cities full of space
qualities of density

A city should be buzzing




full of people, functions, movements. In order not to be oppressive despite that density and fullness not to be oppressive, a city also features grand open spaces. Relatively small pieces of urban fabric offer a complete film of impressions. When part of such a condensed piece of city is broken down, it is often found to have covered a relatively small footprint.

ingenious density

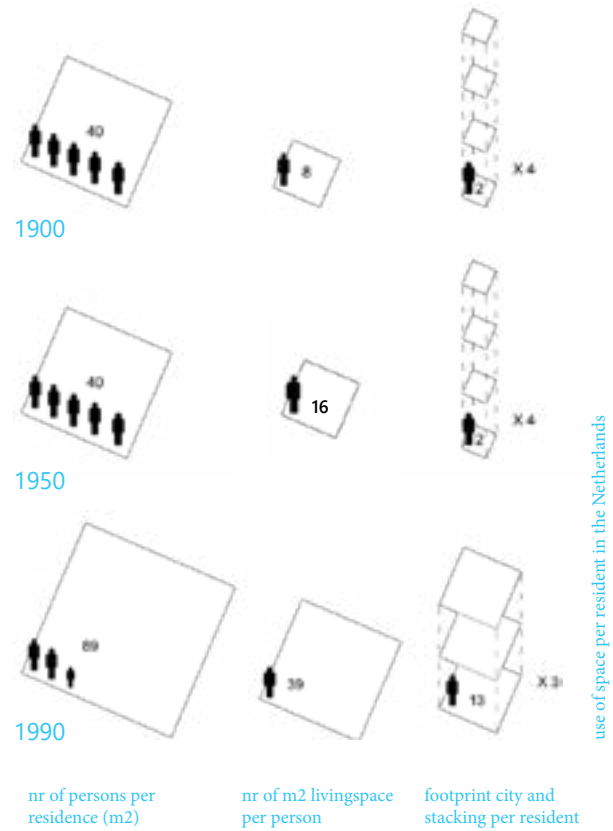
The paradox 'space in density' is the secret of beneficent cities. To design new cities to be designed with the same qualities, existing cities need to undergo observations, typological explorations and fundamental research must be carried out. Due to centuries of inventiveness in the use of space, a lot of implicit knowledge stored there about how density works.
The sample cities were not designed all at once designed at once: their density and spatial stratification grew almost organically, born out of a pursuit of companionship, prosperity and distraction. Because of this need for proximity (the essence of the city) grew the population and the number of functions. Higher and deeper building made the urban fabric increasingly dense. Both operations complicated some of the spatial qualities of inter intertwined urban activities, more dynamism and more efficient land use. Ingenious spatial systems of public and collective spaces where the meeting of different subcultures leads to synergy - the urban potential.

explosion of the city

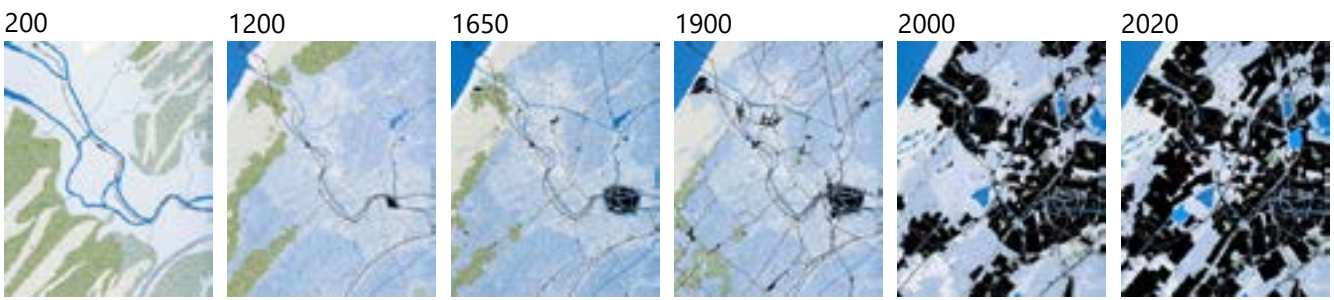
The need to densify is now not found in the city itself anymore. Protective ramparts have long since lost their function: Due to more intensive mobility, technology and the decreased economic importance of agricultural land the boundary between city and landscape has become diffuse. Big cities have exploded and have 'spilled' enormously with space. Amsterdam for example, grew in a century from 15 km2 to 200 km2, the thirteenfold, for housing only one and a half times as many people (500,000 to 750,000 inhabitants).

