks, and interior courtyards of nearly 3.000 square meters have been widely discussed. Quite often he has been criticized about worrying too much about street intersections, proposing blocks that are too wide or neglecting architecture.

The question still remains how different Barcelona would have been with Berlin, Buenos Aires or Manhattan blocks?

Many researchers have tried to find the secret reasons for the peculiar measures of his project, so strange that they should be considered key design decisions. They have speculated about the mysterious origin of the form of the block and its measures.

But in fact we discovered twenty years ago that the engineer Ildefons Cerdà tested quite different measures, before designing his 113 by 113 meter blocks. And we further

³ Hippodamus of Miletos proposed some regular city layouts (Hippodamian grid) during the 5th century BC. He seems to be the originator of the idea that a town plan might formally embody and clarify a rational social order.

⁴ The *bastides* were usually fortified towns founded in the 13th century in south-west France, where some fine examples still remain. These medieval new towns were usually built to a strict grid layout, with equal space allocated to each house and had various functions, including improving security and safety of the residents and promoting trade. A central square often contained a market hall and sheltered arcades around the edges.

discovered that he consciously decided the measures of his project not considering astronomic, magical or geometric criteria, but trying to optimise the efficiency and mainly the habitability of the new city, evaluating and providing the volume of air that every dwelling occupier needed (30 m³ per hour), through a complex mathematical formula.

A few decades later German professionals like Stübben, Baumeister or Eberstadt wrote impressive studies, where they formulated the discussion on the shape and dimensions of urban layouts, or the most appropriate and most logical depth of blocks from the point of view of economy and hygiene.⁵ Nevertheless not one of their treatises achieved the scientific level and precision of Cerdà's contributions.⁶

3. The measures of urban tissues are quite relevant to guarantee their quality

Thirty years ago we analysed more than a hundred city foundations and town extensions over a long time span, all of them based on regular grids.

Measuring the width of the streets, the depth of the block and the area of the basic module, we tried to answer some intriguing questions:

Would it be possible to find some regularity among these projects, some significant relations between these parameters?

Would it be possible to find some precise measures that guarantee more efficient, healthier or even more beautiful cities?

Our analysis concluded that shape and dimension of streets and blocks, typological features of the buildings, and the resulting quality of the city are quite closely related. It was possible to discover quite precise intervals where these street and block dimensions implied better urban scores regarding health, efficiency or even beauty. We also found some categories of cities that gave priority to different attributes. Following this argument, one of our main goals as urban designers should be, like being at the tailor's workshop, to choose precise measurements.

⁵ See mainly Joseph Stübben "Der Städtebau" (1890); Reinhard Baumeister "Stadterweiterungen in technischer, wirtschaftlicher und polizeilicher Hinsicht" (1876) and Rud Eberstadt "Handbuch des Wohnungswesens und der Wohnungsfrage" (1909).

⁶ Among other main treatises see his report on the first project for the Barcelona town extension (1855); "Teoría de la construcción de ciudades aplicada al proyecto de reforma y ensanche de Barcelona" (Theory of city construction as applied to the Barcelona reform and town extension project, 1859); "Teoría general de la vialidad" (General road theory, 1863-67); "Teoría general de la urbanización" (General theory of urbanisation, 1867).

4. Some specific cities score well in this kind of “league tables”, and in this sense many international observers regard Barcelona’s town extension (*Eixample*) as one of the greatest pieces of urban architecture

In 1859 the Cerdà interpretation of the grid implied in 1859 a dimension of modern rationality, a mixture of order, discretion and homogeneity that generated empathy with the Catalan society. But what are their specific measures that contribute to this?

The central *Eixample* covers today 819 hectares, half of this area taken by roads, open spaces and public facilities, and the other half by private zones. We could roughly talk about one third for roads; one third for open spaces and interior courtyards and one third occupied by public and private buildings.

The streets of 20 meters and avenues of 30-meter width define 498 quite regular octagonal blocks, and 10.235 plots, also quite regular.

In the *Eixample* 308.340 inhabitants live and there is around 264.500 people daily working. It implies an average density of 323 jobs per hectare, a figure only found in quite specialized and dense central areas.

The residential floor area covers 56% of the total built surface, and the non-residential one a 44%, including public buildings that generate a lot of activity. These proportions are quite similar to those of high-valued central areas where housing is still quite present. Such a high concentration of people and jobs is supported on a high floor area ratio (more than 3 square meter floor per one square meter land).

There have been recent attempts to measure the amount of information of different cities.⁷ In the *Eixample* this amount of information (diversity) shows its centrality. It scores values over six bits of information per individual, becoming the greatest area of centrality in Spain. It has been built as a complex ecosystem, comparable, in relation to natural systems, to the tropical rainforests or coral reefs.

The *Eixample* radiates activity around it and it extends the urban complexity along some streets. Interruptions in the linking of activities are shown by holes that mean lower levels of urban diversity. A so called 22@ district is currently under development.

⁷ A “bit” is an information unit that measures the amount of uncertainty that exists in the situation in which one has to choose between two possibilities; for each possible trajectory one bit is added.

When it is completed, this enlarged *Example* will become one of the most important world urban fabrics in terms of activities related to information.

You may add the enormous flexibility provided by the grid, which allows urban fabric to host diverse architecture, and an intensive network of public transport and services. All these characteristics make this area a paradigm of contemporary urban planning. Its functional mixture and urban complexity provide a great level of urban sustainability.

5. Not always high residential densities and high intensity of activities have been regarded as positive urban features

A high concentration of population in 19th century industrializing cities has been considered to be one of the major causes of fires, illnesses, epidemics, deaths and social turmoil.⁸ Therefore in this period, density was introduced as a powerful tool to analyse the quickly growing and often overcrowded cities and their problems. After decades of increased public intervention (cities and state), density evolved into an instrument used to search alternatives and to control urban parameters in order to guarantee air, light and privacy to every home. Despite this extended opinion today it has become clear that we need minimum densities to support facilities and public transport, even more, to guarantee social coexistence and urbanity, as part of the ingredients to produce more sustainable urban environments with potential for vital human interaction.

This shift from prescribing *maximum* to propagating *minimum* densities can be illustrated referring to two famous planners: Raymond Unwin and Jane Jacobs. Unwin claimed, at the beginning of the 20th century, that nothing was to be gained from overcrowding in cities; and he proposed a maximum density of 30 houses per hectare.⁹ Fifty years later Jane Jacobs warned that American slums were not only an issue faced in the inner cities, but also in the low-density, dull areas on the suburban extensions. She suggested that a minimum of 250 dwellings per hectare was a necessary condition for a vital and participatory city life.¹⁰

⁸ See Berghauser and Haupt, op cit.

⁹ Raymond Unwin, "Town planning in practice: an introduction to the art of designing cities and suburbs", T. Fisher Unwin, London 1909.

¹⁰ Jane Jacobs, "The Death and Life of Great American Cities", Random House, Inc., New York 1961.

6. Today we share a general consensus that high densities are more sustainable.

In many occidental cities the dramatic increase in space consumption during the last century has become a crucial problem in urban agendas. There are some clear trends in the so considered wealthy societies: the number of inhabitants per dwelling unit decreases, dwellings become larger, and cities less densely built. The sprawl of people and activities has dramatic effects generally acknowledged, like the increase in car and goods transport, in energy consumption, air and noise pollution, fragmentation in the ecosystems. Public transport, local amenities and public services become hardly viable.

Currently city development follows quite different trends. It evolves explosively and out of control; it obeys quite strict public rules, or it occurs through negotiations between private and public actors. But whatever the political, economic and technical balances will be in the near future, some urgent issues, like urban density require substantial responses. One century ago, the overcrowded English industrial cities provoked some reactions (Garden City Movement and limitation of densities). But today, overcrowding, extreme poverty and human misery have moved from Manchester to Manila.

Demographic, social and economic trends have impulsed low densities and created new problems driven by overconsumption of resources (transport, goods, energy and space). And evidently high density is not enough to face these problems. But today we know that low densities contribute to private car dependency, increase of carbon dioxide, less social contact and less urbanity. Densifying our cities has become one of the main requirements to achieve a more sustainable city, a priority in urban agendas.

7. The fastest growing cities in the world are achieving quite high densities, but urban residential density and activities intensity may have some limits, and obviously some added requirements to guarantee urban quality

Barcelona's town extension (the *Eixample*) has, like some other important cities, quite a high density of people and activities. However this has caused, like in so many other dense cities, excessive car occupation, high levels of air and noise pollution, visual intrusion and low proportion of open spaces per habitant. And Barcelona's gross density is just 376 inhabitants and 323 jobs per hectare. You may consider it already

quite high, but it is just one third of the proposed at the Vertical Cities Asia competition, and never achieved until now covering a whole city.

Therefore all the entries in the competition have done a great effort locating this amount of people and jobs in only one square kilometer; even if we admit that several of these proposals have compromised a larger area (the whole 5 square kilometer proposed as reference site). Meanwhile net density achieved 1.000 people per hectare, gross density only scored one fifth. But even in these cases it becomes higher than in the most dense cities in the world.

Despite urban growth follows a variety of patterns, the current tendency is to increase the concentration of population and the intensity of their activities. A new generation of megacities with over 10 million people is developing, mainly across Asia and in a second level, in some parts of Africa, North- and South America.

The pace of urban change can be measured by the amount of people who will be added to each city every hour by 2015,¹¹ or by the increasing international air journeys, that bring cities into closer contact, and at the same time highlights the differences between them.

This pace becomes more and more accelerated, and the human concentration in megacities higher.

If we look at New York, Shanghai, Mexico, or to many fast growing cities in the world, we discover that they are achieving quite high densities. But in these cases the highest gross average density arrives only to 9.610 people per square kilometre in New York. In Shanghai it increases until 24.673 people, if you consider just its urban core and until 37.600 people per square kilometre in the Barcelona town extension. This implies just one third of the proposed at the Vertical Cities Asia competition.