half as many people in 3x as large houses

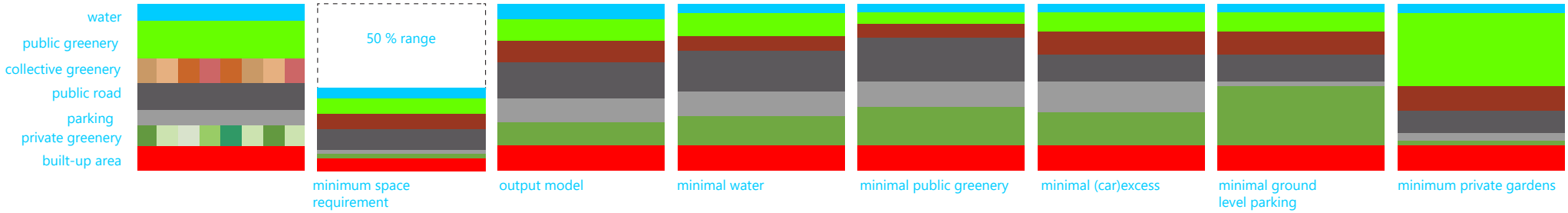
The use of space per person, direct and indirect, accounts for a factor of 6 for the expansion of the urban area: 'half as many people in 3x as big houses'. When those houses are then also on 2x as much land are, that works out cumulatively as 2 x 3 x 2 = 12.



The Dutch population will hardly grow in the coming decades, but housing will: to 150-200 m2. The efficient housing machines Le Corbusier dreamed of will never be realised. Western man does not want that efficiency, wants be able to wander in his own home. And if occupancy rates fall by 20%, the space requirements of our homes is likely to increase by a factor of 2 to 3. We will need to develop strategies how we can the city accommodate this expanding private property?



Recent explosive growth of te city of Leiden



science: space economics

To arrive at these strategies, we need to systematically gather knowledge and link awareness, knowledge and precision link. Particular achievements in of the efficient use of space can lead to a new science, an 'economy of space'. Historic cities constitute rich sources of knowledge about density to spaces for the purpose of basic and design research.

measuring densities, floor space index (fsi)

Answering these such questions can only be done when sufficient data are available. How effective are newly developed, but certainly also historical urban tissues really? The widely used measure of density in (urban) residential areas is the number of dwellings per hectare. Although the concept of housing density, due to its apparent connection with a number of inhabitants appeals to the imagination, as a unit of measurement it comes for a more scientific approach falls short due to a number of implicit variables. For how big is a dwelling? And is it only about housing or are there other functions in the area? It is therefore much better to express density in the unit fsi, the Floor Space index, which objectively maps how efficiently handled with space. A ratio: The realised amount of floor space in relation to the floor area. Values between 1 and 2 are already quite urban. After all, 2 means that the built-up area is is 2 times the size of the land area. Portions of Barcelona with densely placed building blocks seven storeys high come close to an fsi of 3.

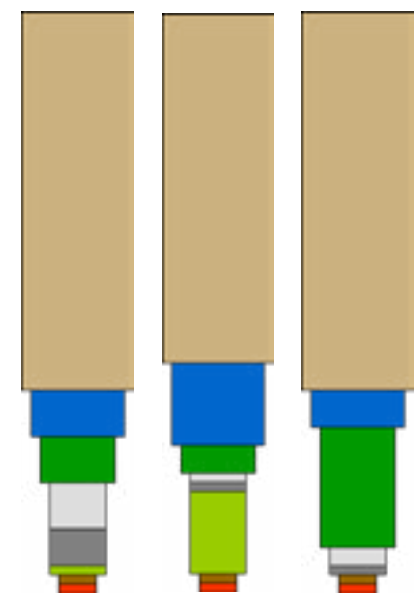
fsi

The fsi is only a useful piece of information when the one area can actually be compared with another can be compared, and they are clearly delineated. The ratio of net to gross (the specific density of building and urban fabric) is different at each scale level: net house or residential building: lowest scale level. The fsi will be close to the stack factor: voids, setbacks and cantilevers will cause deviations. Following this: fsi net plot: including the necessary outdoor space (plot, issued/private land). fsi gross plot: including public space for access and light to the buildings. urban net fabric: building block or strip, villa/tower or residential unit plus immediately surrounding space. The length of a row of houses affects the fsi: the heads require additional space. the neighbourhood: a hierarchy of accesses, including parks and amenities. district, city, region, country: the highest scale levels.