So density matters, but it seems that there have been until now some limits to growing densities.

¹¹ 23 to Mexico and Guangzhou; 24 to São Paulo; 25 to Beijing and Manila; 32 to Shanghai; 39 to Jakarta, Kinshasa and Dehli; 42 to Karachi and Mumbai; 50 to Dhaka and 58 to Lagos.

8. High density is not enough to achieve positive scores; it should be always accompanied by a really efficient public transport system, and by strict open space requirements

Vertical Cities Asia demands a really high density (100.000 inhabitants and 100.000 jobs per square kilometre; around 400 dwellings per hectare). As far as we have seen, it implies at least four times the highest records achieved by the densest cities. And being so dense, all these cities have to deal with difficult questions like car congestion, pollution, and lack of air, light or green space for their inhabitants, not to talk about participatory city life or social equity.

One should also consider that the one square kilometre piece of the Vertical City would have to be connected to several other pieces, or to other cities, requiring a very intense and efficient public transport system.

The biggest and densest cities in the world show us until what extent they rely on public transport, or how many people have to cycle or walk to arrive to their workplace.¹² So reducing the amount of forced movements, due to increasing teleworking, mixing commerce and services with housing, and providing a quite efficient public transport system becomes absolutely essential, as we have seen in all the proposals presented to the competition.

Architecture alone, without urban considerations, does not guarantee the solution. But it is part of the solution. An area intensively occupied with dwellings, services and facilities usually does not allow enough space at the ground floor level for open spaces. So three-dimensional considerations have been taken into account by all the participants in the competition.

Some years ago Kazuyo Sejima argued in her “Metropolitan dwellings study” that high density and the corresponding high buildings did not avoid enjoying an own open space. She developed different alternatives of apartment buildings (with 70 square meter dwellings). Even with high and narrow buildings quite close to one another, it was possible for all the units to face the side that gets most sun. Terraces of individual units appear like random holes in a flat volume, revealing glimpses of the landscape on the side of the block and reducing its monolithic quality.

¹² Public transport covers 24% of the total movements towards working places in Shanghai, 55% in New York and 78% in Mexico. 15% of New Yorkers walk or cycle to their workplace, only 1% in Mexico, but 67% in Shanghai.

Nevertheless one should explain that Kazuyo Sejima's proposal achieved a gross density of only 120 dwellings per hectare (one third of what Vertical Cities requires).

9. Density determines urban form

Scholars have argued that the use of density for anything but statistical purposes is questionable. And many professionals, as well as researchers, have held the opinion that density and other physical properties are independent of each other.

Once arrived to this point one should consider the extraordinary rich research of Berghauser-Haupt. "Space, Density and Urban Form" shows us that urban density contains valuable information about important spatial properties and has the potential to be effective in developing a method capable of simultaneously articulating quantity and quality (eg. related to daylight access, parking, privacy and buildings types).

But to do so the concept of density has to gain in sophistication and complexity. In that sense density should be considered a *multivariable* parameter, composed by three main indicators: intensity (FSI), compactness (GSI) and network density (N).¹³

To discuss simultaneously these indicators, a three-dimensional diagram, the *Spacematrix*, has been proposed. On the y-axis, it is expressed the built intensity of a certain area; on the x-axis, an indicator of the compactness of the built environment, and on the z-axis, the network density, an indicator of the size of the urban layout. After analysing more than a hundred samples their research The outcomes of the research show different regularities. For instance the variety in profile widths is larger when the network density is lower; the samples with the highest network density mostly have narrow streets and islands that contain low-rise buildings; wider streets are often accompanied by higher buildings.

After analysing more than a hundred samples the research concludes that by combining building and network densities, the performance of an area, in terms for example, of daylight access, public parking, urbanity and privacy changes substantially. Urban density conditions the performance of an urban fabric.

10 So summarising:

¹³ See Berghauser and Haupt, op cit.

- a) Over centuries city builders have searched the ideal form and measures of the city.
- b) Several recent research projects tried to find relationships between the measures of urban parameters that ensure more efficient, healthier or even more beautiful cities.
- c) In our research we could not finally find the magical dimensions, but quite interesting regularities and some precise intervals of measures where these street and block dimensions assured better urban scores regarding health, efficiency or even beauty.
- c) In a broader and more complete interpretation density really matters and a more sophisticated, multivariable definition of density determines urban form.
- d) Higher urban densities, but not only this measure, will be required to face in the future the main threats and challenges of our urban societies.
- e) Vertical Cities Asia has intended precisely to answer these challenges by multiplying by three the scores of our most dense and most intensive cities, without affecting their quality of life.
- f) Many students and scholars have been encouraged to “think out of the box”, and I am quite sure that these kind of contributions will become a real milestone in future urban planning proposals and decisions.