The precise definition of these fsi types is especially scientifically important because it allows the comparability of urban tissues is improved. With this, more exact statements about capacity possible. Socially, the absolute values realised are values are also important. They provide insight into the different distribution models and can thus make clear in which sphere space and volume is organised.

tare telescope

The so-called rate telescope allows the various urban planning choices can be visualised and assessed. The tariff telescope brings together the ratio between net and gross area at the various scale levels. It is therefore an instrument to monitor and programme monitoring and programming, thereby stimulating diversity. Per scale level in discs expressed in a bar graph, the per area (district) the tariff telescope shows a different structure and different disc thicknesses.

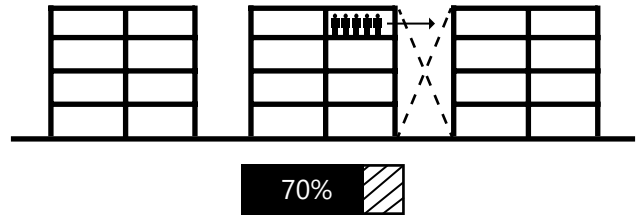


Tare telescope at city level: street city, garden city and park city. Brown represents gross urban space.

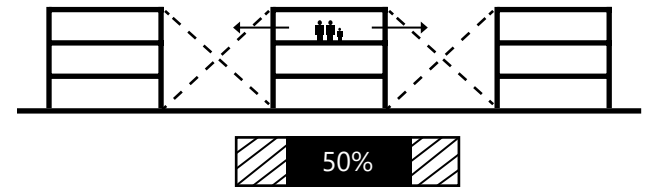
Analogous to topographical maps, there are red discs (built-up), green (unbuilt-up) blue (water) and white (infrastructure). The composite profile of discs says a lot about the character of an area: the division between private, public and landscape gives the Gooi a very different profile from a CIAM-neighbourhood. We can make city models with different allocation of space across those scales with each other. The spread in choice composition is both from the point of view of varied living situations (choices) and for landscape variety of great importance. When distributing the available space budget, the telescope different characteristics can be created. In doing so, the average value of that space budget will be important. Not as a solution but as a standard or indicator of the (in)equality of an area.

arithmetic, patterns and profiles

We examine the laws underlying underlying spatial density (of dwellings) in urban areas in relation to their spatial quality. We want to understand density (functional density, density to diversity, density to significance) and spatial quality is the ultimate goal. To this end, a computational model in which the densities are studied that can be realised with four building types can be realised - the point, patio, strip and block buildings - and what their urban and spatial qualities are. The calculation model has a number of important parameters. he façade index is one such parameter: the ratio of façade area to gross floor area (GFA). The façade index is an important economic factor because the amount of façade largely determines for construction costs. Optimising the façade index, i.e. keeping the amount of façade per square metre GFA as low as possible, is a big advantage in economic terms. However, these financial benefits here, as more often, against the (spatial) qualities.
The more façade a building has, the better the daylight access, the more generous the views and the more imposing the spaciousness.



1900
5 persons per residence
short cross-sections
limited vision unilaterally oriented
narrow streets



2000
2.3 persons per residence
long cross-sections
view two sided
broader streets

Another important variable is the daylight angle. It determines the distance between two buildings or building volumes so-called shadow distance. This results from the assumed angle of obstruction and obviously affects on the fsi. The larger the daylight angle, the smaller the shadow distance and the closer the buildings are to each other. Reasoning through, the the obstruction angle also determines the relationship between space and mass.

laws of density For a city, a good relationship between volume and space is crucial. Not only as an absolute ('ideal') percentage but especially as a distribution issue where particle mass and space are optimally organised in relation to each other are organised. Distributions across different scale levels lie on top of each other and thereby determine the final urban fabric. Our research yielded the following laws of density:

1. Higher and deeper building leads to higher density (expressed in higher fsi)
2. Density does not increase linearly: with increase there is reduced lake yield.
3. Deeper or higher by itself leads to lower higher yield than when applied in combination. applied.
4. Patiopatterns, for equal height and construction depth, achieve the highest density, towers the lowest.
5. Corrected for equal façade index, the density of the density of strip-building blocks and patios do not. Point buildings score slightly lower.
6. Point building optimised as a checkerboard gives the highest density (for equal façade index and obstruction angle).
7. fsi is scale-independent. When storey heights are proportional to building depths are increased, this has no influence on the density (fsi) and the façade index also remains the same.
8. With fixed overall building height h and equal gross floor area shallow, lower floors yield a slightly higher fsi.
9. The larger the external obstruction angle the higher the density.
10. Density does not increase linearly but closer building together has greater effect with fewer layers.
11. Exposed area in buildings is linearly proportional to the façade index.
12. At equal obstruction angle, penetration depth is daylight is greater with less street width.
13. The theoretical penetration depth of daylight is: street width* floor height (building height/ ceiling height relative to ground level).
14. Realised penetration depth is reduced by any obstruction caused by facade and side walls insofar as they do not reflect (%).

manipulating space and mass

Space is created by eroding volume, enlarging, deepening, switching and stacking. Spatial differentiation is made by separations in space, for instance with walls and floors. Both means we also easily associate with the concept of density. With floors you can stack and create literally more usable surface area, with walls the space is compacted and different functions and activities take place independently yet take place closer together. The volumes studied in the mathematical model - point buildings, patio buildings, block buildings and strip buildings - are basically simple extrusions of plan or section, of straight solid stacking or cross-sectional extrusions. Subsequently, it is also possible to make towers or strips bend, rotate along the longitudinal axis, grow or just waistline. Taking it a step further, the flat can be laid out on the ground like a letterbox, as a slab building, or other 2d circuits. That flat, too, can then be curved. Volumes not straight on top of each other, but stepped stacking, in two, but also in three dimensions, like a three-dimensional checkerboard. Or even more dynamic, rotating them as well. Thus creates emptiness under mass, in the form of gates or extra-high spaces. In a more or less reversed process also assume mass instead of space be assumed. By strategically placing gaps creates an urban fabric like a kind of sponge or hole cheese.

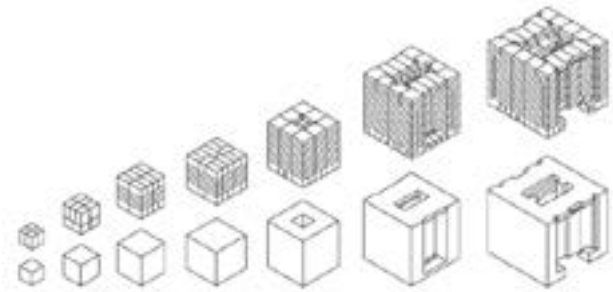
rebuilding in the city: block library

At the TU Delft Faculty of Architecture, research has been done with students to come up with new building typologies. Typologies that as it were, must be found among the standard types. must be found. To this end, a three-dimensional matrix was developed in which, in a systematic manner, 880 volumes have been explored. The smallest volume is 5 x 5 x 5 metres, with increments of 5 x 5 x 3 increased to the maximum volume of 50 x 50 x 50 metres. Subsequently, the volumes thus created requirements regarding daylight access and the most efficient means of access.

research and results

To explore the relationship between urban densities and building shapes, a computational model was developed at TU Delft developed a mathematical model that is available via the website available to anyone. Patio buildings are found to have the highest Floor Space of the four of the four building patterns studied, patio building has the highest Floor Space index (fsi). Not surprisingly, as with patios, the mass can be closely pushed together, and the fsi increases when building masses are raised and/or deepened. Growth does not appear to be linear, proceeding from a certain point so slowly, that

Block library: in the increasing range of possible building volumes from 5 x 5x 3 m to 50 x 50 x 50 m, 880 positions are conceivable that have been filled in by students with possible housing arrangements: the exercise depicted with point buildings can be repeated for strip buildings, building blocks and patio buildings



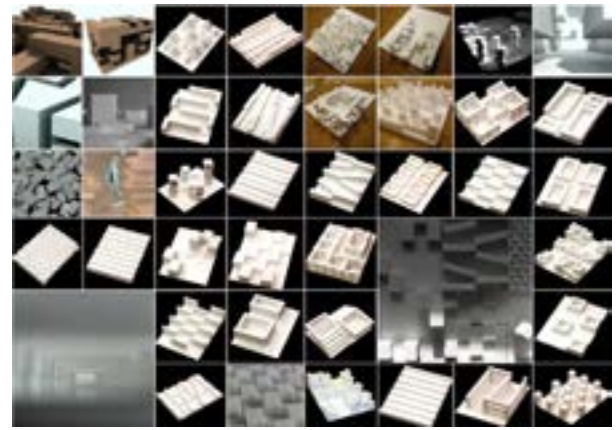
Website of possibilities

In order to use the matrix in a quick a spatial navigation system has been developed, for which a dedicated website is being developed. Volumes (building types) can be easily be selected. Datasheets and graphs make the efficiency clear. Comparison with another building type is quickly made. The computer programme provides a new palette of sensible hybrid residential buildings - hybrid in the sense that we do not belong to one standard type, but also not to another either. To meet the new demands of users and at the same time make the city liveable again and as rich as before, we will have to move more and more into this area of hybrid types. Actually, this has been happening for some time. Over the last decade we are already seeing all kinds of buildings appearing that no longer fit into the suitcase of standard solutions of the urban planner fit: back-to-back patio types on Borneo Sporenburg, superblocks on Java island, tall patio blocks on Funen (Amsterdam) and thick towers on Mullerpier (Rotterdam).

building even higher or deeper building no longer makes sense.
Even more remarkable is the relationship between point building and density: towers yield the lowest fsi. Moreover, building higher with this type does not always lead to higher density. Building deeper does have this effect. At any building depth, a certain number of layers yields a maximum fsi. As is known, the fsi makes the relationships between building typology, height, depth and possible densities. But the index does not say very much about the quality of the city: Whether a city captivates depends on its density but certainly also on the compensations offered for this offered. We have 'discovered' combinations of depth and number of layers 'discovered' where with the checkerboard pattern higher densities than with the strip, block and patio buildings.

how to use the calculation model as a tool

When certain urban planning assumptions are known, such as a desired fsi, a maximum building height or a desired building depth, the calculation model can be used to can be used to investigate the possibilities offered by different building types offer. When for example, an fsi of 2.5 is desired, the the mathematical model shows that for patio buildings a minimum of three storeys high and four metres deep should be built. To achieve the same fsi with a point building, it is necessary to build at least four layers high. The building mass should then be 30 metres deep. By juxtaposing the four types of buildings in this way each other in this way, well-considered well-considered considerations about the types to be realised. Urban development plans are thus drawn from the more or less intuitive; they can be substantiated with numbers. high-density low-rise buildings Like a grocer, almost all plans try to get net-to-gross ratio high, to budgeting on net metres. Asking the estate agent 'what does a sqm do in this area', because that's what the sales/ rental budget determined, and the construction budget. If I can get more net metres into less



gross metres, I keep more money for the facade. The whole national policy is driven by the idea that the terraced house is what people want. But that necessarily leads to residential environments that are up to densities of 40 dwellings per hectare. That is why at tu Delft and at my office in Amsterdam pay a lot of attention to exploring the possibilities of high-density low-rise buildings. We are studying the possibility of also making more than 40 won/ha with ground-level housing. Could that number also go to 50, 60 or 80 won/ ha? go? I think it could even go up to 100 won/ ha could go up, although this depends on the housing size. In Almere, 40 won/ha applies, a Duivesteijn spreadsheet that you can go sliding with: residents may sit at the slide. The Hague and Rotterdam are more densely built-up than Amsterdam, in number of inhabitants per hectare across the whole city. Utrecht is also very dense. See profiles across different cities! What do cities spend their space on? The moment you start making observations with it do, can parlay this kind of speculation with coherent ratios, the the mathematical model also becomes a design tool and it comes to life.

quality as compensation for density

The advantages of building in high densities are obvious. It is the only way to prevent the land from silting up and leaving no space for landscape, cultivated land and (possibly) expansion. In the city, density also ensures a more efficient use of space: higher density has relatively less land, roads and infrastructure (pipes, lighting) needed. Not danger-free: in extremely dense cities, for example, orientation can be tricky be. Offering different views within the field of view not only makes the city more fascinating, but also insightful as a whole: an important spatial quality. In addition, a city should remain dynamic, never reaching a reach a final form. The city is constantly subject to change in a process of urbanisation. The urbanite who moves through the city moves through the city perceives the city in three dimensions and in time. There is structure and order: orientation in the city both by space (streets, squares) and by mass (buildings): prominent buildings, streets and squares. Too easily rememberable and legible is boring. Variation we want to see, especially when the same road is travelled more often. Staging the view in urban space. Balance between legibility and variety, reassurance and stimulation, order and surprise. buildings: projects that are illustrative for the mathematical design methods presented in this book. Supplementing the publication, a special tu website enables urban planners and architects to apply the Uytenhaak method method themselves in design practice.